2013.1 - Grade A & B Proposals

2013.1.00001.S

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COI	van der Werf, Paul	EU	Netherlands	Leiden University
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COI	Ibar, Edo	CL	Chile	Valparaiso, University of
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COI	Michalowski, Michal	EU	United Kingdom	Edinburgh, The University of
COI	Arumugam, Vinodiran	EU	United Kingdom	Edinburgh, The University of
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Title

Witnessing the birth of the red sequence: the physical scale and morphology of ultra-red starbursts

Abstract

We have defined a large sample of galaxies that are both faint (ergo unlensed - in this regime we cannot afford the vagaries of galaxy-galaxy lens model reconstruction) and extremely red (ergo very distant). We then further refined our sample via SCUBA-2 imaging, rejecting z<4 interlopers. The remaining galaxies represent the most intense starbursts in the z>4 Universe - the precursors of massive galaxies on the red sequence.

Our goal here is to fully and directly characterise the physical scale and morphology of the dust in the 30 faintest and reddest of these z>4 starbursts - the first time a significant sample of such distant systems has been imaged interferometrically. Is the physical distribution of the dust best modelled as a compact, optically thick disk, as with local ULIRGs, or by a more extended optically thin disk, like local spirals? Is the Schmidt-Kennicutt law different in such young galaxies? What drives these early starbursts - major mergers, or the steady accretion of gas onto a disk, or perhaps something unexpected?

Via the relatively simple observations proposed here, ALMA will reveal the manner in which the ancestors of today's massive galaxies were formed.

2013.1.00008.S

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Title

Toward Resolving the Magnetic Flux Problem in Star Formation: Mapping Poloidal B-field in Edge-on Disks

Abstract

Poloidal magnetic field is expected in protostellar disks, if magnetic flux is dragged into the disks from star-forming dense cores. Such a poloidal field can play a key role in disk evolution and jet launching. However, direct evidence for its existence has been lacking. Here, we propose to detect and map the poloidal field in the young, edge-on, and resolvable disks in two nearby disk-jet systems, HH 212 and HH 111, using polarization observation of thermal dust emission. If detected, it would mean that some of the core magnetic flux is indeed dragged into the disks and the poloidal field can indeed play a key role in both disk evolution and jet launching. A negative result would cast serious doubt on the poloidal-field driven disk evolution and jet launching. It would also imply that the long-standing ``magnetic flux problem'' is somehow resolved at large distances beyond the disks, so that none of the core magnetic flux is dragged into the disks. To have the best chance of polarization detection, we request 1 Science Goal in TDM in Band 7 at 345 GHz at 0.16" angular resolution. If succeeded, we would produce the first maps of poloidal B-field in young disks.

2013.1.00014.S

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Title

How big is the AGN obscuring torus?

Abstract

Unification of active galactic nuclei (AGN) is based on toroidal obscuration of the nuclear activity, which is powered by accretion onto a supermassive black hole. Understanding of the nature and origin of the obscuring torus requires reliable measurements of its size to determine whether it is within the gravitational sphere of influence of the black hole or of the galactic bulge. Thanks to its high spatial resolution and sensitivity to the thermal dust emission, only ALMA is capable of determining the torus end point. Here we propose observations of the archetypal Seyfert 2 galaxy NGC1068 in ALMA bands 7 and 9 to measure the radius of the obscuring torus and determine the radial profile of the toroidal cloud distribution. According to our radiative transfer calculations, these ALMA bands are within the wavelength range where the differences between continuous and clumpy torus models are maximized. Indeed, detailed simulations of the proposed observations show that by measuring the extent of continuum emission we will be able to assess the torus structure and distinguish between proposed models for the AGN torus.

2013.1.00018.S

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Title

Understanding the Origins and Dynamics of the Multiple Outflows Around IRAS 16293-2422

Abstract

Jets and outflows are the most obvious signposts of ongoing star formation, when the accretion during the Class 0 phase powers bipolar ejections perpendicular to the forming disk. Many nearby star-forming regions show multiple bipolar outflows coming from a single protostellar core, which is a sign for the formation of multiple protostars. This proposal aims at getting the first complete picture of the interaction, morphology and kinematics of outflows within such a protostellar system.

We target IRAS 16293-2422, one of the best-studied Class 0 systems. It consists of a protobinary (Source A and B), separated by 600AU. Source A is also a binary system with a separation of 36AU. Our aim is to fully resolve all known sources and their outflows in both the velocity and spatial domain to understand the interplay between the outflows, the ambient medium and the forming stars.

To pursue that goal we target CO(3-2) and 13CO(3-2) - to get the full dynamics of the outflow - CS(7-6) and C34S(7-6) - to get the infall motions towards the sources, and the dynamics of the dense gas in the disk - and SiO(8-7) - a shock tracer to understand the interaction of the outflows with the quiescent gas.

2013.1.00020.S

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Title

Hydrides as diagnostic tools for the z=0.89 absorption toward PKS 1830-211

Abstract

The z=0.89 molecular absorber toward the quasar PKS 1830-211 is the best known source for obtaining very detailed information on the physical and chemical state of the molecular gas in the disk of a galaxy with a look-back time of more than half the age of the Universe. In ALMA Cycle 0, we observed strong absorption lines of most common interstellar molecules, revealing the absorption along the two lines of sight with unprecedented detail. Now, we propose to focus on hydrides, the key molecules at the root of the interstellar gas-phase chemistry, and use them as diagnostics of the physico-chemical gas properties. We will investigate the nature of the absorbing gas, the cosmic ray ionization state of hydrogen, the local turbulence, the hydride chemistry, and the cosmological enrichment of the interstellar medium.

2013.1.00021.S

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Title

NGC 4650A: the prototype Polar Ring Galaxy

Abstract

Polar-ring galaxies (PRG) are a unique class of objects, tracing special episodes in the galaxy mass assembly: they can be formed through galaxy interaction and merging, but also through accretion from cosmic filaments. In addition they are highly interesting to study the dependencies of the star formation laws on surface density and metallicity, and determine 3D-shape of dark matter haloes. We propose to map in the CO(3-2) line at high resolution the polar ring of NGC4650A, the prototype of the class. The polar disk is the most recently assembled sub-system, very rich in gas and where new stars are formed. We will determine the gas distribution and the star formation efficiency, with possible thresholds. The high resolution kinematics of the molecular gas, predominant in the central parts, will precise with more accuracy the determination of the 3D-potential, already tackled through optical, near-infrared, and HI-21cm data. Through comparison with numerical models this will help to deduce the dark matter content and the halo 3D-shape.

2013.1.00025.S

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COI	Wilner, David	NA	United States	Harvard-Smithsonian Center for Astrophysics

Title

The Origin of Debris Rings: Planets or Gas?

Abstract

Imaged in scattered light, the bright dust rings around the 10Myr old stars HD 181327 and HR 4796A appear unusually narrow, with steep radial brightness profiles compared to other disks and theoretical expectations. The origin of these rings is unknown; they may be true debris disks where dust is created in collisions between large planetesimals, but may be a product of dust-gas interaction. Both disks also show departures from symmetry that may indicate the dynamical influence of planets, but could alternatively arise from dust-gas interaction. These scenarios have observable differences, which can only be tested with ALMA. We propose to use ALMA for 3.7h to image these two sub-mm bright rings to i) compare their radial extent to the scattered light emission to distinguish between collisional debris and gas-driven ring scenarios, ii) conclude whether the rings are truncated by planets, iii) use observed asymmetries to draw conclusions about the possible dynamical influence of planets, and iv) detect CO gas that may point to a gas-driven scenario. These results will shed light on the status of planet formation at 10Myr, shortly after dispersal of the gaseous protoplanetary disk.

2013.1.00031.S

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COI	Li, Zhi-Yun	NA	United States	American Astronautical Society
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COI	Segura-Cox, Dominique	NA	United States	Illinois at Urbana-Champaign, University of
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Title

Are Close Binaries Formed through Disk Fragmentation?

Abstract

Over 50% of sun-like stars are found in binary/multiple systems.
Their formation is thought to occur during the early stages
of the star formation process, but the formation mechanism
remains unclear. The most likely possibilities are either disk
fragmentation or turbulent fragmentation with dynamical evolution.
To understand protostellar multiplicity, we have conducted a
VLA 8 mm survey of all protostars (N~80) in the Perseus molecular

cloud (d=230 pc) at a resolution of 0.3" (70 AU). With this unprecedented survey, we identified 17 close proto-binary systems with separations less than 500 AU, and of these, 14 are new discoveries. While these detections are significant, the VLA data do not convey their formation mechanism. Therefore, we propose to use ALMA to observe dust continuum and molecular line emission (C18O, 13CO) toward these 17 sources to determine if these sources have circumbinary disks in the apparent dust continuum and we will use the molecular line maps to determine if the disks are rotationally-supported. This sample is large enough to reveal general trends as to whether or not binaries typically form via disk fragmentation or turbulent fragmentation.

2013.1.00032.S

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Title

AGN feedback and molecular line flux ratios in infrared luminous dusty galaxies

Abstract

We propose molecular line observations of nearby infrared luminous dust/gas-rich galaxies for which the relative energetic importance of AGN and starburst has been quantitatively well-calibrated through previous infrared spectroscopy. Using different feedback from AGNs and starbursts to the surrounding molecular gas, we aim to establish a reliable method to scrutinize optically elusive buried AGNs in dusty galaxies, based on bright molecular line flux ratios at the dust-extinction-free (sub)millimeter wavelength. Our pre-ALMA and ALMA Cycle 0 observations have shown that enhanced HCN emission is empirically an excellent AGN indicator, but its physical origin is unclear. We propose ALMA Cycle 2 observations of these well-calibrated galaxies, at multiple transition lines of HCN/HCO+/HNC, in order to clarify the physical origin (i.e., an HCN abundance enhancement or excitation effect). Our (sub)millimeter energy diagnostic method using bright molecular lines, once established, will have a large potential to understand the interplay between suparmassive blackholes and star-formation in distant infrared luminous galaxies, which are known to dominate the cosmic dust-obscured activity.

2013.1.00033.S

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Title

The role of infrared radiative pumping for molecular gas emission in AGNs

Abstract

We propose to thoroughly investigate the strengths of the vibrationally-excited (v2=1f) rotational (J)-transition lines of HCN, HCO+, and HNC lines, in the two AGN-hosting, narrow-molecular-line, luminous infrared galaxies which show detectable HCN v2=1f J=4-3 emission lines. Our immediate objective is to investigate whether an infrared radiative pumping mechanism indeed works more effectively for HCN than HCO+ and HNC, and is responsible for the enhanced HCN emission observed in AGNs, as proposed by theories. ALMA's high-spatial-resolution (<0.6 arcsec) is crucial to probe only AGN-affected molecular gas emission at galaxy nuclei, with minimum contamination from spatially-extended starburst activity in host galaxies. ALMA's high sensitivity (better than a few mJy noise level) is indispensable to clearly address this issue. Our ultimate scientific goal is to establish a physically-understood reliable tool to separate AGNs from staburst using bright (sub)millimeter molecular emission lines, which can be used to understand the physical nature of dust/gas-rich infrared luminous galaxies from the local to distant universe.

2013.1.00034.S

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Title

Evolution of ISM in Star-Forming Galaxies at z = 1 - 5

Abstract

We propose to measure the ISM contents of 180 galaxies at z ~ 1.15, 2.2 and 4.8 -- sampling both the normal star-forming galaxy main sequence and the starburst population with IR luminosities elevated up to 20 above the main sequence. The sample is stellar mass selected at 0.3-4x10^11 solar masses. The ISM masses will be determined from ALMA Band 7 & 6 continuum observations which measure the long wavelength, optically thin dust emission -- this technique has major advantages compared to CO line measures: avoidance of the CO conversion factor issues (i.e. dependence on excitation conditions -- temperature, density and metallicity) and much greater speed (approximately 10 times faster to the same mass limit). With these ISM masses for statistically meaningful samples, we can determine the gas mass fractions as a function of redshift and stellar mass and also investigate the elevated star formation activity above the main sequence. Is the enhanced activity due to larger ISM masses or enhanced efficiency for conversion of gas to stars?

2013.1.00041.S

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COI	Struck, Curtis	NA	United States	Iowa State University
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Title

Star Formation, Shocks, and AGN in a Pre-Starburst Galaxy Collision

Abstract

We propose an ALMA CO(1-0) map plus three HCN(1-0) and HCO+(1-0) pointings of the pre-starbust interacting galaxy pair IC 2163 and NGC 2207. CO will trace the total molecular gas distribution and kinematics. HCO+ and HCN will spatially resolve excesses of dense gas to relate to nuclear flows, turbulence, large-scale shocks, and local star formation rates. Line ratios in these AGN and AGN-free nuclei will probe the link between dense gas reservoirs, nuclear star formation, and black hole activity. Starburst activity in galaxy mergers can be driven by nuclear flows, gas fragmentation, and large-scale shocks, and can be balanced by feedback from young stars and black holes. The role of these mechanisms in boosting star formation efficiency in mergers is poorly understood. This galaxy pair offers an ideal laboratory to study these phenomena. Their grazing collision has increased gas turbulence, produced Super Star Clusters and shocks, and fueled nuclear activity. It is well observed and modeled, with HST optical, SST infrared, XMM X-ray, VLA 21 cm emission and 6 cm and 20 cm continuum, Herschel PACS and SPIRE broadband data, and simulations fitting over 30 features.

2013.1.00046.S

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Title

The molecular jets of the proto-planetary nebula HD101584

Abstract

It is well established that bipolar jets dominate the rapid transition from the asymptotic giant branch (AGB) to the planetary nebula (PN) phase and it is widely conjectured that the jets are driven by interactions with a binary companion. HD 101584 is among the most powerful proto-PN jet systems, and is unique in having a companion that was engulfed by the AGB star and ejected the stellar envelope during the interaction - and survived. We propose to observe the HD 101584 system in the 12CO, 13CO, and C18O 2-1 lines to image the ejection geometry at high resolution, to determine the kinematics of the outflows, and to measure the energetics of the ejected components. Comparison with the envelope binding energy and the in-fall energy released by the companion will provide valuable constraints on models of the binary interaction mechanism.

Essentially the same proposal was accepted as a filler project in Cycle 1 (2012.1.00248.S). This proposal can therefore be removed should the Cycle 1 observations be carried out fully.

2013.1.00047.S

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Title

Accretion in the Mira binary system

Abstract

We propose to make the first direct observations of the capture of molecular gas and the formation of an accretion disk in a binary system, using the nearby double star Mira. Mira is a well-known, mass-losing giant with strong circumstellar CO emission. It is orbited by a white dwarf companion at a separation of 0.5". The companion gravitationally captures the mass-loss of the primary and forms an accretion disk. We propose to measure the accretion stream onto the companion in the CO (3-2) line and the spectrum of the accretion disk in the continuum. These observations will provide crucial information on key aspects of stellar evolution that have never been observed before, and particularly will be used to test competing models of capture in detached binaries. ALMA makes this uniquely possible in a system where the components can be resolved.

Keywords: Evolved stars - Shaping/physical structure, Asymptotic Giant Branch (AGB) stars.

2013.1.00048.S

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Title

Physical properties of an accretion disk around Orion Source I

Abstract

We propose high resolution multi-transition observations of vibrationally excited H2O lines in a circumstellar disk around a massive YSO Source I in Orion KL.

In ALMA cycle 0, we detected a vibrationally excited thermal H2O line at 336 GHz (excitation energy of 2939 K) for the first time in Source I. The velocity centroid map of the 336 GHz line is elongated with a size of 0.2". Most importantly, it shows a clear velocity gradient perpendicular to a bipolar outflow, implying a rotating ring-like structure with an enclosed mass of 7 Solar masses. The spectral profile can be reconciled with an excitation temperature of >3000 K possibly heated via accretion. However, due to the limited resolution (0.4"), derived parameters would contain large uncertainties. Moreover, the temperature of the H2O gas could not be obtained by excitation analysis due to a lack of multi-transition data.

Vibrationally excited thermal H2O lines can be unique tracers to reveal the hot molecular disk around Source I. Our observations will allow us to derive its detailed properties such as size, mass, temperature, density, and H2O abundance, which are crucial to understand accretion processes in the disk.

2013.1.00053.S

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Title

A search for the elusive sub-mm polarisation in protostellar disks

Abstract

We propose to use ALMA in its narrow-field polarimetry mode to detect sub-mm polarized emission for the first time in a protoplanetary disk. ALMA's high resolution will avoid smearing out of the polarized signal, giving a 5x improvement in beam size and a factor of 100 improvement on the polarised flux over previous studies.
The well-studied nearby disk HD163296 is ideal for this work, and we will image the polarisation out to a radius of 145AU to 0.3% rms, giving 60 vectors over the map and 12-15 vectors at the ALMA polarisation sensitivity limit of 0.1% (out to 100AU radius).
The orientation and structure of polarisation vectors will allow us to pinpoint the grain alignment mechanism and the degree of alignment and grain non-sphericity. Even a non-detection will provide stringent limit on the shape of mm-sized grains, turbulent mechanisms hampering grain alignment and upper limits to alignment mechanisms.

2013.1.00055.S

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Title

The footprints of SF and AGN activity in NGC1068 (II)

Abstract

We propose to map the emission of a set of dense molecular gas tracers (CO(6-5), HCN(1-0), HCO+(1-0) and
CS(2-1)) in NGC1068 using the unique spatial resolution (0.1"-0.5") and sensitivity of ALMA. The science case of this project builds on the results of our successful Cycle 0 project. These data have revealed that the kinematics of the molecular gas in the circumnuclear disk (CND) are driven by an AGN-powered outflow
from r~50pc to r~300pc. The new 12CO(6-5) maps proposed in this follow-up will offer an unprecedented view of the gas flows in the central r~35pc of NGC1068 with a spatial resolution of ~a few pc. This will allow us to study the expected signature of gas inflow closer to the central engine and to spatially resolve the emission of the torus. We also propose to map the emission of HCN(1-0), HCO+(1-0) and CS(2-1) with a
0.5"(35 pc) spatial resolution in a larger area that extends out to the starburst ring. The new maps will be combined with the Cycle 0 maps obtained for the mid-J transitions of the same species, a crucial step to characterize the changes in the excitation and chemistry of the dense molecular gas on critical scales in and around the CND.

2013.1.00056.S

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Title

Anatomy of a mid-life crisis: can sigma Orionis disks still make Jupiters?

Abstract

The prevalence of extrasolar Neptunes, with masses that are large enough to undergo runaway growth in the presence of gas suggests that the timescale for planetary core formation and disk gas dissipation must be quite similar. We propose to examine this directly by measuring the dust and gas content of circumstellar disks in the middle-aged sigma Orionis cluster. The sample consists of all 92 known members of the cluster with Spitzer mid-infrared excesses. Our previous JCMT/SMA observations show that disks have low, but detectable, dust masses and are associated with gas. With a 5-sigma detection of the mean level of continuum emission, we will obtain Earth mass dust sensitivity and expect to detect many sources. We will also independently achieve Jupiter mass sensitivity in the gas through observations of the 13CO and C18O 3-2 lines. This sensitive, uniform study of a large, similarly aged sample will be a benchmark for disk evolution studies and inform planetary synthesis models. If insufficient gas remains in these middle-aged disks to form Jupiters, we will be able to place firm limits on the formation history of our Solar System.

2013.1.00059.S

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COI	Riechers, Dominik	NA	United States	Cornell University
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Title

Resolving the molecular gas and dust in a unique star forming disk galaxy z~2

Abstract

We propose to obtain simultaneous high-resolution imaging of the CO 4-3 and [CI] 1-0 emission lines and dust continuum in the best characterized star-forming disk galaxy at z~2. These observations will provide a unique test on the predicted modes of gas accretion by resolving the kinematics and distribution of the molecular gas into kpc-scale regions of active star formation. This will enable an unprecendented view to the obscured star-forming regions that are hidden to the available optical/UV imaging and spectroscopy. We will be able to (1) perform accurate modeling of the galaxy kinematics (kinemetry); (2) characterize the molecular gas and star forming clumps; (3) test star formation laws (gas vs SFR surface densities) in kpc scales, and (4) use their line ratios as a proxy to the fraction of dense gas mass (versus total) to probe the gas excitation in kpc scales. In combination with the previous measurements of CO 3-2/1-0, the proposed observations will allow us to put into context the derived physical properties of the ISM (Tkin, n_H2) for a comprehensive study about the properties of this galaxy.

2013.1.00060.S

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Title

Physical and Chemical Properties of Giant Molecular Clouds in the Starburst Ring of NGC 1068

Abstract

We propose the band 3 observations toward the central ~1' diameter region of NGC1068 with high spatial and velocity resolution (1.1"=80pc and 1.3 km/s) in the 13CO(1-0), C18O(1-0), CS(2-1) and CH3OH(2-1).

Using ALMA CYCLE 0 DATA for the central ~1' region of NGC 1068, systematic spatial variations of the CS/13CO and CH3OH/13CO are found at the GMA-scale (~ a few 100 pc), alhtough the observed C18O/13CO are found to be fairly uniform. We find that CH3OH/13CO is decreased in the bar-end regions where active star formation occurs, suggesting that the production of CH3OH is suppressed there due to high dust temperature (>20K).

Clearly, the next step is to study the chemical and physical properties of ISM in the GMC-scale (<100 pc) and their relation to the global scale (> kpc) structures in galaxies. The primary goal of the proposed study is to identify GMC-scale clouds in optically-thin tracers and study a GMC-scale variation of chemical and physical properties across the disk region. We will verify our scenario on the CH3OH/13CO ratio variations in GMC scales.

2013.1.00061.S

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Title

Investigating the water deuteration in a young protostellar system

Abstract

The evolution of water from its formation in the molecular cloud until its incorporation in the protoplanetary disk and then comets and asteroids is still unclear. Measuring the water D/H ratio is particularly helpful to answer this question. We propose to carry out multi-line observations of the water isotopologues (HDO, H2-18O and D2O) at high spatial resolution (0.3arcsec, 35 AU diameter) towards the inner regions of the well-known Class 0 protobinary IRAS16293-2422, which is now possible thanks to the enhanced capabilities of ALMA cycle 2. Through the study of the kinematics and the determination of the HDO/H2O and D2O/H2O ratios with radius from the protostars, we can determine if the water present at the Class 0 stage was preserved or reprocessed until its incorporation in disks and primitive icy bodies. The data will also allow us to determine the mechanisms that control the water vapor abundance in the warm inner regions of Class 0 protostars.

2013.1.00063.S

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Title

Resolving SN1987A: a detailed look at a unique laboratory of shock, dust, molecular, and nuclear physics

Abstract

Supernovae drive the evolution of the ISM: they disperse heavy elements, inject mechanical energy, accelerate energetic particles, and create molecules and dust. SN1987A was the closest SN explosion to Earth observed since 1604, a unique target to study supernova and SNR physics.

We will build on our Cycle 0 observations of strong CO and SiO emission, and exploit the high angular resolution of Cycle 2 to create the first 3-d resolved maps of these species in the ejecta of SN1987A, and the temperature and density of the ejecta. We will resolve the predicted clumpy structure, constraining instabilities that occurred during and shortly after the explosion.

We will simultaneously image the high-frequency continuum. Our Cycle 0 observations found a very large mass of dust formed in the ejecta. The relative distribution of dust, CO and SiO emission will constrain dust composition and formation physics.

A high-frequency spectral index map will help resolve the mystery of whether particles are accelerated at the forward or reverse shock, how that nonlinear particle acceleration changes as the shocks interact with the dense circumstellar ring, and the nature of the compact remnant.

2013.1.00071.S

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Title

Resolving the atomic gas accretion flow surrounding the SgrA*

Abstract

The Galactic center uniquely provides the opportunities to resolve how the supermassive black hole accrete in inner than 5 pc scale. Our previous GBT-100m and SMA observations of molecular lines have resolved that the well-known 2-4 pc Galactic circumnuclear disk (CND) may be the convergence of several >2 pc scale molecular gas streams. The ionized mini-spiral arms in the inner ~1 pc radius further indicated that part of the molecular gas streams may penetrate inside the CND. However, the previous 22" resolution OI line observations suggested that the ionized mini-spiral arms may be merely the ionized rim of the ~10 times more massive atomic gas streams. In this proposal, we want to take the advantage of the new CI observation capability of ALMA Band8, to resolve these atomic gas streams at a subarcsecond resolution. The aim of this proposal is to unveil detailed morphology and kinematics of the atomic accretion flows for the first time, and will diagnose from both spatial distribution and the observed velocity, how the atomic gas survive the ionizing flux when approaching the central OB cluster and the black hole.

2013.1.00073.S

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Title

A Search for Molecular Gas in the Circumnuclear Disk of M87

Abstract

We propose to search for CO(J=2-1) line emission from the circumnuclear disk of M87 to test theoretical models of accretion flow to supermassive black holes. Optical emission lines from atomic gas in this disk have been observed with HST. The model of Tan & Blackman (2005) predicts that this disk, accreting at the Bondi rate from the surrounding hot, X-ray emitting gas, should be gravitationally unstable and thus form stars via molecular clouds. Such a model may help explain why the system is underluminous compared to standard thin accretion disk models. A search for CO(J=2-1) emission with the SMA (Tan et al. 2008) has placed upper limits on the molecular gas content of the disk of ~8x10^6 Msun. In fact, weak (up to ~4 sigma) emission features were seen in the spectrum at the expected velocity, which, if interpreted as CO(2-1) emission, imply a gas mass of ~5x10^6 Msun. The proposed ALMA observations will achieve a factor of ~10 increase in sensitivity compared to the SMA observations. If the SMA-observed emission features are real, then ALMA will make a definitive detection, which would have important implications for our understanding of supermassive black hole accretion.

2013.1.00080.S

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Title

Spatial Structure of the Brightest Unlensed Submillimeter Galaxies

Abstract

Distant SMGs represent the most massive of the young galaxies rapidly building up their mass in the early universe. Their importance in terms of understanding the cosmic stellar mass build-up history is amplified if they represent the pinnacle of the ``cosmic downsizing'' phenomenon. Here we propose to investigate detailed spatial distributions of dust in the intrinsically most luminous SMGs as a direct test of how such extreme starbursts can be fueled and sustained. We request 3 hours of ALMA Cycle 2 time in band 7 at 0.13" resolution. As demonstrated by our simulated observations of the Antennae galaxies, the high angular resolution and high sensitivity possible with ALMA Cycle 2 are required to address this question properly, and only the most intrinsically luminous SMGs can be studied this way even using ALMA. Whether mergers or cold flow accretion, the knowledge we will obtain through this experiment on the process responsible for supplying large quantities of material over a short period of time to these SMGs will also serve as a key process feeding the bulk of the stellar mass build up process among the less luminous starforming galaxies at the same epochs.

2013.1.00087.S

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Title

Multi-Phase Imaging of the Outflow from the Edge-On Starburst Galaxy NGC 3628

Abstract

We propose to observe an outflow from the starburst galaxy NGC 3628 with various molecular gas phase tracers. Some of the most important insights on the outflow phenomenon have come from the presence of molecular gas. Stars form from molecular gas, so the molecular outflows from starburst regions directly affect the star formation activities and galaxy evolution, since the outflowing features directly indicate the decrease of fuel for forming stars and the quenching of star formation. These weak features have, however, rarely been observed (and only with CO) with previous less sensitive telescopes. As a case study, we observe the outflow from NGC 3628 with the diffuse (CO), dense (CS), and shocked (HCN, HCO+, and SiO) molecular gas tracers to obtain the detailed characteristics of the outflow for the first time. Combining this data set with the previously published X-ray (plasma) and Halpha (ionized gas) images, we compare the results with our ionization/hydrodynamics code, which simulate the outflow including molecular gas and dust for the first time, and reveal the evolution of the molecular outflow and galaxy itself, and study the effects of the outflow on the disk material.

2013.1.00088.S

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Title

The Mass Accretion Reservoir Surrounding a Variably Accreting Young Star

Abstract

We propose to obtain band 6 continuum observations of the new FU Orionis object HBC722, which was first observed to flare in 2010 and remains in the elevated state to the present day. The flares associated with FUors are generally attributed to enhanced accretion from the surrounding circumstellar disk. Recent SMA and PdBI observations of HBC722 did not detect a circumstellar disk down to an upper limit of 0.02 solar masses, already making it the lowest mass FUor disk known by at least a factor of 3. Our proposed observations will provide approximately 50 times better mass sensitivity than possible with the SMA or PdBI and will probe down to a disk mass of 4.2E-4 solar masses. With these data we will study the physical properties of the HBC722 disk, the evolutionary status of HBC722, and the driving mechanism of the current flare.

2013.1.00092.S

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Title

How do massive star forming galaxies at the peak of cosmic star formation shut down?

Abstract

Throughout cosmic time, the bulk of field star-forming galaxies (SFGs), which form a fairly tight sequence in stellar mass versus star formation rate (hereafter, "main-sequence"),grow by gas accretion/minor mergers and in-situ star formation until their stellar mass exceeds the Schechter mass, logMS*~11, at which point they rapidly shut down and join the red sequence. Why is this so? We propose to measure CO-based molecular gas fractions and gas depletion time scales of a statistically significant sample of massive (M*≥MS) z~2 SFGs that are below the main sequence and thus should be in the process of transitioning to the red sequence. The proposed observations, along with our other data of SFGs at z~1-2 above and on the main sequence, will test for two main proposed INTERNAL quenching mechanisms. Rapidly dropping gas fractions below the main sequence would favor AGN feedback driving the shutdown. Rapidly increasing depletion time scales would favor morphological quenching, where the buildup of a massive bulge/spheroidal component acts to stabilize the galaxies against global gravitational instabilities,as a key player.

2013.1.00095.S

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Title

Tracing the evolution in the interstellar medium of galaxies from z = 0.2 to z = 1

Abstract

The steady decline in the cosmic star formation rate density at z < 1 hints at a fundamental change in the processes that regulate star formation at this epoch. Star formation rates, merger rates, and galactic structure all evolve dramatically over this half of cosmic history. It is not understood whether this evolution is primarily due to a decline in the gas supply in galaxies or lower efficiency at which they can convert the interstellar medium into stars. We propose to measure the mass of the interstellar medium in a representative, statistically signifiant sample of 200 galaxies from z = 0.1-1 through ALMA observations of their 850 micron dust continuum emission. Our goal is to study the interstellar medium in both main sequence and starburst galaxies in order to study which mode of star formation dominates as a function of redshift during this critical epoch.

2013.1.00096.S

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Title

The Lowest Metallicity Molecular Clouds

Abstract

The structure of star-forming clouds at low metallicity is predicted to be different from that at high metallicity. As the metallicity drops, the cold and dense, CO-emitting part of a cloud where stars form shrinks relative to the warm photo-dissociation region (PDR) around it. The H_2 part can become much more extensive than the CO, and the HI layer around all of this can be more extensive still. We propose to obtain 12CO(1-0) maps of 3 metal-poor dwarf galaxies that span a range of metallicity down to 5% of solar. For these regions we also have Herschel maps of the PDRs and VLA maps of HI at high spatial and velocity resolution that show the cloud and its relation to the rest of the galaxy. The sequence of molecular clouds at decreasing metallicity will show us the changing cloud structures and allow us to calibrate the CO fractional mass. We will also address the question of what effect the shifting boundary between HI, PDR, and CO has on the star formation rate per molecule. These data will test star formation models that include the formation of H_2 and will improve our understanding of star formation in the metal-poor early universe.

2013.1.00099.S

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Title

Dense Gas Thermometry of Starburst Galaxies

Abstract

A characterization of the physical properties of the dense gas within the interstellar medium of starburst galaxies is critical to our understanding of their evolution. Many of the molecular tracers used to characterize the dense gas in star-forming galaxies suffer from a coupled degenerate sensitivity to the kinetic temperature and volume density. A molecular tracer which can decouple individual physical conditions is required. Results from a survey of a sample of active star-forming galaxies has shown that Formaldehyde (H2CO) is a reliable and accurate density probe for extragalactic environments where the kinetic temperature is known. Ammonia (NH3) is a

traditional probe of the kinetic temperature in dense gas environments, but its utility requires an assumption of cospatiality between dense gas tracers is required. Using the unique sensitivities to kinetic temperature afforded by the excitation characteristics of several transitions of H2CO, we propose to continue our characterization of the dense gas in galaxies exhibiting starbursts by imaging the gas kinetic temperature in a representative pilot sample of three starburst galaxies: Arp220, NGC253, and NGC4945.

2013.1.00100.S

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Title

Feedback of planets on the protoplanetary disk: gas holes and dust traps in Oph IRS 48

Abstract

Planets form in disks of gas and dust around young stars, but little is known about their formation and properties at this early stage. In ALMA Cycle 0 we discovered a major asymmetric dust structure at 60 AU in the transition disk Oph IRS48 indicative of a dust trap which may be the site of planetesimal formation. Our Band 9 12CO 6-5 data also hint at density drops (signatures of one or more embedded planets) inside 60 AU. We propose here higher angular resolution and deeper observations of this fascinating disk, targeting the 13CO and C18O isotopologues of the 3-2 and 6-5 transitions in Band 7 and 9 at 0.2'' to measure the depth of the gap inside 60 AU and quantify any azimuthal asymmetries in the gas in the 60-100 region of the dust trap. We also request 12CO 3-2 observations at 0.12'' to measure the depth of the gas in the 20 AU gap. These measurements will give us direct insight in the properties of potential planets, their formation process and feedback on the disk. Finally, we will measure the wavelength-dependent azimuthal extent of the dust trap to test our proposed mechanism for the dust trap through combined observations of the Band 7, Band 9 and Band 4 continuum.

2013.1.00105.S

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Title

Completing the disk census in Taurus

Abstract

We propose to observe 69 single and multiple young stellar systems in Taurus to answer how protoplanetary disk mass depends on both stellar mass and multiplicity. While previous surveys have demonstrated a clear correlation between stellar and disk mass, most sources below spectral type M3 are undetected and it is not known if the same dependence holds down to the stellar mass limit. Our Cycle 0 observations of wide binaries in Taurus detected disk masses down to 10-4 MSun and revealed a range

of disk mass distributions. ALMA's unmatched combination of sensitivity and resolution enables us to observe a complete sample to tackle this issue; these systems will be observed at a sensitivity level over 10 times better than previous large surveys of this region. The sample has been chosen to provide complete coverage of all stars in the disk-only phase by targeting undetected single stars and undetected or unresolved multiple systems. Using these new 1.3mm (Band 6) continuum fluxes as a measure of outer disk mass, combined with the wealth of ancillary data on Taurus, we will be able to establish the influence of stellar mass and multiplicity on the potential for planet formation.

2013.1.00111.S

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Title

The extreme UV through ALMA's eyes: a unique probe of the ionizing power of starbursts and super massive black holes

Abstract

The extreme ultraviolet (EUV) of starforming and AGN sources cannot be probed directly from the ground or from space; their EUV are thus very poorly constrained. Our recent theoretical work demonstrates that the mm/submm recombination lines of HI and HeII are excellent probes of the EUV: they have little dust absorption, they arise from H and He (thus independent of metallicity) and their fluxes depend linearly on number of EUV continuum photons. The He++ region (producing HeII emission) requires 54 ev photons, thus the EUV hardness is directly proportional to the HeII/HI flux ratio.

We propose observations of HI and HeII in compact OB star regions and galactic nuclei (SgrA* and NGC 1068). These observations will demonstrate the potential of the HI and HeII lines -- opening a new observing window on the EUV. Themeasured hardness of the EUV spectra will provide critical input to starburstsynthesis models. Based on prior near infrared line detections, we confidently expect expect detectios of the line emission in both SgrA* and NGC 1068. In the former, ALMA will image the 10^4 K ionized gas at 0.2 arcsec resolution (0.01 pc radius) for the first time.

2013.1.00112.S

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Title

The mysterious gas in the 49 Ceti debris disk

Abstract

Debris disks stand between gas-rich protoplanetary disks and mature planetary systems, shedding light on the late stages of planet formation. Unfortunately, astonishingly little is known about their gas content. Only two debris disks out of hundreds known showed sub-mm CO emission detectable before ALMA, indicating that primordial gas has largely dissipated. However, there are puzzles about one that does show CO emission - the well-known bright disk 49 Ceti. Is it an extremely rare late-stage protoplanetary disk? Or is the gas coming from extrasolar comets, as in the case of the famous Beta Pictoris debris disk?

The mystery recently deepened with discovery of strong circumstellar atomic gas absorption in UV spectra of this edge-on disk. But no CO absorption was seen, showing that the atomic and molecular gas must have very different spatial distributions. This points to different sources for the two gas populations. We propose an ALMA spectral and spatial map of CI emission from 49 Cet. By comparing it to the coming ALMA CO map (scheduled in Cycle 1), we can disentangle the different gas components in this important disk system.

2013.1.00114.S

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Title

Origins of H2CO in protoplanetary disks

Abstract

Organic ices are the expected major reservoirs of volatile organic material in protoplanetary disks. Their distributions across disks are key to predict the organic composition of planetesimals, and thus the likelihood of organic delivery to terrestrial planets. H2CO is the only detected molecule in disks that may directly probe this reservoir of organic ices. H2CO can form together with CH3OH through CO ice hydrogenation, and this pathway followed by non-thermal desorption is the proposed dominant origin of observed H2CO gas in disks. We propose to constrain the relative importance of ice and gas formation pathways of H2CO in the protoplanetary disk TW Hya, by 1) imaging the H2CO gas distribution with respect to the known CO snowline location at ~30 AU, and 2) determining the H2CO/CH3OH abundance ratio. If H2CO gas originates from H2CO ice, it will only be present in a ring, with the inner edge at the CO snowline and H2CO/CH3OH~1. In contrast if H2CO is mainly a gas-phase product it will present a centrally peaked emission profile and H2CO/CH3OH>>1. The proposed observations will thus directly teach us what the origins of H2CO in disks are.

2013.1.00116.S

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Title

How Strongly are the 2 Known Class 0 Disks Magnetized?

Abstract

To date only 2 Class 0 objects have well detected, ~100 AU Keplerian circumstellar disks: L1527 and VLA 1623. Other sources with similar or better resolution observations do not exhibit clear Keplerian disks, e.g. L1157, down to 10 AU scale. What is the difference in these two populations? Although a very small sample so far, there is an interesting trend. The sources with 100 AU disks have inferred magnetic fields nearly perpendicular to their disk rotation axis, and the sources without detected 100 AU disks have magnetic fields nearly aligned with their outflow axis (a proxy for the rotation axis). This is suggested by many current theoretical simulations as magnetic braking reduces the angular momentum of material falling onto the disk, resulting in a smaller circumstellar disk: 10 AU or less compared to 100 AU. In this proposal, we request time to measure the dust continuum polarization in the 2 known 100 AU Class 0 disk systems at a resolution of 50 AU. With the ability to constrain the inferred morphology and magnetic field strength in the systems, we will make better theoretical models to investigate magnetic braking and the early disk formation and evolution.

2013.1.00118.S

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Title

Unveiling the population of high-redshift submillimeter galaxies with ALMA 1.2 mm imaging

Abstract

Submillimeter galaxies (SMGs) are dusty star-forming galaxies at high-z that directly trace the most intense episodes of stellar mass build-up in massive galaxies. Despite the large progress in understanding their properties, all we currently know about SMGs is severely affected by the biases imposed by the traditional radio/IR counterpart identification methods. We propose to perform ALMA 1.2 mm continuum imaging of a complete, flux-limited sample of 129 SMGs in the COSMOS field. These observations will allow us to find unambiguous counterparts and thus perform a critical, unbiased analysis of the SMG properties. Taking advantage of the unprecedented multi-wavelength and photometric redshift coverage of the COSMOS field, this will provide a legacy sample to study the cosmic evolution, dust properties, masses and environments of SMGs. Most importantly, we will quantify the intrinsic redshift distribution, providing a conclusive measurement to the abundance of SMGs at z>4. Finally, this study will illuminate the homogeneity or diversity of the SMG population, possibly changing our view of their evolution and role in the formation of massive ellipticals.

2013.1.00120.S

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Title

Dense Gas and Chemistry in the Super Star Cluster Environment of NGC 5253

Abstract

Nearby starbursts are forming super star clusters (SSCs), which in many respects appear to be newborn globular clusters. The super star clusters are expected to profoundly influence gas in their immediate neighborhood. Under such hostile conditions, one cannot expect star formation (SF) to proceed in the same fashion as it does in the Galaxy today. It is vital to characterize how SF does occur since every galaxy --- including our own --- goes through an epoch of globular cluster formation. The goal of this project is to use ALMA's great increase in sensitivity to investigate the properties of the natal dense gas toward the extremely young super star cluster forming dwarf, NGC 5253. NGC 5253 hosts the nearest (D = 3.5 Mpc), newborn (<2 Myr old), massive SSC. We propose to map the dense gas tracers, HCN(1-0), HCO+(1-0), CS(2-1 & 5-4), the photon dominated region tracers C2H(1-0 & 3-2) and the shock tracers SiO (2-1 & 5-4) and HNCO(4_04-3_03 & 12_012 - 11_011) on 60 pc scales. The maps will be used to characterize the location, amount, density and chemical properties of the dense gas that form and are influenced by these massive clusters.

2013.1.00122.S

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Title

Mapping the Gas in II Zw 40

Abstract

We propose to map CO(1-0), CO(3-2), and continuum in the dwarf starburst galaxy IIZw40, which appears to be highly efficient at forming stars. The goals are to determine gas masses, to constrain the star formation efficiency, and to look for evidence of radiative feedback in the form of hot, CO(3-2)-bright gas. Mapping at subarcsecond resolution is critical in the determination of efficiencies and line ratios.

2013.1.00126.S

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Title

Defining the Neutral Material which Survives to within 0.1 parsec of the Galactic Supermassive Black Hole

Abstract

Previous observations of hydrogen recombination lines toward the Galactic center detected ionized mini spiral arms, which appear to be material that is gravitationally accreted toward the Galactic supermassive black hole SgrA*. The new capabilities offered by Cycle 2 ALMA in band 9 allow us to probe the very hot neutral counterpart in the very central region. By observing the spatial distribution, the velocity, and the linewidth of this gas, we will determine how closely the hot neutral material can approach SgrA*, without being ionized, and to constrain the excitation conditions of this material within a ~0.1 pc radius. The optimal tracer of this material is multiple, highly-excited molecular transitions, which will better differentiate zone of different excitations, and provide more information on the kinematics of the accretion flow than observations of the hydrogen recombination line.

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Title

The Extinction-free Metallicity Indicator for High-z Galaxies: Its Calibration and Application at z=3

Abstract

Measuring the metallicity of galaxies at various redshifts is fundamental to investigate the physical process regulating the chemical evolution of galaxies. So far the metallicity of galaxies has been measured up to z~3.8; however, the conventional metallicity diagnostics exploit rest-frame optical emission lines, which prevent us from measuring the metallicity beyond z=4 due to the limited NIR atmospheric window. A more serious problem in the conventional methods is that they cannot be applied

to heavily-obscured dusty young galaxies, that are the crucial population to study the galaxy evolution. To overcome these problems, we have developed a new metallicity indicator that consists of FIR fine-structure lines, the flux ratio of [NII]205/[CII]157. In Cycle 0, we have shown that this ratio is fairly high in a galaxy at z=4.8, suggesting that massive galaxies experienced their major chemical enrichment at very high-z. Here we propose to calibrate this indicator by observing this ratio for z~3 galaxies, whose metallicity has been measured also by conventional methods. Once we calibrate this FIR metallicity indicator, we will establish the new way for metallicity studies beyond z=4.

2013.1.00146.S

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Title

A Molecular ALMA Deep Field in the UDF

Abstract

To date, our understanding of the molecular gas content in high-redshift galaxies is fundamentally limited by pre-selection of the galaxies at other wavelengths (optical/NIR/IR, sub-millimeter, radio). To overcome this, we propose an unbiased molecular deep field (CO spectral scan of band 3, covering all z>1) in the Hubble Ultra Deep Field. We will reach a molecular mass limit that is an order of magnitude deeper than previously possible, below the expected 'knee' of the CO luminosity function. We expect to detect >20 galaxies (both in line and continuum) and these detections will be compared to (1) our detailed SED modeling of all galaxies in the UDF (2) our analytic-empirical models that build on our current understanding of high-redshift molecular gas and (3) the latest adaptive moving mesh cosmological hydrodynamic simulations that include molecular gas. Stacking (both 2D and 3D) will push the statistical detection of sources to unprecedented depths. In summary, we will put unbiased observational constraints on the redshift-dependent CO luminosity function and meaningfully constrain the cosmic evolution of the universal molecular gas density for the first time.

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Title

Circumstellar magnetic field of VY Canis Majoris --the Extreme Red Supergiant

Abstract

We propose to make polarization observation of the peculiar red supergiant VY Canis Majoris to determine its true nature of cirsumstellar magnetic field. Comparing with our spectropolarimetric observations of SiO transitions, this ALMA observation will strongly constrain the mechanism which produces a high degree of polarization in the SiO emission observed in a wide range of energy levels.

2013.1.00148.S

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Title

Characterizing the disk & collimated outflow around a high-mass protostar using multi-wavelength interferometry

Abstract

In spite of its importance for astrophysics, the process through which massive stars form is only poorly understood. Recent VLTI near- and mid-infrared interferometry observations by our team allowed us to resolve the AU-scale circumstellar environment around the high-mass (20 solar-masses) YSO IRAS13481-6124, revealing a hot compact accretion disk around this object. Perpendicular to the disk plane, we detect a molecular outflow and two bow shocks, suggesting the presence of a collimated bipolar jet. We propose ALMA observations in various outflow- and disk-tracing lines and continuum emission that will allow us (a) to determine critical disk parameters, such as the outer disk radius and the total dust mass, (b) to search for kinematical signatures in disk-tracing emission lines, (c) to determine the jet collimation angle and other outflow properties close to the source. Our existing best-fit radiative transfer model suggests that the disk mass might be comparable to the mass of the central object, which could result in observable self-gravitating effects in the disk density structure.

2013.1.00151.S

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Title

The gas content and gas depletion time of massive, normal star forming galaxies beyond z=3

Abstract

We request rest-frame ~250um continuum observations of a complete sample of 86 massive (log(M_stellar/M_sun) > 10.5) normal star-forming, i.e. main sequence, galaxies at high redshift in an epoch of increasing SFR density (z~3-4) identified in the 2 sq.deg COSMOS field. Using our new, empirically calibrated correlation between mono-chromatic sub-mm luminosity and total gas content we will measure the cool gas mass in these systems. Combined with estimations of their star formation rates from the IR spectral energy distribution (and incoming high-sensitivity Jansky VLA radio continuum imaging), the gas depletion time, or its inverse - the star formation efficiency, of each galaxy will be derived. The proposed observations will provide the first solid measurement of the mean depletion time for normal star-forming galaxies beyond the peak of star formation activity (at z~2-3). A reduced depletion time (relative to local star-forming galaxies) has been inferred for z~1-2.5 samples, but conflicting results based on small (< 5) samples exist beyond these redshifts. These proposed observations are vital in providing the necessary constraints for current galaxy evolution models.

2013.1.00156.S

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COI	Müller, Holger	EU	Germany	Cologne, University of
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Title

Dust nucleation in oxygen-rich envelopes of two evolved stars, VY CMa & Mira

Abstract

Although dust plays a vital role in many astrochemical processes, its formation taking place around dying stars remains elusive. In particular, it is not understood how inorganic (non-carbonaceous) stardust is produced. The current nucleation theories predict that the first clusters (seeds) are formed from refractory oxides of Ti and Al, but these species remained undetected until very recently. We propose observations in which ALMA will spatially resolve the emission of TiO, TiO2, and AlO, which are the most important gas-phase species preceding the formation of seeds. The proposed observations will provide a direct view on the dust nucleation process in oxygen-rich stars. Two objects in which we have already detected the metal oxides will be observed: a red superiant, VY CMa, and an AGB star, Mira. They are prototypes of the high- and low-mass stars at the end stages of their evolution. In 6.9 h of total observing time, we will not only address the urgent questions about dust nucleation, but also shed more light on the mass-loss mechanism in late-type stars and solve some of the long standing problems about the nature of VY CMa, Mira and its companion.

2013.1.00157.S

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Title

Revealing Binarity and the Youngest Disks in Oph

Abstract

We propose a survey of multiplicity toward all known Class 0 and Class I protostars in Oph (50 sources). Using a dust continuum sensitivity of 0.1 Jupiter masses, we will probe the binarity of these sources from 15 AU out to 1000 AU, which well samples the peak of the main-sequence and pre-main sequence binary separation distributions (30 and 60 AU) toward the younger protostars for the first time. Combining with our Perseus VLA 8mm continuum survey, we will have 130 sources (great statistics) in two clouds, which will mitigate concerns of environment. This is the largest and most complete high-resolution millimeter-wave survey of protostellar binaries ever undertaken and will significantly improve our understanding of the formation mechanisms and prevalence of close binaries during the early stages of star formation. In addition, the survey will also be perfect for detecting protostellar circumstellar disks. There are currently only 2 disks in Class 0 sources known, so this project will increase the number of candidate Class 0 and I disks, help resolve the current controversy on early disk properties, and constrain disk formation scenarios that are hotly debated.

2013.1.00162.S

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Title

Confusion-free Mapping of the Node within the Cosmic Web at z=3.1

Abstract

We propose mosaicing observations of 1.1mm continuum emission with ALMA band 6.
The target region is the central 2'x3' core of the SSA22 protocluster at z=3.1.

We select this area since it seems to be the densest region at z=3 and a site where assembly of galaxies and massive black holes is accelerated.
The reason is as follows:
(i) the "node" of the three-dimensional filamentary structure traced by Lya emitters (LAEs) at z=3.06-3.12.
(ii) the existence of several SMGs, QSO, and LABs at z=3.09

Furthermore, the 2'x 3' region contains significant overdensities (2x to more than 12x) of active and star-forming galaxies such as Lyman break galaxies (LBGs) and distant red galaxies (DRGs).

We have two main goals:
(1) to reveal obscured star-formation and clarify the environmental dependence on galaxy formation, via number counts and the census of 1-mm properties (far-IR luminosity, SFR and SSFR) of major galaxy populations.
(2) to resolve the close environment around the SMGs and probe the smaller(>=100 kpc) cosmic web traced out by dusty star-forming galaxies.

The proposed study will allow us to explore how environment did affect the formation and evolution of galaxies.

2013.1.00163.S

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Title

Masses of Low Mass T Tauri Stars

Abstract

We propose to measure the masses of young (<10 MY old) low-mass (<0.5 solar masses) stars by the rotation of their circumstellar disks. The improvements in the understanding of the evolution of young stars that result from the proposed research will enable astronomers to obtain a more reliable understanding of the mass spectra of the stars produced in star forming regions and of the chronology of their formation.

2013.1.00164.S

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Title

CH+(1-0) absorption: the very first probe of turbulent dissipation in high-z galaxies

Abstract

The growth of galaxies in the Early universe is largely governed by the conversion of massive gas reservoirs into stars. The gas-feeding of star-forming galaxies generates intense turbulence that delays star-formation as long as it is not dissipated: turbulence acts as a mass and energy buffer over timescales that are essentially unknown. The unique chemical properties of CH+ make it a robust tracer of turbulent dissipation. The recent discovery of very bright lensed submillimeter galaxies (SMG) at high-z, combined with the outstanding sensitivity and resolution power of ALMA, opens, for the first time, the possibility of CH+(1-0) absorption spectroscopy against the continuum of 7 SMGs with star-formation rates (SFR) differing by a factor of 7: detections will give turbulent dissipation rates whose scaling with the SFRs will be searched. They will also allow to (1) distinguish infall and outflow from turbulence, (2) trace weakly molecular gas of low density, and (3) image the absorbing gas across the lensed images of the SMGs and along the four star-forming regions in the Eyelash galaxy.

2013.1.00166.S

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Title

Unravelling the dust formation process in oxygen-rich AGB stars

Abstract

As of today, the mechanism triggering the onset of the stellar wind and mass-loss rate in O-rich AGB stars is not yet understood: (1) We still do not know which are the first little dust seeds formed. (2) Launching a wind seems only possible when the grains are already quite large close to the star. (3) It has been hypothesized that the primary dust species in low and high mass-loss rate AGB stars are different.

With ALMA, it is possible for the first time to get decisive information on the chemical processes, dynamics, and geometrical structure in the dust forming region of O-rich AGB stars. With ALMA band 7 in extended configuration, we can spatially resolve the dust forming region in 2 cornerstone O-rich AGB stars, being the best representatives for low and high mass-loss rate AGB stars: R Dor and IK Tau.

By observing key molecular species contributing to the formation of dust grains (MgO, MgOH, AlO, AlOH, TiO, TiO2, SiO, H2O, CaOH, NaCl, FeO, and MgS), we will be able to answer key questions on the efficiency of gas depletion by condensing onto dust grains, the dynamical structure in the dust forming region and the spatial correlation between the gas and dust species.

2013.1.00168.S

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Title

Diagnosing supernova explosive nucleosynthesis by using ArH+ to measure the 36Ar/38Ar ratio in the Crab Nebula

Abstract

We have detected the noble gas molecule 36ArH+ in the Crab Nebula via strong emission in its J=1-0 and 2-1 rotational transitions at 617.5 GHz and 1234.6 GHz in Herschel SPIRE spectra (Barlow et al. 2013). We propose to use ALMA to test explosive nucleosynthetic predictions by measuring the 36Ar/38Ar ratio in the Crab, the first time an isotope ratio will have been measured in a supernova remnant. We wish to use the high sensitivity and spatial resolution of ALMA to detect for the first time the 38ArH+(616.649 GHz) line as well as the 36ArH+(1-0)(617.525 GHz) line by observing the region where the emission is brightest. To do this we will undertake a band 9 spectral scan from 616.2 to 617.6 GHz in a single pointing of the 34 element array in its most compact format. We request 0.5” spatial resolution, 1.9 km/s spectral resolution and 46 mJy/beam sensitivity at 617.22 GHz in order to achieve high signal to noise on the 36ArH+(1-0) line and at least a 5 sigma detection of the 38ArH+(1-0) line. To undertake this project will require 1.22 hours on source time according to the OT time estimator. This estimate assumes the best observing conditions and a 3 km/s integration bandwith.

2013.1.00170.S

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Title

The cool sub-millimetre chromospheres of alpha Centauri

Abstract

Like the Sun, its twin alpha Cen A displays the phenomenon of temperature minimum in its FIR/submm spectral energy distribution (SED). The temperature minimum is associated with the bottom of the chromosphere beyond which temperatures rise all the way up to several million Kelvin in the corona. The processes that lead to the heating of these atmospheric layers constitute a major challenge to solar physicists. The observation with ALMA of the chromospheres of the solar-type stars alpha Cen A and B will put the solar heating problem into astrophysical context, potentially contributing to its solution. ALMA will provide the necessary sensitivity to sample their submm continua in all bands at a high rate. This will provide detailed information about the shape of the SEDs and hence provide a handle on the opacities, governing the thermal balance of their chromospheres. As these stars exhibit different levels of activity in their cycles, the simultaneous comparison addresses the open question as to whether the cause of the solar heating is to be sought over the integrated stellar disc (QS) or in active sub-arcsecond structures (AS), providing feedback between solar and stellar physics.

2013.1.00171.S

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Title

Cold gas in AGNs hosts: walking along the 'main-sequence' of star-forming galaxies.

Abstract

Probing the properties of the molecular gas reservoir is a key ingredient of galaxy evolutionary studies: it is out of this gas that ultimately stars are formed. An open question is what is the role of black holes in the evolution of the gas content of their hosts. Previous CO studies of AGNs have been focused on bright quasars, whose hosts are well above the 'main-sequence'. But most of z>1 AGNs and star-forming galaxies are actually located in this 'main-sequence'.
The main goal of this proposal is to use ALMA to address the scientic question: does the presence of an active SMBH affect the cold gas content of 'main-sequence' galaxies at z~1.5?.
We propose to measure the CO(2-1) in a representative sample of 'main-sequence' z~1.5 AGNs. The measure will allow us to: a) Compare the star-formation

efficiency of 'main-sequence' galaxies hosting AGNs with that of inactive galaxies and verify if AGN feedback is modifying the star-formation process in its host (e.g. positive feedback). b) Compare the gas fraction of these active galaxies with that measured for inactive galaxies and test if the molecular gas content in SMBHs hosts has changed due to AGN feedback.

2013.1.00180.S

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Title

Does the CO excitation in an outflow differ from that in the ambient medium? Insights from 4C12.50

Abstract

Black holes have been claimed able to heat the gas in galaxies via jet/radiation-driven shock fronts. Indeed, evidence of heating of the molecular gas in an AGN-driven outflow was recently discovered: using Spitzer, IRAM Plateau de Bure & 30m telescope, and Herschel data of a radio-loud and ultraluminous-infrared galaxy, 4C12.50, we demonstrated that the mass ratio of warm (~400K) to cold (~25K) gas is >=30 times higher in the outflow than in the ambient medium. Our conclusion that the accelerated gas is heated is robust against major sources of uncertainty including the CO-intensity-to-H2-mass conversion factor, the warm gas temperature from rotational H2 lines, and the warm gas mass probed by high-J CO lines. Motivated by this result, we request CO(1-0), (3-2), (4-3), and (6-5) observations to compare the spectral line energy distribution in the outflow and in the ambient medium of 4C12.50. Our goal is to test whether the gas heating is detectable as an excess emission by CO molecules in intermediate rotational states J, facilitating the discovery of outflows at intermediate/high z. We request 3.2 hrs for a project that can serve as a reference for future outflow searches.

2013.1.00183.S

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Title

The Pre-Stellar Core Mass Function with Deuterium Chemistry in an Infrared Dark Cloud

Abstract

Similarities between the shapes of the core mass function (CMF) and the stellar initial mass function have been noted, which may reveal a fundamental aspect of the star formation process. However, the relation of these "cores", typically observed via their dust continuum emission, and the pre-stellar cores (PSC) that will actually form stars is unclear. Here we propose to measure the PSC mass function by mapping N2D+(3-2) over a contiguous region of an IRDC that we have already observed in N2H+ with CARMA and in which we have already identified at least two relatively massive N2D+ PSCs with ALMA in

Cycle 0. We expect to identify ~75 N2D+ cores, and measure masses via mm continuum emission, mid-infrared extinction and virial methods. We will carry out astrochemical modeling of the cores to estimate deuteration ages, which can help de-bias the observed PSC mass function to obtain the true PSC mass function. We will also study the chemical evolution from PSCs to protostellar cores. Finally, we will measure core-to-core kinematics and compare with simulations of molecular cloud turbulence.

2013.1.00186.S

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Title

Star formation in the 1000 km/s shock of Stephan's Quintet

Abstract

The Stephan's Quintet group of galaxies is one of these must-do targets revealing surprises each time being looked at by a new instrument. The most striking feature is a giant intergalactic shock created by a 1000km/s galaxy collision, with very low star formation despite an amount of warm molecular hydrogen comparable to the molecular content of the Milky Way. Our Herschel [CII] and IRAM 30m CO(1-0) measurements show that the gas kinematics are complex (FWHM=1000 km/s) on large scales (10 kpc). PdBI CO(1-0) observations reveal molecular complexes of 2-5kpc in size, but with star formation efficiencies varying by a factor of 20. Why? We propose to map the CO(2-1) and SiO(2-1) emission at spatial resolution of 0.3", comparable to the size of Giant Molecular Clouds (GMCs), to measure the gas turbulence on scales where gravitationally bound clouds may form, and identify whether the star-forming regions in the shock are the sites of dissipation of kinetic energy through molecular shocks. These ALMA observations will characterize the role of the energy cascade, from bulk motions to turbulent motions on GMC scales, on the regulation of star formation in extremely turbulent environments.

2013.1.00188.S

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Title

A detailed study of infrared radiative pumping in a nearby bright pure AGN

Abstract

We propose HCN/HCO+/HNC observations at vibrationally-excited and -ground levels, of the nearby bright AGN-dominated nucleus of NGC 1068. Our scientific goal is to estimate the strengths of vibrationally-excited emission lines of HCN/HCO+/HNC, and to clarify whether infrared radiative pumping indeed selectively boosts HCN emission, when compared to HCO+ and HNC. Detailed study of this prototypical pure AGN will play a crucial role to resolve the highly disputed issue of whether infrared radiative pumping is indeed important to enhance HCN emission in many AGNs. If the infrared radaitive pumping is ubiquitously at work for HCN excitation in AGNs, vibrationally excited HCN emission lines must be clearly detected in the NGC 1068 nucleus with ALMA. If these lines are not detected, ubiquitous role of infrared radiative pumping for enhanced HCN emission in AGNs is strongly ruled out. ALMA's high-spatial-resolution (<0.6 arcsec) is vital to probe only the AGN-dominated nuclear region, with minimum contamination from surrounding starburst activity in the host galaxy. ALMA's high-sensitivity (sub-mJy noise level) is indispensable to clearly distinguish between contradictory scenarios.

2013.1.00191.S

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Title

Blowin' in the Wind: the Properties of the Starburst-driven Wind in NGC 253

Abstract

Using ALMA observations in cycle 0 we have imaged the starburst-driven molecular outflow in the nearby starburst galaxy NGC 253 (Bolatto et al. 2013a). These observations demonstrated that the molecular outflow carries enough mass to substantially shorten the current star formation episode in this galaxy. It is unclear whether the gas can escape the galaxy, or only reach into the halo to be later recycled. To escape, the molecular gas needs to be accelerated, possibly through mixing with the faster ionized wind. This study will measure the extent of the CO emission away from the starburst, and the distribution of velocities in the molecular wind. It will also measure the acceleration, and provide further insight into the physical entrainment and mass-loading mechanisms of the outflow. Finally, the observations proposed here will allow us to refine substantially our estimate of the mass-outflow rate. Together, they will shed unprecedented insights in the fundamental properties of the nearest starburst galaxy accessible with ALMA.

2013.1.00195.S

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Title

Dust Properties and Physical Conditions in the coldest dense core LDN183

Abstract

The Planck and Herschel data have identified regions of the interstellar medium (ISM) where dust is particularly cold (T<7K).
These cold-cores (CCs) are likely to be very dense self-gravitating structures where star formation has not yet begun. Analysis of the dust
spectral energy distribution (SED) of CCs revealed unusual dust properties, with very steep spectral emissivity indices (beta>3.5)
-- in contrast to the much flatter spectrum of the Milky-Way (beta~1.8) -- that cannot be explained by classical dust models.
Grain growth and aggregation that are likely to occur in cold, dense environments affects estimates of dust emissivity.
This severely limit our ability to derive accurate masses and precise column density profiles from the dust emission,
despite the wealth of high quality Herschel data available.
The goal of this proposal is to use the excellent angular resolution of ALMA to determine the physical properties of LDN183,
one of the coldest dust condensations known to date. We will take advantage of the wide bandwidth of ALMA to measure the
dust continuum emission SED shape and to determine the density structure and thus the stage of prestellar evolution.

2013.1.00196.S

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Title

The protosolar nebula heritage: measuring the nitrogen isotopic ratio in disks

Abstract

In which forms were the chemical elements incorporated in the Solar System ? This broad topic is at the crossroads of several fields of investigation: cosmochemistry, astrobiology, and astrophysics. Because models are not able to follow the abundances of chemical species along the molecular cloud to star and planet forming sequence, this question can only be tackled observationally using ratios of stable isotopes. ALMA has the potential to revolutionize the question of our origins, by allowing us to trace our chemical history back into our parental and dispersed molecular cloud. This proposal focusses on nitrogen, a key element for terrestrial life, for which interstellar chemistry provides a consistent view of the isotopic ratios measured in embryos of star forming regions and in the protosolar nebula. Yet, one crucial measurement in the foregoing sequence is lacking, which may be key to the emerging picture of the chemical heritage of the protosolar nebula: namely, the nitrogen isotopic ratios in circumstellar disks. We propose to perform the first measurement of the 14N/15N ratio in the TW Hya disk, using CN as a carrier which is the best tracer of the bulk isotopic ratio.

2013.1.00198.S

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Title

Chemical Abundances in Planet-Forming Disks: The Carbon Reservoir

Abstract

Recent observational results have suggested that the CO abundance in the TW Hya disk is well below the ISM value. This result was enabled by a detection of HD by Herschel that set strong constraints on the total gas content thereby opening a pathway to explore chemical abundances in protoplanetary disks. We propose resolved ALMA observations of simple carbon bearing species in two protoplanetary disks systems of disparate age (TW Hya at 3-10 Myr and DM Tau at 1 Myr) that each have HD detections. We will target transitions of C2H, C3H2 and H2CO (TW Hya; to be combined with cycle 1 observations of C18O) and C2H, C3H2, CH3OH, and C18O (DM Tau) with enough resolution to explore chemical gradients within each disk. Armed with the additional information from HD and dust continuum we will characterize radial abundance gradients relative to H2 (from HD) and CO (from C18O) in each disk in the emissive layers. With these data we can start to explore the question of where the carbon resides in protoplanetary disks, while also setting more stringent constraints on the distribution and evolution of chemical abundances.

2013.1.00199.S

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Title

To launch or not: A study of magnetic fields in post-AGB objects with and without massive outflows

Abstract

The study of magnetic fields in evolved stars is crucial for understanding the extreme departures from spherical symmetry that occur in the late stages of stellar evolution. Indeed the field's ability to launch and collimate the bipolar jets believed to be involved in the shaping of the envelopes of post-AGB (pAGB) objects is a matter of intense debate. But the observational study of magnetic fields so far is very limited. We therefore propose to use ALMA and its new full continuum polarization capability to study magnetic fields through observations of linear polarization of dust grain emission, in two well-studied pAGB objects. These are OH231.8+4.2 and the Red Rectangle, with the former showing a massive outflow and the latter a very weak one. The high-resolution ALMA data will allow us to detect and map the field at small scales and test the outflow-launching mechanism in each object.

2013.1.00205.S

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Title

Smoking gun confimation of dusty nuggets as progenitors of the red nuggets at z~2

Abstract

The discovery of the "red nugget" population (massive, compact, quiescent galaxies) at z=2 indicates that early passive galaxies were remarkably compact compared to their present-day elliptical counterparts. Recent observations have identified a population of compact, star forming galaxies (so-called "dusty nuggets") that appear to be the direct progenitors of the red nugget galaxies. While several pieces of indirect evidence link these two populations, ALMA observations will provide the smoking gun

confirmation that dusty nugget galaxies are the star forming progenitors of the first generation of red sequence galaxies. Therefore, we request 3.7 hours on-source to obtain Band-7 luminosities and continuum maps on eight dusty nuggets to: (a) determine if their star-forming components are as compact as the stellar components of red nuggets, and (b) verify a short quenching (gas depletion) timescales consistent with the rapid build up the red nugget population.

2013.1.00208.S

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Title

A systematic study of gas in z > 2 Main Sequence galaxies

Abstract

We propose to measure total dust masses in 27 Main Sequence galaxies at 2 < z < 2.5 for which we are obtaining CO measurements and other diagnostics of the gas content, including star-formation rates, metallicities and gas outflows. Our goal is to use this combined 5-dimensional data to build up a self-consistent picture of the mass and atomic/molecular state of the gas and thereby better understand the cosmological regulation of star-formation in Main Sequence galaxies. We will also investigate and isolate possible systematic effects arising from the lower metallicities of these gas- rich systems. This comprehensive data set of high quality measurements on a representative sample of galaxies will also be important for calibrating other less extensive data or those obtained at lower signal to noise.

2013.1.00209.S

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Title

The Stellar Masses and Disk Properties of Class I Protostars: Edge-on Disks in Orion

Abstract

Class I protostars and their disks reflect the outcome of the the early
phases of the star formation process and set the stage for planet formation.
Even for this late phase of protostellar evolution, however, we only
know the masses of 7 protostellar systems and well-constrained disk properties for even
fewer. We propose ALMA observations of 8 edge-on Class I protostars in the Orion molecular
clouds at 0.2" resolution. We will conduct both continuum and molecular line observations
of the CO, 13CO, and C18O (J=2-1) transitions. The molecular line data will be used to trace
the disk rotation curve to directly measure the protostar masses,
doubling the number of Class I protostars with measured masses. The edge-on
inclinations of the systems remove ambiguities in the geometric orientation.
The continuum data will enable us to probe directly the bulk of the disk mass
and the resolved observations will enable us to construct a robust models of
these systems incorporating both the near-infrared scattered light and
millimeter imaging. These data will enable us to characterize disks at the end of the
infall phase and at the start of planet formation.

2013.1.00210.S

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Title

Unveiling the building elements of nearest and youngest starburst galaxy NGC5253

Abstract

The nearest and youngest starburst galaxy, NGC 5253, is the most suitable
target for understanding the intense massive star formation and their
stellar feedback in a nuclear starburst system. We aim to unveil the
molecular and ionized gas structure around the very young massive super
stellar clusters (SSCs) known to co-exist in the central starburst
in NGC5253.
Monreal-Ibero et al. (2010) suggested a scenario that the outflow
of the ionized gas from the central SSCs expels the ambient gas outwards and
encounters with the quiescent gas shell, which is likely the site for formation of subsequent generation of
stars.
We have confirmed with our pilot SMA CO(2-1) observations that the molecular
gas is associated with the central SSCs,
but the spatial/velocity resolution is insufficient to verify their scenario.
We propose to observe at 3pc resolution the CO(2-1) emission, which is a
tracer of the parental molecular gas of the SSCs, and hydrogen recombination line
(H30alpha) to study the structure of the ionized gas around those

SSCs, and CS(5-4) for shocked dense gas by interaction between the expanding ionized gas and ambient gas.

2013.1.00211.S

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Title

X marks the spot: outflow-infall interaction in B335

Abstract

We propose to observe the central region of the isolated Class 0 prototar B335 with a 7-point mosaic in Band 6 with an angular resolution of 0.8", which corresponds to spatial scales of <100 AU at the source distance, to obtain detailed information on the physical and dynamical properties of the infalling circumstellar envelope and of the outflow-infall interaction. Our final goal is to highlight the interaction between the outflow and the accreting envelope close to the protostar, where outflows could actually reverse and end the infall of material, preventing further growth of the central protostar. This will give insights into the important role that the outflow-envelope interaction plays in the mass-assembling process and in determining the final mass of the forming star. Different outflow and high-density tracers (12CO, 13CO, C18O, H2CO, 13CS and CH3OH), together with the continuum, will be observed to probe different density and kinematic regimes, trace the morphology and kinematics of the outflows, the physical properties of the outflow cavity walls and the impact of the outflow on the envelope, and the distribution of the infalling gas and its interaction with the outflow.

2013.1.00212.S

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Title

Detailed molecular gas distribution of an active star forming region within a low-metallicity environment: CO/CI observations of N83 in the Small Magellanic Cloud (SMC)

Abstract

The aim of this observation is to reveal for the first time the detailed molecular gas distribution of an active star forming region within a low-metallicity environment to understand the formation and structure of GMCs as well as the star-formation process at low metalicity. We propose mosaic observations toward a molecular clump associated with the active star forming region N83 in the SMC in the J=2-1, 3-2 lines of 12CO and 13CO, and [CI] with a final angular resolution of 1.5 arcsec, corresponding to a spatial resolution of 0.44 pc. CO observations will be used to precisely determine the density and temperature of

the gas, and in combination with the velocity information, we can investigate the dynamics of hot-dense molecular clumps associated with HII regions and cold-dense molecular clumps prior to massive star formation. [CI] line is also another important probe to reveal the distribution of molecular gas without CO emission, being a significant mass component of the cloud, affecting the system's self-gravity and providing an additional supply of gas to fuel star formation, and also a key to understand the variations of the CO-to-H2 conversion factor.

2013.1.00216.S

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Title

Skimming the Surface: An Absorption Study of Heavy Water in a Young Protoplanetary Disk

Abstract

Cold water vapor revealed by energetic UV photodesorption of icy mantles in the outskirts of protoplanetary disks provides a unique view into the composition of their largely invisible ice reservoir. Surface water (H2O) emission has been detected via this mechanism, however interpretation requires uncertain excitation modeling to derive a column. Based upon our Herschel PACS observations of water towards the young and inclined protoplanetary disk, RY Tau, we find that the data are strongly suggestive of deep unresolved self-absorption. We propose an experiment to measure HDO in absorption against the dusty continuum to determine the column density of cold HDO vapor and thereby obtain the first estimate of the D/H ratio in a young planet-forming disk with ALMA. If this photodesorbed layer is representative of the ices themselves, which grow and settle out over time, we are directly probing the composition of the gas that becomes incorporated into planetesimals, comets, etc., i.e. the building blocks of planetary systems. Such observations will provide important constraints on the initial HDO/H2O ratio of disk ices down to Earth's ocean-levels (VSMOW) and potentially lower.

2013.1.00218.S

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Title

Spatially resolved 3 mm imaging line survey toward NGC 7469

Abstract

We propose to conduct a line survey toward the central kpc region of the nearby
type-1 Seyfert galaxy, NGC 7469, at 3 mm wavelength.
This observation will be combined with our accepted cycle 1 program toward the same region, to fully

cover 86-116 GHz range.

From this observation, we will investigate the effect of AGN and starburst activity on the molecular materials.
For example, we focus on the abundance variation of (1) HCN and CN, which are expected to be enhanced in AGNs, (2) molecules sensitive to UV radiation such as HNCO, which can be used to probe the phase of starburst activity, and (3) dust-related molecules such as SO, CH3OH, SiO, CH3CN, to investigate their properties especially in AGNs.

All observed properties will be compared with chemical models and results of our ALMA cycle 0/1 programs toward NGC 1097, 253, and 1068, to further investigate the effect of AGN and starburst on molecular properties.
In addition, NGC 7469 hosts a bright type-1 AGN whose Eddington ratio is comparable to QSOs. Therefore, this observation can also serve as a local template of molecular properties for exploring high-redshift QSOs in future ALMA cycles.

2013.1.00220.S

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Title

Disk Demographics in Lupus

Abstract

We propose to survey the gas and dust in 98 protoplanetary disks in the nearby Lupus star forming region. This is a complete sample of all known optically visible stars with large infrared excesses and stellar masses > 0.1 solar. We will observe the 13CO and C18O 3-2 lines and have developed models to derive total gas masses and surface density profiles. The sensitivity of these data is a few Martian masses (0.2-0.4 Earth) in the dust and Saturnian masses (0.1-0.3 Jupiter) in the gas. We will be able to detect the lowest mass disks in both the continuum and line for a gas-to-dust ratio similar to the ISM. We will observe to about 20 AU linear resolution, sufficient to measure sizes and surface density profiles in all but the smallest disks. At these scales we also expect to see features such as inner holes and azimuthal asymmetries that may signpost planet formation. The sample size, sensitivity, and resolution of this survey will provide much needed demographics for disk studies and planetary synthesis models. To maximize its impact, we will reduce the proprietary period to 3 months and make the data products available through a dedicated disk archive within 1 year.

2013.1.00221.S

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Title

Investigating strongly-shocked and X-ray-irradiated dense gas properties: SiO multi-transition 40pc-resolution imaging in the center of NGC1068

Abstract

The central 300pc circum-nuclear disk (CND) of Seyfert 2 galaxy NGC1068 seems to contain X-ray dominated regions (XDRs) and compact shocked regions. However the contribution of these mechanisms onto the existing molecular gas properties has not yet been clarified.

In this program, we propose to observe the CND of NGC1068 by multiple SiO lines including J=2-1, 3-2, 5-4, and 6-5, which can trace both shocks and XDRs. We will derive the spatial distribution of SiO abundance (via rotation diagram) and kinetic temperature (via LVG analysis) from multi-transition lines. We aim to achieve the following science goals:

(1) constraint of the spatial distribution of XDR:
We will compare the obtained SiO abundance map with the existing X-ray flux image.
The region where they correlate well is considered to be affected by the XDR.

(2) detailed properties of the bulk of shocked molecular gas at the vicinity of the nucleus:
Multiple SiO emissions can trace the bulk of the shocked gas.
We will study the spatially resolved physical and chemical properties of shocked gas via temperature, abundance and line shapes.

2013.1.00222.T

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Title

Broadband transient jet emission from accreting black holes

Abstract

In Galactic X-ray binaries, an enormous amount of energy is harnessed to produce powerful relativistic jets. The engine for jet
production is a compact object surrounded by an accretion disk, but the production mechanism and many of the jet properties are
subjects of debate.

In order to constrain the physical mechanisms involved in jet production, we propose Target of Opportunity observations of black
hole X-ray binaries in outburst with ALMA. We aim to catch the hard spectral state, corresponding to the unique period when
their powerful compact jets are building up. Our objectives are to determine the contribution of the jets to total energetics
of the system with ALMA and with already accepted quasi simultaneous observations in radio, optical-infrared, X-ray (Swift,
Integral, Suzaku, NuSTAR) and up to very high energy (Fermi). ALMA is the only telescope able to bridge the gap between the
radio and infrared frequency ranges with very limited observing time.

2013.1.00226.S

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Title

A survey of deuterium chemistry in protoplanetary disks

Abstract

Protoplanetary disks links protostars and Solar System bodies physically and chemically. Deuterium fractionation is one of the most common tools to probe how these different stages are connected. Deuterium fractionation in molecules can for example be used to infer the importance of cold chemistry for different volatiles in the Solar System, including the Earth's sea water. The utility of deuterium fractionation as a probe is currently limited, however, by few, and seemingly contradictory observational constraints on the deuterium chemistry in disks; the spatially resolved fractionation pattern seems radically different both between molecules and between the two most well-studied disks, TW Hya and hD 163296. We propose to carry out a modest (6 source) survey of deuterium fractionation in disks that span a range of stellar and disk characteristics to explore (1), the variability in deuterium-enrichments during planet formation, and (2), the link between this variability and disk structures, ages, and impinging radiation fields. This would provide the strongest constraints to date on how the deuterium chemistry

evolves between the protostellar stage and the mature Solar System.

2013.1.00227.S

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Title

ALMA Detection of a Superwind-Driven Shocked Shell Associated with the Proximate DLA of SDSS J124020.91+145535.6 at z=3.1

Abstract

In order to investigate the origin of damped Lyman alpha absorption systems (DLAs) at high redshift based on the superwind-driven shocked shell model (Taniguchi & Shioya 2001), we propose to observe a proximate DLA (PDLA) found in the line of sight to the quasar SDSS J124020.91+145535.6 at z=3.1 studied by Hennawi et al. (2009).
In this PDLA, an extended Ly alpha nebula is associated with a size of 5 arcsec (=38 kpc), being identified as a Lyman alpha blob (LAB). Since one of plausible origins of LABs is a superwind-driven shocked shell (Taniguchi & Shioya 2000), this PDLA is an ideal laboratory to prove this idea. Here we propose to observed this PDLA in [C II]157.74 emission in the Band 8 on ALMA. Our main science goals are to detect [C II]157.74 emission from the PDLA host and the shocked shell causing DLA features and to investigate their dynamical properties in detail. This observation provides us a bland-new approach to understand the nature of high-redshift DLAs.

2013.1.00229.S

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Title

Circumnuclear molecular disks in early-type galaxies as a probe of black hole masses

Abstract

ALMA will make it possible to measure masses of supermassive black holes in early-type galaxies via an entirely new method, by mapping the kinematics of rotating, circumnuclear molecular disks. HST images provide an optimal method for pre-selection of targets, because ~10% of early-type galaxies have circumnuclear dust disks on arcsecond scales which are associated with regular rotational kinematics. However, there are very few southern-hemisphere early-type galaxies

that have round, symmetric dust disks and known CO fluxes. We propose 12CO(2-1) observations of the six best and most promising southern-hemisphere targets culled from an extensive search of the HST archives. Our efficient observations will resolve the gravitational sphere of influence of the black holes and reveal rapid rotation from molecular gas in the inner disks, and we will carry out dynamical modeling to derive constraints on the black hole masses. Once we have determined the CO fluxes and linewidths, in future ALMA cycles we will propose to carry out deeper and higher-resolution observations that will provide exquisitely accurate black hole masses.

2013.1.00231.S

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Title

Revealing Magnetic Field Structures: Intermediate-mass Prestellar and Protostellar Cores in OMC-3

Abstract

Understanding the magnetic field on size scales smaller than a core (<0.05 pc) is crucial to see how the magnetic field is responsible for setting initial conditions for star-formation.

Here, we propose polarization observations in Band7 toward candidates of intermediate-mass prestellar and protostellar cores located in OMC-3, where is the nearest ideal laboratory for studying the magnetically regulated core-collapse process.

The main goals are: (i) to spatially resolve the polarization distribution (an angular resolution of 0”.59), (ii) to measure the polarization degree, and (iii) to study how the magnetic field changes with respect to the evolutionary stages of cores. We emphasize that proposed targets are all sitting in the same filaments. Therefore, the natal star-forming environment is same. The obtained results will be compared and iterated with theoretical models (MHD simulations) optimized specifically for our targets.

Our previous SMA experiments and the observing simulation tool (demonstrated in this proposal) suggest that these proposed observations will even be able to image the magnetic field structures toward prestellar cores with the sub-arc second resolution.

2013.1.00234.S

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Title

Initial gas structure in a cold, massive clump: cluster formation in its earliest stages

Abstract

The two main models for high-mass star formation, `core accretion' and `competitive accretion,'predict different internal
structures for cluster forming clumps only in the very earliest stages. The best way to distinguish between these models
therefore is to identify a cold, cluster forming clump and measure its internal structure directly. The core mass function
(CMF) is especially diagnostic: in the early stages `core accretion' predicts high-mass cores and a CMF resembling the initial
mass function, but `competitive accretion' predicts no high-mass cores and a CMF more sharply peaked around ~1 Msun. Using
Galactic Plane molecular line and dust continuum surveys, we have found a single clump, G331.372-00.116, that satisfies all the
requirements (cold, dense, and high-mass) for a cluster forming clump in a very early stage. We will use ALMA to measure its internal
structure, deduce its core mass function, and determine their virial states. Our simulations show that ALMA has sufficient
sensitivity and angular resolution to measure the CMF reliably and to distinguish between the predictions of `core accretion'
and `competitive accretion.'

2013.1.00243.S

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Title

Spatially resolved AGN and starburst multi-phase outflows in the LIRG NGC 5135. Mapping the cold molecular phase

Abstract

NGC 5135 is a nearby LIRG where there is evidence of extended (1-2 arcsec) muti-phase gas outflows associated with its Compton thick Seyfert 2 nucleus, and with several star-forming regions, located at ~3 arcsec from the nucleus and dominated by supernovae and young stars, respectively. Outflows in the coronal, ionized, partially-ionized, and warm molecular gas are already identified. We propose sub-arcsec (0.3 arcsec) CO(2-1) ALMA mapping of the extended and massive (> 5-50 x 10^6 Msun per region as derived from the outflowing warm H2 mass) cold molecular gas outflows, will derive their 2D structure (collimation, kinematics, mass) on scales of 100 parsecs. Gauging the contribution of the AGN versus that of the starbursts as the drivers of the outflow/feedback in U/LIRGs is difficult, and NGC 5135 is an ideal target for this kind of study. When combined with our already existing near-IR sub-arcsec VLT/SINFONI spectroscopy, a full picture of the multi-phase AGN-, supernovae- and stellar-driven outflows

on the same galaxy will become available.

2013.1.00244.S

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Title

Water released in a protostellar accretion burst

Abstract

Low-mass protostars have been suggested to show highly variable accretion rates throughout their evolution. Such changes in accretion, and related heating of their ambient envelopes, may trigger significant chemical spatial and source-to-source variations. In ALMA Cycle 0 observations of the deeply embedded protostar IRAS 15398-3359, we detected a depression in the emission of H13CO+ in the inner 150-200 AU of the central protostellar core. This likely reflects that HCO+ is destroyed by reactions with extended water vapor present in parts of the core where the temperature is as low as 30 K, well below the freeze-out value. A possible explanation for this extended destruction by water is that the water vapor has been released due to an accretion burst during the last 100-1000 years, which increased the luminosity of IRAS 15398-3359 by a factor 100 above its current luminosity and thus caused the water ice mantles on large scales to evaporate. We here propose to image the emission from two water isotopologues in band-8 to confirm this picture and to reveal the gas dynamics affected by this recent burst and its relation to the newly-formed disk.

2013.1.00246.S

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Title

Highest Resolution Imaging of the Thermal Sunyaev-Zel'dovich Effect

Abstract

We propose to perform the highest resolution imaging ever achieved of the thermal Sunyaev-Zel'dovich effect
(SZE). Our target galaxy cluster, RX J1347.5-1145 at z = 0.45, is best-suited for the SZE imaging in Cycle 2, because of its compact size and the largest SZE signal known. It also hosts a violent merger as revealed by
our past investigations. By achieving the 4 arcsec resolution in Band 3, we aim at i) identifying the shock front location and direction, ii) determining thermal and kinematic energies of the shock, and iii) unveiling heating mechanism of the intracluster medium. This will open new directions in exploitation of the physics of galaxy clusters and serve as a pathfinder for more comprehensive SZE studies to be done with full ALMA.

2013.1.00247.S

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Title

AGN Feedback in Action: The Molecular Outflow in the Nearest Active Galactic Nucleus

Abstract

Galactic winds/outflows are poorly understood although they are essential to feedback processes that quench star formation and limit the total mass of large galaxies in today's universe. Thus, insufficient understanding of feedback associated with them, in particular of the molecular phase, is one of the greatest shortcomings in our knowledge of galaxy evolution. Outflows associated with galactic winds are fueled by both starbursts and AGN, and the ways in which the two winds differ is unknown and can only be gleaned through observations of both. Modeled after previous successful ALMA observations of a starburst driven wind, with 1.2 hours of ALMA time on source we will observe the AGN driven wind within the central 1.5' of Circinus, the nearest Seyfert galaxy. We will assess the morphology and kinematics of the molecular wind, and estimate the molecular outflow rate.

2013.1.00248.S

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Title

Resolving the Initial Conditions of Massive Star Formation - A Tale of Two Cores

Abstract

We detected two massive, apparently-starless cores with ALMA in Cycle 0. Now we wish to resolve them with 10 times better angular resolution, the finest available in Cycle 2, to make definitive tests of massive star formation theories. One core C1-South appears very rounded, centrally-concentrated and monolithic. We will be able to resolve its diameter with more than 30 resolution elements in both 1.3mm continuum and molecular lines, principally N2D+(3-2). If it continues to remain smooth and coherent, we will be able to derive its radial density, temperature and dust emissivity profiles. We will measure the radial profile of its velocity dispersion, and thus turbulent pressure, to test models of hydrostatic equilibrium. The other core, C1-North, appears more fragmented and we will be able to resolve this substructure, both spatially and kinematically. Having these two distinct cores close together within the same field of view provides a convenient laboratory for testing massive star formation theories.

2013.1.00250.S

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Title

A Redshift Survey of ALMA SMGs at z>4 from ALESS

Abstract

We propose to search for the redshifted [C II]157.7um emission in a sample of 21 ALMA-identified SMGs in the Extended Chandra Deep Field South from the ALESS survey.

These SMGs have photometric redshifts of z>4 and all are "red-peakers" with SPIRE 500/350>1 colours. We will use two band 7 spectral scans, f=335-365GHz and f=280-310GHz to cover the redshift range z=4.23-4.7 and z-5.16-5.82 respectively.

Our primary science goals are to:

i) search for the [CII] emission in order to measure spectroscopic redshifts for these SMGs and so measure their bolometric luminosities and hence the contribution of z>4 SMGs to the comoving star formation density at this epoch

ii) derive the bright end of the CII luminosity function at z=4 and test how this compares to z=0 and z=2.

iii) measure the ratio of CII/FIR in a well selected sample of high-z ULIRGs to test whether the "CII" deficit is ubiquitous at high-redshift.

iv) search for signs of extended CII emission in the observations to place constraints on the dynamical masses which can be compared to gas and stellar mass estimates.

The total time request for this program is 5.17 hours.

2013.1.00251.S

		Exec	Country	Institute
PI	Groenewegen, Martin	EU	Belgium	Royal Observatory of Belgium

Title

Mass loss on the RGB: reaching the limits

Abstract

For stars with initial masses below about 1 Msol, mass loss on the first red giant branch (RGB) dominates that on the later AGB phase. Nevertheless, RGB mass loss is always parameterised by a simple Reimers law in evolution models.

Groenewegen recently showed that mass loss exists in nearby RGB stars from modelling the SEDs. As follow-up, 5 stars were observed with IRAM and APEX. HIP 53449 was detected in the CO 2-1 line (and marginally in 3-2), the object with the largest mass-loss rate based on the previous analysis of the SEDs. The shape of the line profiles is intruiging. The expansion velocity is unexpectedly large, and there is a hint for a rotating disk. The comparison to a line emission code suggests that the CO envelope is significantly smaller than follows from the photodissociation radius.

It is proposed to observe HIP 53449, and the star with the next largest detection probability HIP 67665, in the CO 2-1 and 3-2 lines. The observations will unequivocally determine the line profiles. More importantly the spatial resolution of ALMA will allow to determine the size of the CO enveloppe and show if it is indeed much smaller than the standard photodissociation radius.

2013.1.00252.S

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Title

The massive, fast-bipolar outflow of the extreme AGB star OH231.8+4.2

Abstract

One striking aspect of the late evolution of Sun-like stars is the sudden change in morphology of the circumstellar gas from the asymptotic giant branch (AGB) to the planetary nebula (PN) phase. On the AGB, the stellar mass loss is roughly spherically symmetric, but this rapidly evolves into prominent non-spherical morphologies in the proto-PN phase. There is a small class of objects that show well developed PPN-like morphologies but have AGB central stars. The prototype of this small class of objects is OH231. We propose to map with unprecedented spatial resolution (0.24") and sensitivity its bipolar molecular outflow, where the effects of the recent collision between jets and the dense AGB wind are notable. We request a 5-point mosaic of the 12CO J=3-2 (and, simultaneously, 13CO J=3-2 and CS J=7-6) emission, and one single-pointed map of the CS J=6-5 line. We aim to constrain the mass and temperature stratification and the velocity field along and across the lobes. CO transitions are the best tracers of the bulk of the envelope (predominatly cold, 10-40K). The CS J=6-5 line selectively traces warm (~200K) gas discovered by us from low (~8"-40") angular-resolution observations.

2013.1.00254.S

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Title

A Comprehensive View of Magnetic Fields around Young Protostar NGC 1333 IRAS 4A

Abstract

The hourglass morphology of NGC 1333 IRAS 4A's magnetic field structure has been seen as the textbook example for low-mass star formation under the influence of magnetic field.
We have obtained SMA dust polarization data with all available array configurations.
ALMA now offers unprecedented high sensitivity at high angular resolutions and high image fidelity that, with the observations we request, we will be able to
(1) obtain the most comprehensive view of magnetic field structure around a low-mass proto-binary and trace the variation of the field morphology at the Class 0 stage within ~ 30-1300 AU scale range,
(2) reliably test the theoretical models,
and (3) probe the turbulence power spectrum and its energy dissipation scale in the envelop.

2013.1.00255.S

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Title

[CII] and Continuum High Resolution map of a Quasar Host formed through a wet merger of galaxies at z=4.4.

Abstract

The z=4.4 quasar BRI 1335-0417 provides the unique opportunity to study the ISM of a quasar host galaxy in unprecedented detail. Our high-quality, 0.2" (~1kpc) resolution imaging of the CO(2-1) emission (using the VLA in an unparalleled effort, > 50 hour integration) demonstrates that the molecular gas in the host galaxy is distributed over 10 kpc, and is dynamically complex, hinting at an ongoing gas-rich ('wet') merger. This is the highest-quality/resolution CO dataset available for any unlensed high-redshift source accessible with ALMA. We here propose to complement this dataset with spatially-matched [CII] (and underlying continuum) emission. This is possible given the recent detection of strong [CII] emission in the source using APEX. In only 30 minutes of on-source integration with ALMA, we will map the [CII] and underlying continuum at kpc resolution and unprecedented sensitivity. Together with the CO imaging, this will provide the first beam-matched dataset of a high-z galaxy to study the interplay of star formation (as

traced through [CII] and FIR emission), central black hole accretion (through unresolved FIR emission) and the molecular gas reservoir (CO).

2013.1.00257.S

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Title

Water in Arp220

Abstract

We would like to observe the 325.15 GHz line of H2O towards Arp220. The high spatial resolution provided by ALMA (0.13") is needed to determine the origin, spatial distribution, and abundance of H2O in the gas around the central region of this ultraluminous infared galaxy. Shocks associated with the molecular outflow, the AGN buried in the Western nucleus, and/or the UV radiation from the starburst have been proposed to explain the water emission in this famous ULIRG.

Observations of water from ground based telescopes at 22 GHz and 183.3 GHz, and recently at 325.15 GHz, together with a large number of thermal lines of water observed with ISO and Herschel, are already available. To be efficiently pumped the 325.15 GHz line requires physical conditions intermediate between those of the 22 GHz and the 183.3 GHz lines of H2O. Hence, the proposed observations will provide an extra and unique constraint for the modeling of water in Arp220 with the first spatially resolved water emission map.

The total requested observing time is 1.74 hours of which 45 min are on source.

2013.1.00260.S

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Title

Fragmentation, rotation and infall of a massive disk

Abstract

Understanding the fragmentation, rotation and infall properties of disks around young high-mass stars remains one of the key questions in star formation research. The unique capabilities of ALMA allow us to probe the physical properties of the gas and dust in the inner envelope and disk region around the central high-mass star. Specifically, using the high-frequency band 9 receivers with 1km baselines at a spatial resolution of ~0.1'', we can for the first time resolve the predicted fragmentation scales on the order of several hundred AU. Simultaneously, we can study the gas infall rates via absorption line studies against the bright submm continuum emission. Therefore, we propose to observe one of the best 10^5 Lsun high-mass disk/outflow candidates G351.77-0.54 at 690GHz in continuum and spectral line emission.

Important questions which these observations will address are: What are the fragmentation properties of this massive disk candidate? How large are the infall rates close to the protostar? Are the kinematic properties of the disk-like structure of Keplerian nature or still dominated by a flattened envelope? Are the outflow properties related to those of the accretion disk?

2013.1.00262.S

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Title

ALLO: ALMA Lensed Line Observations

Abstract

We request 3.3 hours of band 6 time to observe [CI] (2-1) and CO (7-6) lines in 5 extremely lensed, but otherwise typical star-forming galaxies at redshifts z=2-3. These galaxies are part of our survey of [CII](158 micron) and [OI] (63 micron) lines with Herschel (the Herschel Extreme Lensing Line Observations 'HELLO'). The HELLO sample of normal galaxies forms an ideal complement to studies of dusty starbursts at z=2.

Our propsed ALMA observations reach interesting limits of [CI](2-1)/FIR = 10^{-5.5} in 40 minutes (with overheads) per galaxy. In 2 cases, we will also detect the H2O 2(1,1)-2(0,2) line.

Combined with the Herschel [CII] line measurements, the [CI] and CO lines will give a complete picture of the physical conditions, including density, far-ultraviolet flux, temperature, and pressures in atomic and molecular gas. With the [CII], [OI], [CI], and multiple CO lines we will have the total cooling budget and we can determine whether their ISM at z=2 is fundamentally different from the local universe. ALMA's spatial resolution will also allow a study of spatially resolved kinematics of these galaxies, among which some show outflows and some show cold rotation.

2013.1.00266.S

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Title

HMSFSiO

Abstract

We propose ALMA high-angular resolution and high sensitivity observations of SiO v=1, J=2-1 maser lines toward new SiO maser sources of 2 high-mass star-forming regions, G19.61-0.24A and G75.78+0.34 which are detected by the Korean VLBI Network single dish telescope. Through the ALMA observations, we investigate the exact positions and spatial distributions of SiO v=1, J=2-1 maser emission. We also expect to investigate the inner part of jets/outflows which regions are playing an important role for launching and collimating the jets/outflows probably related with rotating accretion disks close to the central protostars. In addition, the observational results of several transitions of CH3OH masers, SiO thermal emission, and continuum etc. are compared with those of SiO masers.

2013.1.00269.S

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Title

Sgr B2 - The Proving Ground for Star Formation Theories

Abstract

Sgr B2, a high-mass molecular cloud in our Galaxy's Central Molecular Zone, is the most extreme site of ongoing star formation in the Local Group in terms of its gas content, temperature, and velocity dispersion. If any cloud in our galaxy is analogous to the typical cloud at the universal peak of star formation at z~2, this is it.

We propose a 6'x6' mosaic in the 3mm window targeting gas thermometer lines, specifically CH3CN and its isotopologues. We will measure the velocity dispersion and temperature of the molecular gas on all scales (0.02 - 12 pc, 0.5" - 5') within the cloud, which will yield resolved measurements of the Mach number and the sonic scale of the gas.

We will assess the relative importance of stellar feedback and turbulence on the star-forming gas, determining how extensive the feedback effects are within an ultradense environment. The observations will provide constraints on the inputs to star formation theories and will determine their applicability in extremely dense, turbulent, and hot regions.

Sgr B2 will be used as a testing ground for star formation theories in an environment analogous to high-z starburst clouds in which they must be applied.

2013.1.00271.S

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Title

Sub-kpc Kennicutt-Schmidt star formation law in luminous infrared disks

Abstract

We propose to obtain sub-arcsec resolution CO(2-1) ALMA images of two nearby Luminous Infrared Galaxies (LIRGs) covering the high-density (2-20 Msun/yr/kpc^2) regime of star-forming clumps. The galaxies are representative of the class of extended (~ 3 kpc) luminous star-forming rotating disks. Accurate star formation surface densities on ~ 0.2 kpc scales already exist based on our Pa-alpha HST imaging and Br-gamma SINFONI/VLT maps. The proposed observations will provide a direct measurement of the molecular gas surface densities of the star-forming clumps (and inter-clump medium) on scales of hundred parsec. Our extinction-corrected star formation and the ALMA-derived molecular gas densities will determine for the first time the Kennicutt-Schmidt law on sub-kpc scales for LIRGs, i.e. sampling the

regime of large SF regions with high star formation surface densities. This important class of galaxies that are among the most luminous starbursts in our nearby Universe, also represent the closest analogs of the high-z clumpy star-forming extended disks. Thus the proposed observations bridge the gap between local spirals and star-forming galaxies at cosmological distances.

2013.1.00276.S

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Title

Physical Properties of Galaxies that Ionize the Universe

Abstract

Measuring the properties of low-luminosity galaxies near redshift 6 is central to understanding the reionization of the universe. Although hundreds of bright galaxies have now been identified at this era, their number density is too low to even maintain the ionization of the intergalactic gas, and lower luminosity galaxies detectable only via their line emission provide the closest relation between any post-reionization galaxy population and the objects that actually reionized the universe. Prior to ALMA, however, our knowledge of these important galaxies was limited to number counts and luminosity functions of hydrogen Lyman-alpha emission. The luminosity and line profile of this resonance line depend sensitively on the gas kinematics and dust content of the host galaxy, so Lyman-alpha observations alone provide little physical information about the galaxy properties. To establish the typical star formation rate, dynamical mass, and systemic velocity for the lowest luminosity galaxies yet detected at this important era, we request ALMA observations of their [CII] 158um fine structure emission.

2013.1.00278.S

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Title

Formation of complex organics in solar-type protostars

Abstract

Understanding how, when and where complex organic and potentially prebiotic molecules are formed is a fundamental goal of astrochemistry and an integral part of origins of life studies. Already now ALMA is showing its capabilities for studies of the chemistry of solar-type stars with its high sensitivity for faint lines, high spectral resolution which limits line confusion, and high angular resolution making it possible to study young stars on solar-system scales. We here propose to undertake an unbiased survey of the protostellar binary IRAS 16293-2422 in the important spectral window from 329 to 363 GHz. The aim is to reveal the origin of complex organic molecules in a young protostellar system and investigate the link between this stage and the early Solar System. These data will however also have a large legacy value

beyond the astrochemical focus of our group and we will therefore waive the proprietary period for the obtained data - and furthermore make the fully imaged datacubes available to the community with the first sets of papers.

2013.1.00279.S

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Title

A Complete Line Survey Observation in the 3-mm Band toward NGC 1068 for Diagnosing the Power Source in Galactic Nuclei

Abstract

We propose to obtain high resolution images of molecular distribution from a complete line survey observation in 3-mm band toward NGC 1068. The chemical properties have been expected to be powerful astrophysical tools for the study of galaxies, because the molecular line observations of different galaxies allow us to study the effects of these different physical properties/activities on the molecular medium. So far, some groups have suggested that it is possible to diagnose power sources in dusty galaxies using molecular line ratios. It is the workable strategy to clarify the relationship between the physical properties and the chemical markers in nearby galaxies, in order to understand the power source of distant and dusty galaxies using the molecular lines. We carried out the line survey toward NGC 1068 with the Nobeyama 45-m telescope. And also, our ALMA cycle-0 (PI S. Takano) and cycle-1 (PI S. Takano) proposals toward NGC 1068 in 3-mm band were accepted and we already received cycle-0 data. Therefore, we can combine these data and we will obtain the complete line survey toward NGC 1068 in 3-mm band.

2013.1.00280.S

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Title

Molecules in supernova 1987A - chemistry, nucleosynthesis and gas dynamics

Abstract

Supernovae (SNe) are the main source of chemical enrichment in galaxies. SN 1987A was the nearest SN explosion detected in 400 years. Since its discovery, SN 1987A has given us remarkable insights into the physics and chemistry of SNe.

Our ALMA Cycle-0 detected molecular line emission in the SN ejecta, thus opened up an exciting new avenue of observational research, molecular astronomy in SNe.

In this cycle-2 programme we propose an unbiased line survey of SN 1987A from 210 to 350 GHz. We aim to detect new species of molecules that have been predicted to form in SN ejecta, and to measure the emission from the isotopologues of these molecules, as well as their velocity profiles, densities and temperatures.

Measurements of molecular isotopologue ratios will allow us to measure isotope ratios of C, O, S, Si. This will provide direct constraints on stellar yields from SN nuclosynthesis. These measurements of abundances for species other than CO and SiO will constrain not only chemical models. We will also measure the line profiles from different molecular species, tracing turbulent structure that resulted from the hydrodynamical instabilities caused by the SN explosion.

2013.1.00286.S

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Title

Particle acceleration and magnetic field in the hot spot of 3C 445

Abstract

We propose ALMA observation in polarization mode of the peculiar hot spot 3C 445 South.
The discovery in this hot spot of optical synchrotron emission extending on kpc scale challenges the standard scenario of particles accelerated by a strong shock. High-energy electrons like those responsible for the optical emission should arise from a very small region due to their short radiative time. Two scenarios have been proposed to explain such extended optical emission: multiple, broadly distributed shock structures, or efficient Fermi-II acceleration mechanisms driven by turbulence. The key parameter to discriminate the mechanism at work is the polarization intensity: high fractional polarization is expected in the former case, while low values or absence of polarization in the latter. The aim of this proposal is to discriminate between the two scenarios by studying the polarization properties in the peculiar hot spot 3C 445 South and to determine the topology of the magnetic field across the whole structure to probe the presence of compressed/shocked regions.

2013.1.00287.S

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Title

Investigating the formation of isolated high-mass stars in the LMC

Abstract

High-mass stars usually form in giant molecular clouds (GMCs) as part of a young stellar cluster, but some isolated O/B stars are observed. What are the initial conditions that lead to the formation of these objects? The aim of the proposed observations is to measure the distribution and basic physical properties of the neutral gas associated with 12 isolated intermediate- and high-mass young stellar objects (YSOs) in the Large Magellanic Cloud. We have identified and confirmed the YSOs using Spitzer IRAC photometry and IRS spectroscopy, and single-dish CO observations by our team put upper limits between a few thousand and 10,000 solar masses on their associated reservoir of molecular gas. Here we propose observations of the 1-0 and 2-1 transitions of the main CO isotopes in order to measure the density, temperature and velocity structure of the CO clouds associated with the YSOs and, for a subset of sources, CI observations to investigate the distribution of the neutral gas components without CO emission. The observations will provide the basic empirical measurements that are required to develop a theory for isolated high mass star-formation.

2013.1.00291.S

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Title

The emergent low-mass cluster B59: how to beat magnetic fields

Abstract

B59 is the only star-forming site in the quiescent and magnetized Pipe nebula. It contains a small cluster of low-mass protostars and a very twisted magnetic field in comparison with the more pristine regions of the cloud. We propose to perform a detailed dynamical study of B59 using linear polarization observations. These data will reveal the magnetic field morphology in sources in B59 wich are at distinct evolutionary stages: Class 0, I and II. We want to trace the evolution of the magnetic field properties in the three stages. We expect to resolve the field morphology at the dust envelope of Class 0 objects and at the circumstellar disks at Class I and II objects. Since all targets belong to the same (low-turbulent) parental cloud, we will be able to test predictions of magnetized molecular cloud models. As a complement, molecular line data will trace the kinematics of the cores in order to better constrain the possible ambiguity of projection effects in the polarization data.

2013.1.00293.S

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Title

Detecting atmospheric ionisation from ultracool dwarfs with ALMA

Abstract

We will observe the ultracool dwarf TLVLM513-46546 using band 3 of ALMA to detect radio emission from plasma in the upper atmosphere.

This plasma may have been caused by a variety of mechanisms such as cosmic ray impacts, charged particles causing lighning strikes, or Alven emission. Alfven emission appears the most likely cause of the plasma as it requires a localised magnetic field (which is ~1 kG in TVLM) and particle movement caused by rotation (TVLM has a fast rotation period of 2 hours). This radio emission will be the first to be detected that cannot be attributed to the electron cyclotron maser instability, and using the magnetic field strength, we will calculate the electron number density in the atmosphere, the first time this will have been achieved for an ultracool dwarf. This is particularly important as it will allow much more accurate modelling of plasmas in ultracool dwarf and exoplanet atmospheres, particularly where irradiation and cloud formation are concerned.

2013.1.00296.S

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Title

A search for extragalactic argonium, ArH+, a probe of the very atomic diffuse interstellar medium

Abstract

The J = 1 - 0 transitions of 36ArH+ and 38ArH+ near 617.5 and 616.6 GHz were detected in absorption toward the Galactic Center source Sgr B2 with the Herschel Space Observatory. The former was also seen toward several prominent galactic continuum sources. Model calculations suggest that the cation samples in these observations exclusively the very atomic, diffuse ISM with a molecular fraction of about 10-4 or less. We propose to search for ArH+ toward PKS 1830-211 and B 0218+357 at z = 0.89 and 0.68, respectively, in order to gain more insight into the role of this cation as a probe of the very atomic, diffuse ISM and to determine 36Ar/38Ar ratios in the earlier Universe.

2013.1.00305.S

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Title

Build-up of protoplanetary core-accretion in the dust trap of HD142527

Abstract

According to recent theoretical progress, the clearing of the protoplanetary cavity by an accreting gaseous giant should lead to apressure enhancement in the outer rim of the gap, shaped into a horseshoe, where dust grains are trapped, and where temperatures drop. Core-accretion may occur efficiently in these dust traps, leading to second generation planet formation. In this scenario the origin of the outer disk pressure enhancement is due to on-going dynamical clearing. Inside the gap, the first generation giant(s) channel outer disk material across the gap, thus feeding stellar accretion.

The HD142527 disk is an ideal laboratory to test the scenario of second generation core accretion at large stellocentric radii. It hosts the best-studied horse-shoe and the largest cavity in a face-on orientation, in which gas kinematics have been resolved in Cycle0. We aim to 1- measure grain growth inside the dust trap of HD142527, 2- measure physical conditions and kinematics in the dust trap, and 3- understand the cavity dynamics to ascertain the physical origin of the gap-crossing flows.

2013.1.00319.S

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Title

The life cycle of dust and gas: CO observations of AGB stars in the Large Magellanic Cloud

Abstract

The life cycle of dust and gas is one of the main topics in modern astrophysics.

Both intermediate mass Asymptotic Giant Branch (AGB) stars and Supernovae are believed to be important contributors of dust and gas to the interstellar medium, although the relative contribution remains uncertain. However, we lack evidence of how the gas mass-loss rate of AGB stars depends on luminosity and in particular on metallicity.

A sample of 4 carbon-rich and 2 oxygen-rich very dusty AGB stars in the LMC have been selected for which detailed radiative transfer modelling strongly suggests that we will be able to detect the CO J=2-1 and J=3-2 lines, and for which dust mass-loss rates are available.The observations will result in the first direct determination of the gas mass-loss rate in extragalactic AGB stars by modelling of the CO lines, and yield, through the expansion velocity, the essential parameter for an accurate determination of the dust mass-loss rate. The observations will also provide a critical test to the predictions of dust-driven wind theory on how expansion velocity, dust-to-gas ratio and mass-loss rate depend on metallicity.

2013.1.00327.S

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Title

The Evolution of Young HII regions

Abstract

At the birth of a massive protostar, newly formed HII region expands into the surrounding medium. For the most part, our understanding of how and why are rooted in the Stromgren models, with only a few numerical simulations moving beyond this (e.g. Keto 2002, Peters et al. 2010).

In order to understand the dynamics, feedback and disruption of molecular clouds caused by massive stars shortly after they form HII regions, requires high-resolution sub-mm observations. From these observations, we can determine how the HII regions expand, leading towards answering why.

Here we propose Band 6 observations at 0.4'' of 9 small HII regions. We will use H29a to trace the dynamics of the ionised gas and three molecular species to trace the warm and dense gas around the HII regions. Through high sensitivity observations at the same resolution in both gas populations (ionised and molecular), we can understand the interaction between the HII region and its surrounding material as the ionisation front expands into it.

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Title

A detailed view of the Bird's anatomy: the vital organs of a rare triple galaxy merger

Abstract

The Bird is a luminous infrared galaxy (LIRG), logL_IR(L_sun)=11.89, product of a triple merger. The ongoing star formation (SF) in the least massive of the components (the head) outshines that of the primary nuclei (the heart and the body) as evidenced by our Spitzer-24um imaging, hence dominating the LIRG phenomenon in the Bird. This clashes with the commonly accepted major merger scenario in which the SF is expected to be higher in central compact regions. The Bird has a global high SF rate of ~190Msun/yr and shows spectroscopic evidence for outflowing gas reaching v~600 km/s. The complexity of this system makes it a perfect laboratory to study star-forming regions with a wide range of physical conditions, which we can probe with the aid of sub-mm observations. For doing this, we propose to perform a detailed study of the gas (12CO 1-0, 3-2 and 6-5, 13CO 3-2) and dust continuum of the three NIR-bright components of the Bird.
The proposed ALMA observations, together with our NIR, MIR and optical data, represent a unique dataset that will allow us to test the major merger scenario, whilst making the Bird a local template to be compared to IR luminous high-z galaxy mergers.

2013.1.00331.S

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Title

The structure and dynamics of the very inner equatorial regions of bipolar planetary nebulae

Abstract

The shaping mechanism of bipolar planetary nebulae (PNe) has not been fully understood yet. It is clear that the main role in shaping the nebula takes place at its innermost region, where an equatorial density enhancement should be related to the collimation of light and jet-launching from the central star. Appropriately sampling these equatorial condensations at the core of PNe would help determine the shaping mechanism.

We request ALMA simultaneous band 7 observations (12CO, 13CO J=3-2 and continuum) of the innermost equatorial regions of 3 extreme bipolar nebulae with rich, tight and structured equatorial condensations. They are excellent candidates for ALMA's current capabilities in a reasonable amount of time: Mz 3, Hen 3-401 and NGC 6302. Our main aim is to use high spatial resolution to detect and map these structures, in order to derive accurate ages and sizes to compare with those of their outflows and determine their role in the shaping of the nebulae. Alternatively, should orbiting disks be found as predicted by models, this would be the first direct detection and mapping of stable disks around planetary nebulae showing well-developed, high-velocity bipolar outflows.

2013.1.00332.S

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Title

Physical and chemical structure of massive proto-clusters

Abstract

The very massive and luminous cores SgrB2(M) and SgrB2(N) are probably progenitors of very rich Arches-like stellar clusters in the Galactic center. In spite of their similar mass and luminosity, they are very different, both morphologically (M is very fragmented, N almost monolithic) and in their chemical appearence - while M is line poor, except for rich spectra of sulphur-bearing molecules, N is very line rich, and has yielded many new complex organic molecules. In this proposal, we want to do a full line survey of Band 6 toward both sources, to determine the full physical and chemical structure using 3-d radiative transfer modeling, to identify all lines and possibly find new species, and to characterize the chemical diversity spatially. This will be aided by the availability of full HIFI line surveys of both sources, which will give important constraints.

2013.1.00338.S

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Title

Rotating and expanding gas in protoplanetary nebulae

Abstract

Disks rotating around post-AGB stars should play a fundamental role in the formation of planetary nebulae, since they are needed to explain the post-AGB axial jets and the resulting axial symmetry of the whole nebulae. However, the lack of observational information prevents the proper study of their role in the late stellar evolution. Single-dish observations have shown that the presence of Keplerian disks in low-mass post-AGB nebulae is very common. Recently, spectacular ALMA maps of one of this objects, the Red Rectangle, have confirmed the equatorial disk in rotation, also revealing the presence of an axial slow flow and allowing a detalied description of the complex nebula. However, this object remains the only AGB or post-AGB source in which one of such disks has been properly mapped until now and observations with other interferometers have been found to be not accurate enough to study these structures. We propose to perform maps of 12CO and 13CO J=3-2 emission (as well as of the adjacent continuum) in two similar objects, IRAS 08544-4431 and IW Car, the best candidates to continue our study, in which ALMA (and only ALMA) can yield accurate maps of the expected components.

2013.1.00346.S

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Title

The first extragalactic, extreme, low-metallicity tests of the core mass function and molecular cloud structure

Abstract

The stellar initial mass function (IMF) may be predetermined by the mass distribution of 0.1--0.5pc dense cores in a cloud. Does the IMF result from a universal core mass function (CMF)?
Milky Way molecular clouds follow correlations between size, linewidth, and mass; at ~30pc resolution, clouds follow the same relations in reduced metallicity dwarf galaxies, i.e. conditions similar to the era of galaxy formation. Is molecular cloud substructure universal?

Scales of ~0.1pc are critical to address either of these questions: 0.1pc is the sonic scale at which gravity is expected to dominate turbulent motions in a cloud. Probably not coincidentally, it is also the characteristic scale related to the turnover in the dense core mass function. This scale is now reachable outside of the Milky Way with ALMA.

30 Doradus provides an ideal setting in which to test molecular cloud properties in an extreme setting. Our Cycle 0 observations of 30 Doradus analyzed >100 solar mass, 0.5pc clumps. We can now build on that with an informed study of solar mass, 0.1pc cores.

2013.1.00349.S

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COI	Hanawa, Tomoyuki	EA	Japan	Chiba University
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Title

Spiral Arms and Accretion Motion in the Circumbinary Disk around the Protostellar Binary System L1551 NE

Abstract

We propose follow-up ALMA Cycle 2 observations of the protostellar binary L1551 NE in the 0.9-mm dust continuum and C18O (3-2) and multiple lines at Band 7. Our ALMA Cycle 0 observation of L1551 NE found intriguing substructures of the circumbinary disk around the protostellar binary in the continuum emission, and non-axisymmetric gas motions in the line emission. Models of circumbinary disks around protostellar binaries make the generic predictions of spiral arms and non-axisymmetric gas motions, and our Cycle 0 results are consistent with those models. The angular resolution of the Cycle 0 data is, however, not high enough to unambiguously unveil the spiral arms and disentangle the gas motions in the spiral arms, inter-arm regions, and the circumstellar disks around the individual protostars. In Cycle 2, with the maximum 1.5 km baselines, we aim to unambiguously unveil the winding spiral arms, and gas motions in the spiral arms, inter-arm regions, and the circumstellar disks at a spatial resolution of ~0.13″. By comparing the Cycle 2 images with our theoretical model, we will study the accretion motion onto the protostellar binary in the circumbinary disk.

2013.1.00351.S

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Title

The failure of galactic star formation relations on sub-galactic scales: A direct probe of the physics of star formation

Abstract

We propose to map CO(1-0) emission over a quarter of the optical disk of the nearby (1.9 Mpc) flocculent spiral NGC 300. These data will measure the structure of molecular gas with high spatial (23pc) and spectral (0.32 km/s) resolution and reveal ~500 molecular clouds (MCs), making this one of the finest (extragalactic) MC samples. We will apply these data to a newly developed model - the `uncertainty principle of star formation (SF)' - that relates the scatter in resolved SF and gas tracers (i.e., the `breakdown' of the Kennicutt-Schmidt relation on small scales) to the evolutionary state of SF regions. The model derives the timescale of MC formation, the duration of SF, and efficiency of stellar feedback - all critical parameters of galaxy evolution that are hotly debated. We will also smooth the data to lower resolution to calibrate the model for future ALMA observations of more distant galaxies, opening up a much wider range of environments. NGC 300 is the ideal target as it has a smooth, flocculent, undisturbed gas disk seen at low inclination with active SF, rich ancillary data, and an ideal distance to map a wide area at high resolution and sensitivity within modest time.

2013.1.00352.S

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Title

Search for new sulfur-species formed in H2S-bearing, UV-photoprocessed ice mantles in circumstellar regions.

Abstract

Sulfur is strongly depleted in dense clouds and circumstellar regions around YSOs. The missing sulfur might be locked onto the icy mantles of dust grains, initially in the form of H2S.
Several S-bearing gas phase molecules such as H2S, SO2 or OCS have been observed in low-mass and high-mass hot cores, with abundances that cannot be explained with current gas-phase chemical models. Recent lab experiments have shown that energetic processing of H2S-bearing ices leads to efficient photolysis of H2S, with H2S2 and HS2 as the main products.
We propose to observe several lines of H2S2 toward the hot corino around the IRAS16293-2422 low-mass protostar, where sulfur-bearing molecules are likely released by thermal or photo-desorption. These observations will confirm whether an important fraction of the
missing sulfur is contained in H2S2 and HS2, and will provide key information about the poorly known chemical network of sulfur.

2013.1.00355.S

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Title

The Morphology of the Magnetic Field of HL Tau

Abstract

The formation of disks around protostars is thought to be regulated through magnetic fields, and theoretical models suggest that the fractional polarization should be approximately 2-3%. Nevertheless, resolved observations of disks in T Tauri stars (TTS) have remained undetected and are constrained to have fractional polarization of less than 1%. However, with CARMA observations of HL Tau, we recently found the first detection of a resolved magnetic field about a TTS. Unfortunately, such observations have insufficient resolution to discern the true magnetic field morphology. Therefore, HL Tau is the quintessential source for follow-up ALMA observations. High resolution ALMA observations will allow us to discern the morphology of TTS magnetic fields, which will supply theory with the first observational constraint of the magnetic field morphology during the Class II stage of star formation.

2013.1.00358.S

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Title

Testing the Dark-Matter-Halo Paradigm

Abstract

The use of gravitational lenses as a tool for cosmology has been limited by the small sizes of samples of lenses, but the discovery that most bright submillimetre sources are lensed is on the verge of revolutionising this field. We propose to obtain ALMA observations of 42 bright Herschel lensed sources for which we already have redshifts. We will use the ALMA maps to determine the density distribution around each lens and to reconstruct the unlensed source emission. We will use the results to make an immediate test of the theoretical predictions of the mass function of dark-matter halos, on which all current models of galaxy and cluster evolution are based. Since the reconstructed images of the source emission will have a physical resolution of ~200 pc, only twice the size of a giant molecular cloud, we will also obtain a superbly detailed picture of a large sample of ULIRGs at an epoch when the average star-formation rate was at its peak. Finally, we will also use the dataset to investigate separately the evolution of the dark matter and baryons at the centre of the halos.

2013.1.00359.S

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Title

What lies outside super-Earth planetary systems?

Abstract

We propose to image the debris disk of the nearby (8.5pc) main sequence G5V star 61Vir in band 7 at 1.08” resolution to determine the disk structure at a resolution ~5 times better than previous observations. This system hosts at least 2 super-Earth planets within 0.5AU, a configuration which is

common (around ~50% nearby stars), but the origin of which defies explanation. We recently showed this system has a debris disk with peak brightness at 30-100AU, and that bright disks such as this are more frequently found around super-Earth systems (Wyatt et al. 2012). Little is known about what lies in the empty region 0.5-30AU which must hold clues to the origin and nature of systems with super-Earth planets. We will image the debris disk and use radial and azimuthal structures within its planetesimal belts to set constraints on planets at >0.5AU, not only their current masses and orbits, but also their dynamical history. In this way we will assess different models for the formation of super-Earth planetary systems. The proximity and sub-mm brightness of 61Vir makes it uniquely placed to test such models, and the premier laboratory for understanding the ubiquitous class of super-Earths.

2013.1.00362.S

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Title

The Assembly Line of Normal Galaxies: the Direct Detection of the Dusty Phase of Star Formation at z~3

Abstract

We propose a direct detection experiment of the 850um dust continuum emission in a pilot sample of 10 `typical' z~3 Lyman Break Galaxies (LBGs). LBGs are much more ubiquitous and `mainstream' than the more extreme submm galaxies (SMGs), and so are thought to be the progenitors of `normal' galaxies, such as our own Milky Way Galaxy, giving rise to a significant part of the stellar population in today's galaxies. Until now, we have had a very incomplete picture - recent work has given us a statistical detection of the obscured star formation (which is comparable to or even dominates over the unobscured star formation even in these UV-selected galaxies), and only now with ALMA will we be able to fully characterize the SEDs of individual `typical' run-of-the-mill galaxies in formation, providing: 1) an unbiased measure of the dust obscuration in these systems to compare against the UV-inferred star formation rates, and 2) a probe of the level of activity in LBGs across the merger sequence to test our theoretical picture of galaxy assembly as well as providing a comparison test with the rate of mergers in more massive populations (such as SMGs).

2013.1.00366.S

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Title

A 3-Dimensional View of Protoplanetary Disk Turbulence

Abstract

Turbulence is a central component of planet formation theory, yet observational constraints on its magnitude and spatial distribution have so far been scarce. Millimeter-wavelength spectroscopy of molecular lines at high spectral resolution represents a promising method of constraining nonthermal linewidths in protoplanetary disks. Here we propose to measure vertical and radial variations in turbulent linewidth to measure the three-dimensional distribution of turbulence in a disk for the first time. We will simultaneously observe three molecular lines at 0.5" resolution: optically thick and bright CO(2-1) probes the disk surface and vertical temperature gradient, optically thin C18O(2-1) traces the bulk of the warm molecular layer, and DCO+(3-2) traces the planet-forming midplane. The 0.5" spatial resolution breaks several crucial spatial scales in the disk, and the spectral resolution will resolve below the measured turbulent linewidth. For the first time, we will plausibly resolve, or place the first interesting constraints on, the MHD "dead zone" that is a signature prediction of MRI turbulence theory.

2013.1.00367.S

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Title

What is heating the Orion-KL hot core?: The explosion, the bubble or Source I

Abstract

This proposal aims to find what is heating the Hot Core in Orion KL. We want to reveal the distribution of the highly excited lines at 650 GHz with a high angular resolution (0.2''). The line distribution of such lines will help in understanding which of the outflows in Orion KL are exciting the hot core: the explosion, the bubble or the outflow from source I. Additionally, we will distinguish previously unseen structures, characterize the weak line wing emission, and reveal the true (sub)millimeter sources located within the region. These observations very likely will reveal totally new features of the Orion KL hot core, and show for the first time the kinematics and identify the origin of the highly excited molecular gas at very small scales.

2013.1.00368.S

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Title

Atomic carbon in nearby active galaxies: Studying [CI] in NGC253, NGC1068 and Arp220

Abstract

Exploiting the new capabilities of band8 in Cycle2, we propose to map for the first time the [CI] emission in three nearby prototypical galaxies, the starburst galaxy NGC253, the Seyfert galaxy NGC1068 and the ULIRG and merger Arp220, at unprecedented subarcsecond angular resolution and sensitivity. We aim to evaluate the promising potential of [CI] emission as alternative and equal tracer to CO of the interstellar medium in our currently best templates of nearby active galaxies. How similar is the [CI] emission to that of CO in these environments? Are there differences in the [CI] properties between different activity types (NGC1068 vs. NGC253) and different star formation efficiencies (NGC253 vs. Arp220)? What are the effects of shocks onto [CI]? The proposed observations will further allow us to build up templates for the high-z galaxy population. For the latter, [CI] observations are booming thanks to increased sensitivities of current-day (sub)millimeter observatories and redshifted [CI] emission into atmospherically less constrained frequency windows.

2013.1.00374.S

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Title

Formation of Wide-Separation, Low-Mass Companions: the GQ Lup System

Abstract

We propose to image circumstellar material in the GQ Lup system, a very young Sun-like star with a well characterized substellar (possibly planetary) mass companion in a 100 AU orbit. Such low-mass, wide-separation companions present serious challenges to standard models of both planet and binary star formation. ALMA provides the high sensitivity and resolution to detect and isolate circumstellar emission from various components in nearby systems like this and to provide new constraints on formation mechanisms. In particular, millimeter imaging can constrain (1) the presence of a remnant outer disk that could point to "planet-like" formation of the companion within a large disk around the primary, (2) the

presence and mass of a "circumplanetary" disk around the companion that would be difficult to reconcile with scenarios where the companion was formed closer in and scattered or migrated outward, and (3) sculpting of the disk around the primary, such as a cavity, that could point to an additional close in object involved in a dynamical interaction that. Both detections and non-detections of these circumstellar features will address the viability of proposed formation mechanisms.

2013.1.00376.S

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Title

HCN emission: a diagnostic of Enceladus' cryovolcanic activity and torus dynamics

Abstract

The Cassini mission has discovered active cryo-volcanism on Saturn's satellite Enceladus. Localized fractures with enhanced temperatures are the sources of active plumes rich in gas and icy grains. Plume gases are dominated by water but contain several other compounds (NH3, CO2, HCN...). The presence of liquid water beneath the surface and powering the cryo-volcanism is advocated for, but no single mechanism appears to be able to explain in detail the currently observed composition. Gases and grains escaping Enceladus populate rings of gases (the Enceladus torus) and particles (Saturn's E-ring). Models indicate that the spatial, vertical and velocity structure of the torus is determined by source rates as well as a variety of physical processes, including neutral-neutral collisions. Our observations with Herschel have permitted the first direct detection of H2O in the torus, but at a low spatial resolution (13"). We propose to use ALMA to search for HCN emission in the torus in order to (i) determine the HCN abundance in the plumes and constrain their origin (ii) map the HCN emission in the torus at a much improved resolution of ~4" to constrain torus structure and kinematics.

2013.1.00380.S

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Title

Probing stellar feedback in an extreme low-metallicity starburst

Abstract

Feedback from accreting black holes and from massive stars and supernovae has become a cornerstone for understanding galaxy evolution. Recent theoretical work has shown that dust is an important aspect of stellar feedback because of the interaction of photons with dust grains. However, in the early universe, when galaxies were very metal poor, there are no observational constraints for stellar feedback, even though dust is known to play a role in primordial star formation. Here we propose to remedy this by following up on our Cycle 0 observations of an extremely low-metallicity starburst, SBS0335-052, at 1/30 solar oxygen abundance. We propose to map this galaxy in the Band 9 continuum at 0.2 arcsec resolution to compare dust morphology at a resolution of 55 pc with the distribution of the young massive Super Star Clusters. We will determine the contribution of free-free to the observed emission using high-frequency radio observations at the same resolution. Our proposed observations will provide for the first time constraints of feedback models in an extremely metal-poor interstellar medium, and better establish the metallicity dependence of dust content and column density.

2013.1.00387.S

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Title

Testing the Anisotropy of Turbulence in Protoplanetary Disks

Abstract

Turbulence is a key actor for evolution of protoplanetary disks and formation of planets. Although substantial progress has been made in understanding turbulence and its properties via 3D MHD simulations, these predictions still has to be observationally constrained.

We propose here to test one of the predictions of MHD models, the amount of anisotropy of the turbulence by observations of two disks, one face-on (TW Hya), one edge-on (Flying Saucer). The unique combination of high spatial and spectral resolving power and sensitivity of the Cycle 2 ALMA will allow us to image simultaneously CS 5-4, CN 2-1 and 12CO J=2-1, and characterize distributions of turbulent velocities through these disks.

2013.1.00393.S

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Title

Mapping the Magnetic Field in the Circumstellar Disk in IRAS 16293-2422 B

Abstract

Theoretical studies of magnetized cores show that the process of magnetic braking makes it very difficult to form a circumstellar disk in the earliest stages of the collapse. It is therefore important to detect, measure and map the magnetic field structure in the disk around a young stellar object. The SMA observations reported recently by us (Rao et al. 2013) of IRAS 16293-2422 B at 345 GHz are the first such measurements of the field structure in a disk. The field structure appears to be following a pattern which is approximately toroidal in geometry. However the SMA observations are affected by inadequate angular resolution (0.6 arcseconds) and sensitivity (relative position angle error of >7 degrees). We propose to image the magnetic field in the circumstellar disk around IRAS 16293-2422 B using ALMA in Band 6 with an angular resolution of 0.2 arcseconds

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Title

The Evolution of Disks Around Low-mass Stars

Abstract

The lifetime of primordial, optically thick disks around young stars places empirical constraints on the timescale to form planetary systems. Submillimeter observations play a critical role in quantifying the evolution since the emission is optically thin over most of the disk and probes the cool material where most of the disk mass resides and where most planets form. We request time with ALMA to image the dust and gas toward a complete sample of disks around stars in the 5-11 Myr old Upper Scorpius OB Association that have spectral types between M4.75 and G0, corresponding to stellar masses between about 0.2 and 2 Msun. Upper Sco is the nearest OB association of this age, and thereby provides an opportunity to obtain sensitive measurements of the disk properties at the end stage in the lifetime of primordial disks. By comparing the dust emission from disks in Upper Sco with existing continuum observations of 1 Myr stars in Taurus, we aim to measure 1) the amount of dust that is dispersed from disks on 5-10 Myr timescales, 2) the efficiency of disk dispersal as a function of stellar mass, and 3) how the dust mass evolves between evolutionary states.

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Title

Molecular Gas in the Nearest, Extremely Low-Metallicity, Star Forming Galaxy, Leo P

Abstract

Leo P is the most extremely low metallicity (Z = 0.03 Zsun), low-mass (M_HI = 1x10^6 Msun) star forming galaxies in the nearby universe (D = 1.72 Mpc). The proximity of Leo P affords us the best opportunity to constrain recent star formation models in such an extremely low-metallicity environment in comparison to much more distant objects such as I Zw 18 (D = 18.2 Mpc). We propose to observe the 115 GHz CO (J=1-0) emission in Leo P with a single-pointing observation requiring 5.51 hours (including overhead) of ALMA time. These observations will help to constrain recent star formation models at low metallicity which suggest molecular gas may not be required to form stars. Regardless of a detection or a non-detection, this observation will put valuable constraints on the CO luminosity and its relationship to other star formation tracers such as L_Halpha, L_B, stellar mass, and total HI mass as well as provide important insight into the low metallicity star formation process prevalent in the early universe.

2013.1.00403.S

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Title

Sub-Arcsec Molecular Gas Imaging of the z=2.8 Submillimeter Galaxy SMM J02399-0136

Abstract

We propose sub-arcsec imaging of the molecular gas in the z=2.8 submillimeter galaxy (SMG) SMM J02399-0136, the very first SMG discovered with a confirmed counterpart. This remarkable system is a merger of two hyper-luminous infrared sources with AGN feedback that appears to be enhancing the star-formation activity in the system. We request Band-3 and Band-6 imaging observations with a resolution of 0.45" (~1.5 kpc in the source frame), which is sufficient to distinguish between the various components of the system and to study the possible interaction of the QSO with the red starburst region as well as the surrounding large blue Ly-alpha cloud. We propose to observe the CO(3-2), HCN(4-3), HCO+(4-3), CO(7-6), and [CI] spectral lines to determine the molecular gas mass, gas excitation, kinematics, dense-gas fraction, and star-formation efficiencies of the system. The 3.3 mm and 1.3 mm continuum observations when combined with the archival ALMA Band-9 data will reveal the distribution of the dust mass associated with the various components.

2013.1.00404.S

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Title

Mapping the D/H ratio of Complex Organic Molecules in IRAS16293-2422 to probe its dynamics and chemistry

Abstract

Many complex organic molecules (COMs) have been detected with high abundances towards low-mass protostars. These species are thought to result from active grain surface chemistry during the warm-up phase of the protostellar envelope, and to desorb at high temperatures in the inner regions of protostars. Extremely high deuterium fractionation is a characteristic of low-mass star-forming regions. The

investigation of deuterated COMs will allow to further understand the chemical pathways leading to the molecular complexity and how it depends on the evolutionary stage of young Sun-like stars.
With ALMA's unique sensitivity and spatial resolution, we propose to observe several COMs and their deuterated counterparts in the two cores of the low-mass protostar IRAS16293. These data will allow to determine the spatial distribution of the COMs deuterium fractionation, to assess the dynamical and physical environment of the source and to constrain the COMs formation pathways. For that, we will compare the derived abundances of COMs and deuterated isotopologues as a function of radius with gas-grain chemistry model predictions coupled with realistic dynamical models of each core.

2013.1.00426.S

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Title

Are faint proto-planetary disks still very dense ?

Abstract

The majority of disks around Class II low mass stars are faint (Flux < 30 mJy at 1.3 mm at the Taurus distance). We recently demonstrated, through high resolution imaging at the IRAM array, that their very small size is the principal reason of the
low flux detected. Half of them remain unresolved (< 20 AU radius), and may still be optically thick. Such compact, dense dust cores may be the first direct evidence of the theoretically expected magnetically dead zone.

We propose here to use ALMA to unambiguously resolve these dusty disks, providing a direct constraint on the dust opacity, as well as to probe their gas content through the imaging of the J=2-1 line of the three main CO isotopologues.

2013.1.00430.S

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Title

Resolving the ISM in a z~2 extremely lensed galaxy

Abstract

We propose spatially resolved observations of the ISM in a spectacular gravitational arc (RCS0327) through the [CII] line and rest-frame 100micron continuum. The lensed galaxy lies at z = 1.7, during the peak epoch of star formation in the universe and provides a unique opportunity to study the detailed gastrophysics of a 'normal' star-forming galaxy at this important time. The extreme magnification (up to 100x) further exploits the already superior spatial resolution of ALMA, probing 20-200pc in the source plane. Our observations will allow us to study the physical state of the ISM through comparison with PDR

models: we will constrain the total gas mass of the galaxy, study the spatial distribution of the gas and star formation (and in relation to the stellar population), constrain the intensity of the ambient FUV radiation field and measure the rotational velocity and bulk motions of the ISM. These constraints will allow us, for the first time, to contrast the state of the star formation in normal galaxies at z = 2 with similar local systems, and understand the proceses which shape the universe which surrounds us today.

2013.1.00432.S

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Title

A 3mm Line Survey of IRC+10216 : The chemical view of a C-rich object

Abstract

IRC+10216 is a carbon rich evolved star in which more than 50% of molecules known in space have been detected. While a few diatomic and triatomic molecules are formed in the innermost regions of the circumstellar envelope, long carbon-chain radicals, metal-bearing cyanides, and other complex molecules are formed in an external ring, 14" in radius, where chemistry is dominated by UV photons and reactions between radicals and neutral species.

Recent ALMA cycle0 observations at 270 GHz (Cernicharo et al., 2013) have shown the presence of hundreds of unidentified and intense lines arising from the dust formation zone. The carriers of these lines are certainly participating in the nucleation and growth of dust grains.

We propose to carry out a sensitive line survey at 3mm with the following goals : 1) To fully characterize the molecular composition of the dust formation zone. 2) To fully characterize from several transitions of C4H, C5H, C6H, C7H, and their anions, the physical and chemical composition of the molecular ring where these species are formed. 3) To study the spatial distribution of the gas from the innermost regions (0.4") to the external chemically rich ring at r=14".

2013.1.00433.S

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Title

Characterizing the nature of a protogalaxy in the primordial Universe (z=7.1) seen by ALMA

Abstract

In our previous Cycle 1 observations we have detected [CII]158um emission in a star forming galaxy at z=7.1, well within the epoch of reionization. This is the most distant [CII] detection and in a galaxy representative of the galaxy population responsible for the reionization of the Universe. The [CII] line is extremely narrow (8 km/s) and slightly offset (a few kpc) relative to the Lya emissiion; both these features are in very nice agreement with the expectations for the distribution of ionized and cold gas from simulations of primeval galaxies. The system has a modest star formation rate (less than 10 Msun/yr), indeed in the range expected for galaxies contributing to the Universe reionization. The goals of the proposed observations are 1) to map the [CII] emission with much higher angular resolution and verify the expectatinos of models that [CII] should break up into small clumps with sizes of ~1 kpc; 2) obtain a detailed dynamical map to infer the mass distribution of the system; 3) trace the ionized component of the ISM through the [OIII]88um line, which is not affected by IGM absorption, and which is expected to have a smoother and broader distribution than [CII].

2013.1.00437.S

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Title

Establishing the Disk Mass-Stellar Mass Scaling Relation

Abstract

The disk mass is among the most important input parameters of every planet formation model determining the number and masses of planets that can form. Indeed, the occurrence rate of exoplanets shows trends that are likely the result of stellar mass dependent disk masses. However, the biased population of known exoplanets cannot discriminate between different scaling relations between disk mass and stellar mass. Here we propose a sensitive ALMA survey to measure dust masses for all Chamaeleon I disks around objects from ~2 to 0.05 solar masses (SpTy: G2-M7). This unique coeval sample of 93 disks will: 1) establish how the disk mass scales with the mass of the central star and 2) constrain average disk masses and their spread over a range of 40 in stellar mass. As a bonus our settings cover lines from two CO isotopologues that can be used to trace gas in these disks. Our survey fully samples the numerous but faint M dwarfs which are attractive targets to search for Earth analogues in the habitable zone. In combination with ancillary data our group is assembling we will also test disk dispersal theories and provide an ALMA legacy for followup studies of disks around young stars.

2013.1.00446.S

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Title

Characterizing the Atmosphere and Surface of Pluto

Abstract

We will use the unmatched sensitivity of ALMA to make significant advances in understanding of Pluto's atmosphere and surface. The atmosphere exhibits sublimation-condensation exchanges with surface ices and active photochemisty, but is poorly characterized. Our goals:

* Atmospheric CO detection, vastly improving determination of its abundance, with implications for the nature of surface-atmosphere interaction and constraining atmospheric temperature

* Sensitive search for photochemically produced nitriles like HCN which play major roles in the atmospheric budget

* High SNR individual brightness temperature measurements of Pluto and Charon, and determination of their submm surface emissivities

Our observations are designed to measure important aspects of Pluto and Charon that only ALMA can provide. The New Horizons spacecraft will fly through the Pluto system in July 2015. Our measurements are both distinct from (CO and nitrile abundances) and complementary to (upper atmospheric structure; relation to hazes; surface Tb and emissivity properties) New Horizons observations. They will serve as benchmarks for the study of dwarf planets and other Kuiper Belt objects.

2013.1.00449.S

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Title

Finding Redshifts for the Most Extreme Starbursts in the Early Universe

Abstract

We have developed a technique to robustly select high-z (>4) dusty, massive, star forming galaxies using far-IR Herschel/SPIRE data. Follow up of the first handful of sources has proven this technique to be both efficient and reliable, yet the existence of these sources is emphatically not predicted by current models. We have extended this technique by selecting the 'reddest of the red' sources, which are likely to be at even higher-z. We propose to determine what fraction of these sources are, in fact, at z>5 by using ALMA to measure secure, multi-line redshift for 8 such ultra-red sources selected from the HerMES/HeLMS and H-ATLAS projects, providing a powerful check on models.

2013.1.00450.S

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Title

Exploring the mass-loss history and the dust content in circumstellar nebulae around three magellanic luminous blue variable stars

Abstract

The post-main sequence evolution of massive stars is ruled by mass-loss, through mechanisms that are still poorly understood. We propose to study the mass-loss history and the dust production in massive stars through observations of luminous blue variable nebulae (LBVNe). The possibility that the LBV mass-loss mechanism is independent of metallicity makes these objects among the best candidates for dust production in high redshift galaxies and for the interstellar medium enrichment in the early Universe. Some galactic LBVNe have been observed in a large spectral domain, but a paucity of data exists in the

lower-metallicity environment of Magellanic Clouds, mostly because the IR instruments available have not been suitable for similar studies. However, our previous study evidenced the presence of dust in three magellanic LBVNe. We propose to observe with ALMA such objects in order to provide for the first time images of their dust content. Mass-loss history and physical parameters will be compared with those of galactic LBVNe in order to recover any differences due to lower metallicity. This study we will open new scenarios for the early Universe comprehension.

2013.1.00451.S

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Title

H2S: A New Probe of Hidden Luminosity in Orion KL

Abstract

We propose here that 20" X 20" interferometric maps be carried out for the 2(0,2) - 1(1,1), 4(2,2)-4(1,3), and 9(7,2)-9(6,3) transitions of H2S toward the Orion Kleinmann-Low nebula (Orion KL). These lines were among >90 H2S transitions detected toward Orion KL using Herschel/HIFI.?Modeling the line excitation reveals that the 9(7,2)-9(6,3) transition is tracing extremely dense gas that is likely irradiated by a mid-IR continuum which is stronger than observed. The source of this intense radiation field is presumably hot dust heated by massive embedded protostars. ALMA maps of the J=9 transition will therefore trace those regions exposed to the strongest sources of hidden mid-IR radiation. Maps of the J=2 and 4 transitions, on the other hand, will trace the global distribution of H2S and provide context for the higher excitation line. If Orion KL is indeed heated internally by massive protostars, the sources identified by the proposed observations may represent the origin of Orion KL's tremendous luminosity.

2013.1.00457.S

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Title

A Molecular Disk Survey of Very Low-Mass TWA Members

Abstract

There are precious few examples of young low-mass stars that harbor molecular gas within their circumstellar disks, yet are close enough to Earth for the sort of detailed observational studies that might constrain the conditions under which planets are born. It is essential to have a better understanding of the gaseous component of circumstellar disks as these govern how giant planets form. The ~10 Myr TW Hya Association (TWA) is an excellent group for such studies given that it is young enough to still retain some gas-rich disks (eg, TW Hya), old enough to have already formed planetary mass objects (eg, 2M1207b), and close enough (~60 pc) to permit detailed studies of its members.
We propose an ALMA Band 6 survey for molecular gas disks around 15 very low-mass members of TWA, many of which will soon to be published. Our observations will be capable of detecting 12CO and 13CO line emission as well as continuum emission from cold dust in the circumstellar disks around these stars.

This survey will be the definitive sample for molecular gas disks among ultracool dwarfs and will lead to a greater understanding of planet formation and evolution around low-mass stars and brown dwarfs.

2013.1.00458.S

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Title

Last equatorial flows in axial PNe, effects of a binary stellar system

Abstract

Studying the appearance and properties of bipolar winds is critical for understanding the stellar evolution from the AGB to the planetary nebula (PN) phase. Many uncertainties exist regarding the presence and role of binary stellar systems. M 2-9 is a young PN with very elongated bipolar structure, that singularly yields direct information on its central stellar system. In the equator, rings detected in molecular line emission show unprecedented positional and dynamical imprints of the presence of a binary system. From those, a mass ~< 0.2 Msun was proposed for the companion of the central post-AGB star. If the presence of such low-mass companions can trigger the shaping of very elongated lobes, this would strongly supports the binary-based models.

Here we propose to observe 12CO J=3-2 and 6-5 line emission to dig more deeply into the peculiar kinematics identified in the equatorial rings in M 2-9, and thus better characterize the properties of the binary system. We want to study in detail the excitation conditions of these last winds, the suggested presence of shock dynamics, and of inner warmer components, and the relation between the bipolar outflows and the equatorial rings.

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Title

Mapping CI in the beta Pictoris debris disk

Abstract

The dusty debris disk around the ~20 Myr old main-sequence A-star beta Pictoris is known to contain gas. Evidence points towards a secondary origin of the gas as opposed to being a direct remnant from the initial protoplanetary phase. The dominant gas production mechanism is not identified so far, but believed to be connected to the dust. The reason for the extreme overabundance of C and O compared to metallic elements (e.g. Na, Fe) is also unknown. We propose to use ALMA to map the C I 492 GHz emission from the carbon-rich gas disk around beta Pic. By spatially and spectrally resolving the emission, ALMA will in particular address the following questions:

1) What process produces the circumstellar gas?
2) What is the mechanism behind the extreme overabundance of C in the gas disk?
3) What is the C/O ratio of the gas?

Of key importance in answering these questions will be a comparison to recent ALMA observations of CO(3-2) in the disk.

In addition, simultaneous observations of the dust continuum combined with archival data will map dust properties such as the grain size distribution in the disk.

2013.1.00465.S

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Title

The first dusty envelopes and outflows around proto-BDs

Abstract

The formation of brown dwarfs (BDs) is a hot field of research because there are no clear-cut examples of deeply embedded BDs (or proto-BDs), yielding a 'missing gap' between the stages prior to collapse and the stages where the object is almost formed and deprived of gas and dust. We have selected deeply embedded Spitzer sources in the Taurus region whose infrared magnitudes are consistent with a substellar nature and their colors are typical of Class 0/I protostars. In addition, these Spitzer sources are associated with sub-mm Herschel emisssion, and thermal radiojets like those found in low-mass protostars. ALMA is the only interferometer able to detect the 1-mm continuum and CO (2-1) emission of these faint objects, something crucial to unambiguously characterize their envelope and outflow properties, and compare them to the known stellar properties. This will provide definitive clues to disentangle the different formation scenarios of BDs.

2013.1.00468.S

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Title

Detecting the second generation protoplanetary disk around NNSer

Abstract

The recent frequent detection of giant planets around detached post-common envelope binaries (PCEBs) may significantly influence our understanding of planet formation. These circumbinary planets have likely formed from the expelled material following the common envelope evolution of the host binary system. Such a second generation scenario, if confirmed, could provide crucial constraints on planet formation theories. An ideal test-bed for the hypothesis of second generation planet formation is the PCEB NNSer with its two circumbinary giant planets. The common envelope evolution of NNSer occurred only a million years ago thus any second generation protoplanetary disk will still be detectable with ALMA. We therefore here request 1.16 hrs in band-6 to ultimately test the second generation planet formation scenario.

2013.1.00469.S

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Title

The Warm Molecular Gas of VV 114

Abstract

We propose to observe the luminous infrared galaxy VV 114 in 12CO J=4-3 and J=6-5 to study the distribution of the warm molecular gas. VV 114 has been observed in 12CO J=6-5 with the Submillimeter Array; however, only one out of the three distinct regions of molecular gas concentrations was detected. Our goal is to detect all three regions and to constrain the physical conditions of the warm molecular gas. We also propose to observe 13CO J=1-0 and J=2-1 to detect all three regions and to do a radiative tranfer analysis across the entire galaxy to look for variations in the 12CO-to-13CO abundance ratio.

2013.1.00470.S

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Title

Resolving the star-forming ISM at z~2-3

Abstract

We propose resolved (0.45”), matched-resolution mapping of the CO, [CII], and underlying dust continuum in a carefully selected sample of z~2-3 galaxies in the ECDFS. The proposed targets were drawn from our Cycle 0 870um survey of >100 sub-mm galaxies (SMGs), the largest, most homogenous, and best-studied sample of interferometrically observed SMGs to date. Our recently completed spectroscopic follow-up campaign has allowed us to meticulously identify 4 SMGs with redshifts that allow us to observe both low-J CO and [CII] with ALMA. In addition to providing tight constraints on gas masses, SF efficiencies, kinematics, and PDR models, these observations will reveal the fundamental relationship between molecular gas and star formation (`Kennicutt-Schmidt law') on ~kpc scales. Critically, they will also allow us to test how well [CII] correlates with the cold molecular gas reservoir probed with CO. This is imperative, as [CII] will be the main line for studying the star-forming ISM at even higher-z. These detailed case studies, which are only now becoming possible with ALMA, are an essential complement to larger statistical studies of individual tracers and integrated properties.

2013.1.00474.S

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Title

Complete Census of Young Binaries in Lupus

Abstract

We propose to carry out continuum imaging of Class 0 and I protostars in Lupus at band 7 with the ALMA. The main purpose of continuum imaging is a proto-binary survey: to determine the frequency, separation, and flux ratio (disk mass ratio) of binaries at the protostellar stage. ALMA's high resolution comparable to typical separation of known proto-binaries (0".15) and high sensitivity at submillimeter allow us to conduct a first complete survey of low-mass proto-binaries in Lupus. The band 7 continuum maps or visibility fit can reveal the configuration on tens of AU scale. HCO+(4-3) and CO(3-2) data will show how infalling envelope and outflow characteristics vary with evolution. The ALMA result will be an ultimate test of any theory to form a binary protostar and will identify unique sources to be followed up in the future.

2013.1.00476.S

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Title

Molecular Knots in the Crab Supernova Remnant

Abstract

We propose to measure the CO 3-2 emission from bright H2-emitting knots and absorbing dust blobs in the Crab Nebula. This will provide a critical test of how energetic photons and particles produced in a young SN remnant interact with diffuse gas. Only ALMA has the sensitivity and resolution to execute this test. We will study four locations with contrasting properties. Our detailed observations and Cloudy models of these knots suggest that the Crab filaments present an exotic environment in which H2 emission comes from a mostly-neutral zone probably heated by cosmic rays produced in the SN. Our model robustly predicts that the CO 3-2 line strength should be 1800 mJy km s-1, hundreds of times stronger than CO 1-0 and easily detectable by ALMA. The H2 emitting knots in the Crab present a novel phase of the ISM representative of many important astrophysical environments.

2013.1.00481.S

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Title

Resolving the Mysterious Broad-line Absorption Filaments in the Galactic Center

Abstract

The most intriguing puzzle generated by the ALMA Cycle 0 observations of the "Brick" (G0.25+0.02) is the presence of broad-line absorption filaments seen only in the optically thick HCO+ (1-0) transition. These are new features of the Galactic Center -- never seen before ALMA pointed at the Brick, and we don't know what they are. The features are almost unbelievable -- unresolved (<1.7'') in the narrow dimension and 30 to 50'' long with absorption seen over 20 km/s. We propose a quick and simple experiment to test two theories for the origin of these filaments: (1) ram-pressure confined shocks or (2) magnetic confinement of ions. We will attempt to measure the true width of the filaments by observing at 3 times higher angular resolution. We will also observe the other bright ground-state ionic transition at these frequencies, N2H+ (1-0). It is possible that our observations will rule out both toy models! We are in uncharted territory, and desperately need the additional information these observations will provide to constrain our explanations of these amazing features.

2013.1.00487.S

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Title

Characterizing the Circum-Planetary Disk of GSC 6214-210 b with ALMA

Abstract

Circum-planetary disks are natural outcomes of giant planet formation but are observationally difficult to study. Fortunately, a handful of wide-separation planetary-mass companions (PMCs) below 15 Mjup have recently been discovered from direct imaging planet searches, enabling a detailed look at the atmospheres and environments of young gas giants for the first time. We propose ALMA 870 um continuum observations of the 14 +/- 2 Mjup companion GSC 6214-210 b, the only young (5-10 Myr), wide-separation (330 AU, or 2.2") PMC known to harbor a circum-planetry disk based on accretion activity and thermal IR excess. Planet scattering will severely truncate these disks, so measuring the dust mass for GSC 6214-210 b will allow us to discriminate in situ formation via either disk instability or turbulent fragmentation versus dynamical scattering to a wide orbit following formation closer in. Our 5-sigma detection goal of 1.8 Lunar masses can be achieved in 11 min of on-source integration time (41 min total) with ALMA. Altogether, these observations will provide the first insight into the origin of the growing population of gas giants being found on extreme orbits beyond 100 AU.

2013.1.00489.S

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Title

Are there disks around O-type protostars?

Abstract

Our objective is to establish whether circumstellar disks exist around O-type (proto)stars, and to characterize them. This is crucial because theory predicts that disk-outflow systems can solve the "radiation-pressure problem" and explain the formation of stars up to 140 Mo. In a Cycle 0 proposal, we found 2 Keplerian disks around young B-type stars. The success of our experiment indicates that disk accretion is the formation route of stars up to 20 Mo. We now wish to extend our search to the most massive stars. We have selected the 6 best possible targets based on the luminosity, IR colour, distance, and association with hot-core tracers and outflows. We wish to observe known disk tracers such as CH3CN in the C34-7 configuration in band 6, to attain about 0.2" resolution, sufficient to resolve disks whose size is predicted to be >0.5". We will interpret the data by means of numerical simulations already available to us. We stress that our project will be successful even if no disk should be detected, because we will set a tight upper limit on the disk diameter and prove that disk-mediated accretion in O-type stars is not as effective as in lower-mass stars.

2013.1.00493.S

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Title

Weighing Supermassive Black Holes with ALMA

Abstract

Ubiquitely present at the centres of galaxies, black holes are central to understanding galaxy evolution. However, the correlations driving most theoretical efforts (e.g. black hole mass-central velocity dispersion relation) are based on a relatively small number of measurements and only a handful of methods. Our recent work with CARMA has however shown that it is possible to dynamically estimate the mass of supermassive black holes, by simply probing the near-Keplerian rotation of molecular disks around them at high angular resolution. This is a highly promising method, and in the ALMA era it will make possible hundreds of measurements across galaxies of all morphological types. In Cycle 2, it is already possible to exploit extended array configurations to measure the black hole mass in carefully selected objects. We therefore request here high angular resolution CO(3-2) line imaging of three promising targets spanning much of the Hubble sequence: NGC4429 (SA0), NGC4861 (SAab), and NGC3351 (SBb). With these data, we will probe their molecular gas kinematics on nuclear scales, weigh their black holes, and test the reliability of our measurement method.

2013.1.00498.S

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Title

Dust growth in protoplanetary disks: where in the disk are grains growing?

Abstract

The first step toward planet formation is the growth of submicron grains into centimeter-sized particles inside a circumstellar disk. The long-wavelength emission from large dust is the last observable link in the growth chain from interstellar dust grains to fully fledged planets. Thus, observations of this phase provide crucial constraints to theories of early planetesimal growth and of the transport and evolution of dust particles.

In this proposal we request ALMA observations at 1.3 mm, that when combined with our existing 0.7 - 1 cm spatially resolved observations, will determine where in the disk are dust grains preferentially growing. With careful characterization of the disk thermal and density structure we can determine the dust optical depth and constrain the dust emissivity index throughout the disk. These ALMA observations will establish if spatial variations of grain growth occur in nature, as it is expected from several theoretical scenarios, like particle trapping at pressure maxima arising from vortices, turbulence, or Rossby-wave instabilities.

2013.1.00502.S

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Title

Anatomy of a Fried Egg

Abstract

IRAS 17163 was recently identified by Lagadec et al (2011) as the closest and brightest Yellow Hypergiant. Infrared imaging of the dust emission implies a very intense mass-loss, with 2-4Msun of gas ejected in the last 500 years. This lead to the formation of at least three concentric dusty shells. Recent APEX data indicate the possible trigger of a bipolar outflow. This makes IRAS~17163 a unique object for the study of the mass-loss process ina spectacular short-lived phase towards the end of the life of a massive star, before it explodes as a supernova.
We propose to resolve these shells in CO J=2-1 emission with ALMA, to probe the kinematics and morphology of the gas in this massive stellar envelope.This will enable us to measure the amount of gas ejected, the gas-to-dust mass ratio, the time scale of the ejection, and check whether or not a jet is being formed. These measurements are the key for understanding
the physics of the intense mass-loss during this short-lived, and thus rare, phase of stellar evolution.

2013.1.00513.S

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Title

Through the magnifying glass: a unique view of the low-metallicity ISM at high redshift

Abstract

Low-mass galaxies produce up to half of the new stars at the heyday of galaxy formation, yet our knowledge of the physical processes at this epoch is almost solely based on extrapolations from either lower redshifts or higher-mass galaxies. An exceptionally rare lensing configuration has 30-fold magnified a dwarf starburst galaxy at z=1.847, providing a unique opportunity to explore the ISM conditions in this important but thus far unobservable regime of galaxy evolution. We propose to take advantage of the magnification of the lensed galaxy SL2SJ02176-0513, a 10% solar metallicity, 10^8 Msol dwarf galaxy with a star formation rate of 10 Msol/yr, combined with the unmatched resolution and sensitivity of ALMA,

to obtain the first [CII] map of a metal-poor,
high-redshift galaxy at ~150 pc resolution. By combining this information with existing 0.20 arcsec-resolution UV and emission line maps from HST, we will verify if and how the [CII] line traces star formation in young galaxies. These observations will provide the first ever spatially and kinematically resolved study of the cold ISM in a low-metallicity galaxy at an epoch when the Universe was only a third of its current age.

2013.1.00516.S

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Title

Molecular isotopes as tracers of the i-process in Sakurai's star

Abstract

In many instances of stellar evolution, especially at very low metallicity, H-combustion events (which trigger the so-called i-process) are encountered. The exact way in which the evolution of stars with H-combustion deviates from stellar evolution predictions is not clear. This is however important for the evolution of the first generation of stars in the early universe. A case where these models can be compared directly with observations is Sakurai's object, a post-AGB star that experienced a very late thermal pulse and where evolution can be observed in real time. The mixing of proton rich material into the 12C-rich He-shell induced exotic n-capture nucleosynthesis. In the case of Sakurai's object the high efficiency of this process in combination with the immediate ejection of the burning products offer a unique possibility to study the i-process. It allows even radioactive isotopes like 14C to be observed, which, due to its short lifetime, cannot be a remainder from previous evolutionary stages. The proposed observations of C, N, and O isotopes will be compared to the analysis of 3D hydrodynamical simulations. They will provide strong constraints on the i-process.

2013.1.00518.S

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Title

Constraining the Fragmentation Mechanism in the Class 0 proto-binary BHR71

Abstract

Binary star formation is a ubiquitous phenomenon in astrophysics and we aim to characterize the process of fragmentation during the earliest phase of the star formation process, the Class 0 phase. We propose to observe the wide (3200 AU; 16") Class 0 proto-binary system BHR71 in order to test predictions of the fragmentation theories with observations of the envelope structure and kinematics. The youth of this protostellar system indicates that it has not undergone significant dynamical evolution, thus we are viewing the near initial conditions of fragmentation. The kinematic structure will be observed at 1.7" (340 AU) resolution in C18O (J=2-1) at 1.3 mm; these data will be complemented by our existing ATCA and Parkes NH3 data on larger scales (> 2000 AU) with ~10" resolution. These data will enable us to map the kinematic structure on ~10000 AU scales down to ~340 AU. NH3 and C18O are complementary tracers in that NH3 is destroyed where C18O is present, mostly in the warm gas of the inner envelope.
The spatial and kinematic structure of the dense gas and dust continuum will enable us determine if rotational fragmentation is likely or if another mechanism is at work.

2013.1.00521.S

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Title

Isolating the starbursts in the most massive AGN hosts

Abstract

Using Spitzer, Herschel, SCUBA and LABOCA, we have obtained 12-band 3.6 to 870μm photometry of 71 radio galaxies covering 1<z<5.2, accurately defining their SEDs, their stellar masses of 1-5x10^11 Msun, and enabling us to disentangle the starburst and AGN components. For the handful of high-redshift radio galaxies (HzRGs) with arcsecond-resolution imaging of the dust and CO emission, we find surprisingly complex morphologies, suggesting that in these objects, gas-rich major mergers rather than continuous gas accretion may be dominant.
Here, we propose to test this hypothesis by complementing the existing low resolution data with 0.3" spatial resolution ALMA imaging. Such data are essential to determine whether the FIR emission seen by Herschel is associated with the AGN host, or an interacting companion galaxy that is triggering the starburst/AGN, or some combination of these. This will be the first systematic study of the dust distribution at a few kpc scales in a representative sample of 19 HzRGs. Compared to observations obtained to date, we will quadruple the existing sample, to an order of magnitude lower noise level, and with 5x better spatial resolution.

2013.1.00523.S

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Title

Confirming the recent collisional destruction of an extra-solar Pluto

Abstract

New STIS images of the extremely bright HD 181327 debris ring, a massive analog of our Kuiper Belt, reveal asymmetries consistent with the recent collisional destruction of a Pluto mass object. The STIS image also suggests size segregation in the disk that implies an unseen planet exterior to the main belt of the disk. We propose to observe the HD 181327 debris disk with ALMA to map azimuthal variations in the flux density from mm grains. When combined with our new STIS image, the ALMA observations will confirm or refute the recent collision of a Pluto mass object in the disk and reveal the true visible wavelength scattering phase function, which we will use to confirm or refute evidence for an unseen planet exterior to the belt and improve constraints on the composition of the disk.

2013.1.00524.S

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Title

ALMA Explorations of Nuclear Regions of Nearby LIRGs: Warm Molecular Gas Distribution Down to GMC Scales

Abstract

We propose ALMA mapping in Band-9 at 0.12"/beam of the CO(6-5) line emission and the 450 um dust continuum in the nuclei of 4 luminous infrared galaxies (LIRGs). The data will reveal, for the first time, nuclear dense molecular gas distribution at resolutions < 50 pc, characteristic size of GMCs. Our targets include 2 starbursts and 2 AGNs, and represent two most common nuclear configurations in LIRGs: two targets with a compact nuclear core of < 1" (< 300 pc) and two with a circumnuclear disk of 2" to 2.5" in diameter (500 to 1000 pc). For the latter two targets, we also request quick ALMA observations of CO(6-5) at 0.31"/beam to recover structures over the entire nuclear disk. Our proposal expands our ALMA sample from two LIRGs observed in Cycle-0 to 4 more that represent more typical LIRGs. The ALMA results are crucial in determining physical gas/dust conditions in different nuclear configurations, spatial correlation between CO(6-5) and Pa-alpha emissions, the role AGN plays in gas heating and feedback, and if nuclear dense molecular gas remains in discrete GMCs or is compressed into spatially continuous molecular gas over scales much larger than 50 pc.

2013.1.00525.S

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Title

Caught in a Cosmic Tango: ALMA Spies the Interplay Between Dual AGN in Merger Remnant Galaxies

Abstract

Major galaxy mergers are particularly important for galaxy evolution as they can funnel fuel (gas) into the center of the galaxy triggering both star formation and an active galactic nuclei (AGN). Thus, as a natural consequence, systems with 2+ accreting supermassive black holes (SMBHs) `caught in the act' of merging represent a critical stage in the evolution of a galaxy. Only a few, 13, such dual AGN are known. The properties of the gas in these systems will offer critical clues to the external and internal conditions under which both SMBHs can be activated during these encounters and their influence on the host galaxies. We propose an ALMA study aimed at attaining new understanding of SMBH and host galaxy growth at a critical stage in the merger process: near coalescence. Specifically, we will map at high spatial resolution, ~100 pc, the molecular gas distribution and its kinematics in all 4 merging galaxies for which this is possible given the current ALMA capabilities. These observations will prove instrumental in determining the conditions which are conducive to simultaneous growth of both SMBHs as well as its effect on the host galaxies.

2013.1.00526.S

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Title

[CII] Emission from H I - Selected Galaxies

Abstract

We propose to image directly, for the first time, [CII] 158 micron line emission from the neutral gas associated with two damped Lyman alpha absorption systems (DLAs), i.e., HI-rich galaxies identified in absorption against bright background quasars. The objects at z=1.7947 and z=1.9199 were selected using high resolution spectroscopy for the presence of (1) strong CII*1335.7 absorption lines and (2) emission properties indicating the presence of substantial ongoing star formation. Added to the high metallicities and large kinematic line widths, these properties imply the presence of strong [CII] 158 micron emission. We estimate a 5 sigma detection in 1 hour observing on each object with the cycle 2 compact array. If successful, this will establish CII* imaging with ALMA as the path forward to a prime objective of galaxy-formation research: assessing the mass, kinematic structure, and morphology of these HI-selected galaxies.

2013.1.00527.S

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Title

The carbon abundance in protoplanetary disks

Abstract

The abundance and budget of carbon in protoplanetary disks determines their gas and solid chemistry, and thus the composition of the forming planets and their atmospheres. The Earth is strongly depleted of solid-phase carbon with respect to the Sun, while the atmospheres of some giant planets are thought to have super-solar carbon to oxygen ratios. These differences must originate in the planet-forming disk stage. The carbon budget in a large volume fraction of the disk can be constrained by determining the gas-phase abundance using far-infrared and millimeter lines of the dominant carriers ([CI], [CII], CO). We propose to place the strictest limit so far on the carbon abundance in several planet-forming disks by obtaining sensitive observations of the atomic carbon [CI]~$1-0$ line with ALMA.

2013.1.00532.S

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Title

The Dense Gas Fraction and Its Dependence on Galactic Environment

Abstract

In order to formulate a general star formation theory, the underlying physics that govern star formation processes within galaxies must be understood. Our recent results on extragalactic Giant Molecular Cloud (GMC) populations imply that the internal structure and organization of molecular gas strongly depends on galactic environment - as does their star formation efficiency (SFE), though with different dependencies. Recent studies suggest that the SFE is set by the dense gas fraction and not the global molecular reservoir. Thus, we propose to map the dense gas fraction of massive GMCs (at 70pc(=2") resolution) in the nearby spiral galaxy M74 with ALMA. The dense gas fraction will be determined using several 3mm tracers (low to high density: 12CO, CS, HCO+, 13CO, C18O, HCN, HNC). These tracers will additionally probe the excitation conditions (HCO+, HNC, HCN, 12CO) and independently estimate the CO-to-H2 conversion factor (via the (1-0) transitions of 12CO, 13CO, C18O plus 12CO(2-1)). The requested observations will cover the same area as already mapped in CO(2-1) by our Cycle 1 program that will characterize the general GMC population and the different galactic environments.

2013.1.00534.S

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Title

Is the Central Engine of Markarian 590 Running Out of Fuel?

Abstract

Sometime during the last few years the broad permitted emission lines in the optical spectrum of Mrk 590 have completely disappeared! This goes firmly against our current understanding of active galaxies in the framework where the presence of broad lines depends on source orientation only. Studying extreme behavior such as this often provides the most profound insight and understanding of the physics of active galaxies. It is therefore pertinent that the reason for this unusual behavior be investigated. One plausible explanation is that the central engine is running out of fuel causing the accretion and, hence, the broad line emission to cease. We ask to obtain deep observations of the warm gas in the central regions of Mrk 590 to measure the mass, distribution, and kinematics of the central gas. The aim is to establish if indeed the center is void of gas or whether Mrk 590 may be experiencing cyclic accretion such that the nuclear activity may be revived in the near future.

2013.1.00535.S

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Title

Probing the AGN activity and molecular interstellar medium in ultra-luminous infrared galaxies using CH

Abstract

The goal of this proposal is to establish the CH/CO line ratio as a discriminator between AGN and star-formation dominated galaxies by observing CH (at 560 microns) and CO (J=1-0) in five ultra-luminous infrared galaxies, with and without AGN, at z ~ 0.1. In a small sample of local galaxies observed with the Herschel Space Observatory, we found that the CH/CO abundance ratio is almost an order of magnitude higher in an AGN-dominated galaxy (NGC 1068) compared to three starburst -dominated galaxies (Arp 220, M 82 and NGC 253). This is consistent with the higher abundance of CH expected in X-ray dominated regions, fueled by the presence of the AGN. In addition, estimation of the molecular hydrogen column densities from CH and CO will enable us to test whether the CH is coming from diffuse or dense gas, and thus its reliability as a mass tracer. With the end of the Herschel mission, observations of far-infared CH lines are impossible in nearby galaxies because of atmospheric water vapor. Band-8 of ALMA can detect these lines for galaxies at z > 0.08, the lowest possible redshift for which such a study can be performed.

2013.1.00537.S

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Title

Exploring the chemical fingerprint of episodic accretion

Abstract

We propose to test the episodic accretion model for low mass star formation using the chemical memory engraved in the envelope of low luminosity protostars. For this test, we will observe four low luminosity sources (IRAM04191, CB68, CB130-1, and L673-7), including two VeLLOs (IRAM014191 and L673-7), in C18O 2-1, HCO+ 4-3, and DCO+ 5-4 with the ALMA configuration of C34-1.
With these data we will explore structure in chemical abundances between the inner and outer regions of the envelope. Chemical abundances are strongly sensitive to local physical conditions.
Thus during a burst the chemical signature will change and this signature will persist even when the system enters the quiescent stage. With knowledge of the physical structure we will be able to extract key information regarding the presence and uncertain timescales of episodic accretion.

2013.1.00546.S

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Title

The Explosive Orion OMC1 Outflow

Abstract

The explosive Orion OMC1 outflow in the nearest site of active massive star formation (D~414 pc) may have been triggered by the dynamic ejection of massive stars ~500 years ago. The proposed 1" resolution ALMA J=CO 2-1 mosaic will measure the mass and momentum of gas in near-IR shock-excited fingers protruding form the explosion site. 1.3 mm continuum and molecules will be used to search for dense high-velocity (>100 km/s) clumps expected at the [FeII]-bright fingertips, to measure the masses of dozens of proto-planetary disks in the foreground Orion Nebula and embedded protostars in OMC1, and to trace the 1.2 mm dust and free-free continuum in the field.

The goals are:
* Search for dust and measure radial velocities and masses of clumps in the fingertips.
* Measure the mass, momentum, and structure of the gas along the H2 wakes.
* Determine the masses of the circumstellar disks surrounding in dozens of YSOs.
* Probe the relation between the ~500 year old OMC1 outflow and the 10" long, 200 year old flow from source I.

2013.1.00553.S

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Title

Molecular oxygen in Orion

Abstract

The gas-phase abundance of O2 in cold, well-shielded clouds has been determined by SWAS, Odin, and Herschel to be 2 to 3 orders of magnitude lower than predicted. Explaining this discrepancy is a very strong test of chemical models and our understanding of interstellar chemistry. Herschel has had a major impact, but has not resolved the controversy. One of its limitations has been its relatively large beam size that dilutes the signal from sources of small angular size, and prevents identification of the emitting source and its size in the complex case of Orion OMC1. Unlike the common isotopologue, 18O16O can be observed from the ground. The 234 GHz line is the best candidate and should be detectable with ALMA, and ALMA only. With a synthesized beam size of a few arcsec, we will be able to pinpoint the location of the source of the oxygen emission and its characteristics, and find the explanation for the general absence but selective enhancement of O2 in interstellar clouds.
An additional product of this study will be a deep survey in 14 GHz of band 6, with a sensitivity never achieved in standard surveys. This will help clarify why O2 behaves so differently than expected

2013.1.00556.S

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Title

Structure and properties of the molecular gas in LMC-N11B

Abstract

We propose to map 12CO(1-0) in the star-forming region N11B in the Large Magellanic Cloud. N11B is a unique case of multiple sequential star formation in a nearby metal-poor system.

We aim to examine the structure of the molecular gas with ALMA and to use the synergy with Herschel to solve the long-standing paradigm of photodissociation regions in low-metallicity environments.
There is growing evidence that CO traces a small filling factor (<10%) of the interstellar medium (ISM) in the form of small clumps. On the other hand, the photodissociated envelopes can harbor a significant fraction of the molecular gas H2 - necessary to fuel star formation - accountable via FIR cooling lines such as [CII] 158um.

Our objectives are to:
- identify the CO clumps, study their size and mass distribution as a function of the environment (e.g., feedback from the massive star clusters and the impact on the propagation of star formation under extremely porous ISM conditions).
- examine the [CII]/CO(1-0) ratio and construct a PDR model. We will quantify the mass of CO-dark molecular gas and shed new light on the metallicity dependence of the conversion factor between CO and H2.

2013.1.00566.S

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Title

Bulge Formation in Star-forming Galaxies at z>2

Abstract

We propose to conduct 0¥arcsec.16 resolution dust continuum (350GHz) imagings of 14 star-forming galaxies at z>2 which has been identified by narrow-band surveys with Subaru Telescope in SXDF-CANDELS field. The targets are very suitable for ALMA cycle-2 capabilities because the feasibility is carefully estimated from their MIPS 24um and AzTEC 1.1mm data.
Their rest-frame UV/optical images have already been obtained by WFC3/ACS on HST.

ALMA is the only instrument which can provide us with such high-resolution submm maps.

Combining the rest-frame far-infrared images by ALMA with the rest-frame UV images by HST, we aim to resolve the internal distribution of star formation activities including both dust obscured and unobscured ones and identify the mode of star formation such as ``burstiness'' and ``dustiness'' in each resolved region or clump for the first time.
Our question is, ``where are new stars being formed within high-redshift galaxies?''.
This could be closely related to formation of bulges and disks.
With the extensive high-resolution data-set, we will confirm the epoch of bulge formation and address this issue.

2013.1.00568.S

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Title

Molecular Gas Dynamics of a Dual-AGN Cadidate - W2332-5056

Abstract

We propose to study the molecular gas dynamics within the central 20 kpc of a recently discovered super massive black hole binary candidate W2332-5056 at z=0.3447. A total 2.11 hour, single pointing ALMA observation in band 6, will allow us to probe CO(3-2) kinematics and distribution in the central host, but notably capture the dynamical actions within the central kpc. The observations will provide inimitable dynamical information to test the elusive and rare super-massive AGN binary hypothesis for this system.

2013.1.00569.S

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Title

The origin of H2O emission and molecular outflows in IR-luminous galaxies

Abstract

Water lines provide a unique probe of luminous IR galaxies, since (unlike e.g. CO) they measure the local IR radiation field. Herschel has shown that all local ULIRGs emit strong H2O lines, from highly obscured (opaque at 100 micron), IR-luminous regions with high local IR radiation pressures, which may play a role in driving the molecular outflows. However, progress is hampered by the lack of spatial information.
We will take a major step forward by using ALMA for the first spatially resolved study of H2O emission (3 lines, providing the full diagnostic power), FIR continuum, OH+ emission/absorption (tracing the molecular outflow) and CO(7-6) and [CI] (tracing the high and low excitation molecular gas). We will observe (6 lines in 3 tunings) the gravitationally lensed galaxy SDP17b (z=2.3), at 0.25" resolution (850 pc in the source plane), obtaining the full position dependence of excitation conditions, importance of radiation pressure, occurence and velocity of outflow, and relation to the underlying gas disk. Observations of this type are the only way to probe directly the relation between IR radiation pressure and outflows, and the relation of the H2O emission to other tracers.

2013.1.00576.S

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Title

Observations of the [CII] Emission Line in Hot-Dust Obscured Galaxies

Abstract

The WISE mission has recently identified a rare population of high-redshift, hyper-luminous infrared galaxies, all with bolometric luminosities above 10^13 L_Sun, and many exceeding 10^14 L_Sun. Characterized by their extremely red mid-IR colors and very hot dust temperatures, these hot, dust obscured galaxies (Hot DOGs) likely probe a key stage in the galaxy evolution paradigm. The bulk of the IR emission in Hot DOGs is powered by AGN activity, outshining possible fainter cold emission associated to star formation. The only way to study the ISM properties of the host galaxy in these objects, as well as the effects of the AGN on it, are through kpc-scale imaging of the dust and gas at sub-mm wavelengths. We propose here to use ALMA to obtain deep, high-resolution observations of the 157.7um [CII] emission line and of the FIR continuum in a small sample of carefully selected Hot DOGs to constrain the physical properties of the their dust and gas components and gain insights into their star-formation properties.

2013.1.00582.S

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Title

A Census of the Molecular Gas and Star Formation within a Milky Way-like Spiral at z=1.5

Abstract

Strong lensing can increase the angular sizes of galaxies at high redshifts, enabling studies on significantly finer linear scales than typically possible. One spectacular case of such a system is the z=1.491 spiral galaxy MACSJ1149.5+2233A1, which is lensed into four distinct images having magnification factors ranging between 8 - 23. We propose for 3.8 hr of ALMA Band-4 observations to map each of the 4 lensed images of MACSJ1149.5+2233A1 in the CO (J=3->2) line and 800um (rest-frame) continuum, achieving a physical resolution of ~500pc (i.e., the size of giant HII regions and molecular cloud complexes), to obtain a census of the molecular gas and cold dust content for a Milky Way-like spiral galaxy at a time when the universe was only ~1/3 of its present age. The combination of these new ALMA data with deep HST and VLA data at 0.3" resolution, sensitive to the (un-)obscured star formation, will provide SFR/M_H2 estimates for ~20 individual complexes, leading to a detailed study of the resolved star formation law on ~500pc scales within a disk galaxy at z>1. This investigation undoubtedly has a significant potential for publicity.

2013.1.00584.S

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Title

Characterizing the Earliest Phases of Massive Star Formation in Cold Core Objects detected with Planck

Abstract

IRDCs, seen in extinction against the mid-IR Galactic background, are thought to be the sites of massive star formation. The IRDC samples are however very biased by the detection method, which requires a bright background such as the inner Galaxy. Herschel and Planck, which operate in the far-IR and sub-mm, can detect massive clouds in emission throughout the Galaxy. This offers the opportunity to search for massive star forming clumps in the outer Galaxy and to investigate whether their physical structure, fragmentation, star formation efficiency, and gas dynamics are similar to those found in IRDCs. G191.51-0.76 is a cold core detected with Planck in the outer Galaxy. It has a network of filaments converging into a central massive clump (hub-filament system), and it does not show 70 micron sources making it a precursor of previously reported hub-filament systems such as IRDC SDC13. We propose to mosaic the continuum and N2H+ and HNC (1-0) emission toward G191.51-0.76 with ALMA Band 3 to determine its physical properties, fragmentation and gas dynamics. These results will provide key information about the dependence of massive star formation with Galactic disk location.

2013.1.00586.S

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Title

Testing Schmidt's Conjecture in NGC 300: Bridging the Gap between Galactic and Extragalactic Star Formation

Abstract

A little more than a half-century ago, Schmidt conjectured a power-law scaling relation between the star formation rate and interstellar gas surface densities in galaxies. Much of our understanding of extragalactic star formation is based on this scaling law. However, recent studies of galactic GMCs indicate that our understanding of the Schmidt law may need to undergo serious revision. These studies demonstrate that there is no Schmidt scaling law that relates the SFR and gas surface densities between galactic GMCs. Consequently the empirically derived Schmidt scaling relation for disk galaxies is likely an artifact of unresolved measurements of extragalactic GMCs and not a result of an underlying physical law of star formation. Here we propose to extend our MW studies with an ALMA CO survey and pilot HCN observations of the GMC population in the nearby disk galaxy NGC 300 to: 1) assess the extent to which the physical process of star formation operating in local MW clouds describes the star formation in NGC300, 2) critically test the nature of the Schmidt law in an external star forming environment and 3) bridge the gap between galactic and extragalactic star formation studies.

2013.1.00588.S

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Title

Constraining the Inner Disk Edge of the Solar Analog tau Ceti

Abstract

tau Ceti is the nearest G-type star (3.65 pc) that harbours both a debris disk and planets, with 5 known super Earths tightly nestled inside 1.5 AU. It appears to be a close analog to our Solar System, except that it is missing giant planets on wider orbits, though because of observational biases, if there were any they would not have yet been detected. We propose to use ALMA to image the inner edge of tau Ceti's disk and infer the presence of an unseen massive planet that could be clearing the central hole in the resolved disk.

2013.1.00591.S

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Title

The Interstellar Medium and AGN Feedback in a Young QSO

Abstract

We propose to observe the redshifted far-infrared fine structure transitions of ionized carbon and neutral oxygen, as well as dust continuum from the massive ultraluminous host of the J0927+2001 QSO at z=5.7722. This is a physics-driven proposal with three main goals:

1) We will use fine-structure diagnostics to determine the physical conditions in the starburst within the host of J0927, producing a high S/N map of its [CII] 158 um and continuum emission and detecting the [OI] 146 um transition.

2) We will study gas kinematics, merging activity, and likely outflow superwinds using [CII] spatially resolved spectroscopy.

3) We will detect possible Milky Way-class objects in the FOV within a redshift range of +/- 0.05 (+/- 5 Mpc) from J0927, likely at the center of an early overdensity and destined to become a central cluster galaxy.

2013.1.00601.S

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Title

ALMA measurements of disk turbulence

Abstract

The amount of turbulence in proto-planetary disks controls both the disk evolution and the formation of large solids, which are the seeds for the formations of planets. We propose to image the proto-planetary disk around the young star HD 163296 in the 12CO, 13CO, and C18O J=2-1 transitions to measure the disk turbulent velocity across the entire vertical extent of the disk within the midplane CO snow line. We will study whether the most dense disk regions are quiescent or turbulent, and provide direct constraints to theoretical models for the disk viscosity. The proposed ALMA Cycle 2 observations have the potential to reveal the long-postulated MRI dead-zones which are expected to play a fundamental role in the formation and evolution of planetary systems.

2013.1.00618.S

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Title

A Survey of Very Low Luminosity Objects in Serpens and Ophiuchus

Abstract

Very Low Luminosity Objects (VeLLOs) are young stellar sources that are defined by luminosities less than 0.1 solar luminosity and rising mid-infrared spectral energy distributions. But what exactly are they: brown dwarfs or low-mass stars in formation, systems exhibiting low accretion, extremely young objects? We propose to characterize the VeLLO class through observations of 1.3mm continuum and CO J=2-1 outflow emission of a sample of 12 high-probability candidates in the Serpens and Ophiuchus molecular clouds. This survey is expected to double the number of confirmed VeLLOs, provide estimates on the masses of their inner envelopes, and help address questions concerning the nature of VeLLOs.

2013.1.00645.S

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Title

Resolving the narrow Kuiper belt analog around epsilon Eridani

Abstract

The nearby star epsilon Eridani hosts the closest known analog to our Kuiper belt and is the only K dwarf among the ``Fab Four'' prototype debris disk systems first discovered with IRAS. Sub-mm/mm imaging with SCUBA and MAMBO have revealed the presence of a belt of large grains at a radius of ~ 70 AU which is constrained to have a width <~ 6 AU, implying a Kuiper belt analog which is at least as narrow as the one in Fomalhaut recently studied with ALMA and our own classical Kuiper belt.We will obtain ALMA continuum imaging at 230 GHz (1.3mm) in order to provide the first high resolution and high signal to noise sub-mm data for part of the dust ring of the epsilon Eridani system. The proximity of epsilon Eridani (3.2 pc) makes this the best debris disk to constrain the narrowness of its planetesimal belt. The data will resolve the width of the ring for the first time, setting constraints on the mechanisms which maintain such narrow rings, such as planetesimal shepherding by planets. Additionally it may identify the presence of clumps suggested by previous single-dish images interpreted as planetesimals trapped in resonance with an unseen planet.

2013.1.00647.S

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Title

Gas Temperature Structure and Mass of the Disk around DM Tau

Abstract

We propose high spatial resolution ALMA observations of CO emission lines from the transition disk around the source DM Tau. Our aim is to infer the temperature structure of the disk from a multi-line (6-5, 3-2 and 1-0 transitions), multi-isotopic (^{12}C^{16}O,^{13}C^{16}O and ^{12}C^{18}O) study which traces gas at different spatial locations and hence physical conditions in the disk. The observational program will be accompanied by detailed thermochemical modeling that includes selective photodissociation of isotopic species to compute the gas temperature. Ancillary HD 1-0 line flux measurements will be used to constrain the gas mass of the disk. Comparisons between models and ALMA data will allow us to determine disk gas temperature structure, which is important in regulating the chemical state of the disk and forms a key input to various disk evolutionary processes such as viscous accretion, photoevaporation and finally planet formation.

2013.1.00650.S

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Title

Molecular Gas and Dust in the Environment of the Nearest Gamma-ray Burst

Abstract

We propose to obtain the spatial distribution of CO and dust continuum emission with band 7 toward the host galaxy of gamma-ray bursts (GRB) 980425. While multi-wavelength observations of GRB host galaxies have been conducted, the environment around GRBs is still unclear due to the lack of spatially-resolved observations of molecular gas and dust. In our pilot observations in ALMA cycle 0, we found that the gas-to-dust ratio in a GRB site is significantly lower and dust rich compared to other regions within the host. However, the angular resolution of 4 kpc used in the observations is still not enough to resolve the local environment.
Here we propose to observe the host galaxy of GRB980425 at z=0.0085 (36.1 Mpc). This is the nearest GRB host and the best target to study the local environment around a GRB. The objective of this proposal is to reveal the spatial distribution of molecular gas, dust, and gas-to-dust ratio within the GRB host with 1" spatial resolution (<200 pc). We will examine the difference between the GRB site and other regions in the host to understand the characteristic property of the GRB site.

2013.1.00652.S

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Title

Spying on our Neighbor: Peering into Low Metallicity Molecular Clouds in the Small Magellanic Cloud

Abstract

A dominant reservoir of H2 gas faint in CO emerges as metallicity decreases, which alters the structure of molecular clouds and perhaps the sites of star formation. With ALMA, we can reach the resolution necessary to see the structure of photodissociation regions and the transition from ``CO-bright'' to ``CO-faint'' molecular gas for the first time at 1/5 Solar metallicity in the Small Magellanic Cloud. We propose to map four regions in the Southwest Bar of the SMC at high spatial and spectral resolution (1.6" or 0.5 pc scales and ~0.1 km/s) in 12CO, 13CO, and C18O (2-1). We will determine the mass, structure, and kinematics of molecular clouds across a range of environments. We will explore the structure of CO gas, the transition to CO-faint molecular gas, and the effect of the CO-faint molecular gas on low metallicity star formation. With the slew of ancillary data in hand (much collected by the Co-Is in this proposal), including PAHs, [CII], [CI], [NII], [OI], dust continuum, and dust-based H2 maps, we can fully exploit the ALMA observations and answer key questions needed to inform ISM and star formation models used in galaxy simulations.

2013.1.00658.S

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Title

Hunting for gaps in HEABE disks

Abstract

Gaps in disks are a signpost of disk dispersion and planet formation, but finding disk gaps is challenging. Spectral Energy Distribution (SED) studies do not provide unequivocal evidence for gaps, especially in disks around higher mass Herbig AeBe stars. Recently it has been shown that many of these Herbig stars classified as flaring are in fact disks with developing or fully cleared large gaps. We propose to image three flaring HAEBE disks for which strong indirect evidence of such gaps exists. Our proposal will increase the number of Herbig disks with proven gaps by 3 and deliver constraints on the evolution planet-forming

potential of these disks.

2013.1.00659.S

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Title

Detecting in CO(1-0) the Strongest Molecular Outflow found by Herschel in the Southern Sky

Abstract

We have recently discovered, in IRAS 20100-4156, the second most powerful molecular outflows seen in any ULIRG in the Local Universe. Judging from the absorption profile of the 119um OH doublet, its outflow properties are more extreme than those of Mrk231, itself the most extreme source in the Herschel-SHINING sample. Because of their exceptional molecular outflow properties we are obtaining further observations of these two sources to study their molecular outflows in detail. In March we obtained Herschel spectra of transitions between the excited levels of OH to constrain the outflow geometry. In August we obtained CO(1-0) data for the northern hemisphere target IRAS 03158+4227 from PdBI. Here we propose to observe the high-velocity wings of the CO(1-0) line in our southern hemisphere target IRAS 20100-4156 using the exquisite sensitivity and resolution of ALMA to measure the mass of the molecular gas in the wind, the geometry of the outflow to determine the outflow rate and kinetic power and, in combination with the measurement of the molecular gas reservoir from the CO(1-0) core, the gas depletion time scale for this still deeply buried, but possibly quickly evolving, ULIRG.

2013.1.00663.S

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Title

Unveiling the gas and dust structure of the planet forming candidates SZ91 and MYLup

Abstract

Despite the large number of extrasolar planets that have been identified in the last decade, we still struggle to fully understand the planet formation process. The identification and characterization of protoplanetary disks that are currently forming giant planets can provide the most direct observational constraints on the theories of planet formation. From our large survey of transition disk systems in Lupus, ALMA Cycle 0 data, and VLT/NaCo sparse aperture masking observations, we identified two transition disks that are excellent candidates for harboring forming planets. We here request 0.5 hours of ALMA observations of Sz 91 and MY Lup in band-6 to measure the gas mass of these disks and 1.8 hours in

band-7 to resolve the structure of the inner disks where planet formation could take place.

2013.1.00664.S

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Title

From Hydrocarbons to Dust in Protoplanetary Nebulae

Abstract

We propose to observe two carbon-rich protoplanetary nebulae (PPNe), CRL 618 and CRL 2688, to investigate the physical and chemical conditions that lead to complex hydrocarbon chemistry in the circumstellar environment of evolved stars after the AGB phase. Polyacetylenes and cyanopolyynes have been detected with ISO in both sources. However benzene, the first aromatic ring, is only seen in CRL 618. Only CRL 2688 shows emission from dust grains rich in aliphatics. For both molecules and grains, UV-processing was invoked as a key process in driving the chemical evolution.

We want to explore the emission of vibrationally excited HCCCN in both sources, CCH, HCN, CN and CO to constraint the physical and chemical conditions. In addition towards CRL 618, HCO+ and a recombination line of Hydrogen will be observed to better characterize the photodissociation region (PDR) at the interface between the HII region and the torus. Only ALMA can addressed this project since PPNe have complex morphologies and the most active chemistry is expected to occur in the densest part at scales of 0.2 to ~1". We will obtain unique data to investigate carbonaceous grain formation and evolution.

2013.1.00668.S

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Title

Probing the Gas Excitation in high redshift Main Sequence Galaxies

Abstract

Recent CO observations in normal main-sequence galaxies at high redshift have shown that their star formation efficiency is lower than in case of merger driven SMGs, more consistent with the star formation efficiency in local spiral galaxies. The picture that emerges from this studies is that SMGs form stars more rapidly because their gas clouds are more compressed so they churn more quickly through the available gas reservoir than the typical normal high-z disk galaxies. These differences in the physical conditions of the ISM are expected to affect the CO and CI line ratios. Indeed earlier studies of low-J CO transitions suggest that main sequence galaxies have similar ISM properties than the MW. A coherent picture of the gas excitation in these systems, however, is missing so far.

We here aim to investigate the gas excitation in three main-sequence galaxies selected from the PHIBSS survey. We propose to study the shape of the CO SED in conjunction with both lines of atomic carbon to investigate the physical conditions of their ISM. Our study aims to provide for the first time well characterized templates of the gas excitation in high redshift main-sequence galaxies.

2013.1.00670.S

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Title

Investigation of Gas-to-Dust Mass Ratio in the Asymmetric Disk around HD 142527 in Band 3

Abstract

We propose Band 3 observations of the asymmetrically gapped disk around the Herbig Fe star HD142527 in 13CO/C18O J=1-0 and dust continuum at 100 GHz. Our group made Band 7 observations of the disk in Cycle 0. The continuum emission shows strong asymmetry and is extremely bright (Tb=24 K at 156 AU from the star). There are two possible situations that account for these results: (1) the disk is in gravitationally unstable state to form a gaseous planet, or (2) dust grains are highly accumulated to form a rocky planetary core. The key parameter to judge which is the case is gas-to-dust mass ratio (g/d). Our analyses of g/d with disk modeling suggests that g/d in the regions of lowest surface densities may change significantly in radial direction. However, g/d in most regions of the disk cannot be determined solely from Band 7 observations, because J=3-2 lines of 13CO and C18O are optically thick. The disk should be much more transparent to the J=1-0 lines of CO and dust continuum emission in Band 3, allowing us to better estimate g/d and size distribution of dust particles in the entire regions of the disk.

2013.1.00686.T

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Title

The Distribution of Extended Source Species in a Bright Apparition TOO Comet

Abstract

Certain molecules observed towards cometary atmospheres have a physical distribution that cannot be explained as direct sublimation from the nucleus or gas-phase chemistry within the coma. The extended source of these species is not known, though it is believed to be an organic mixture or degradation of dust. As part of a joint collaborative multiwavelength effort, we will conduct an observational survey of extended source species and their possible parent or related molecules in a target of opportunity comet. This study will image CO, H2CO, and CH3OH. These observations will help constrain the origin and extent of the distributed source for each species, the scalelength of the source, establish accurate molecular abundances, and provide insight into comet chemistry. These results will build off observations of these molecules in Comet C/202012 S1 (ISON) and C/2012 F6 (Lemmon) previously obtained with ALMA. The target of opportunity
comet should have Q(H2O) ~ 1e29 s-1, and may be a new dynamical object or a known apparition undergoing an outburst event.

2013.1.00691.S

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Title

The formation of binary Kuiper Belt objects: evidence through thermal imaging

Abstract

Kuiper Belt Objects (KBOs), which are believed to be amongst the least altered bodies in the Solar System, present a surprisingly high fraction of bodies in binary or multiple systems. Several binary system formation pathways have been proposed, including capture, catastrophic collisions and co-formation through gravitational instability. Dynamic models have shown that understanding the occurrence of those formation mechanisms would put several constraints on the early outer solar system dynamics and evolution. To achieve this, it is essential to physically characterize and compare the individual members of binary systems.
The objective of this project is to obtain a thermal image of two well known binary KBOs (Haumea and Orcus) and to measure for the first time the albedo of each component down to a precision of 20%. This will allow us to establish whether the components share similar albedos, putting constraints on their formation mechanisms. In addition, we will derive better and non-ambiguous measurements of the systems' average density, which is an indication of the ice/rock bulk fraction at the formation location and time.

2013.1.00694.S

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Title

Mapping Ionization Processes in Protoplanetary Disks with Chemistry

Abstract

Midplane ionization in protoplanetary disks plays a vital role in setting turbulent (MRI) and thermal physics, and drives gas-phase pathways towards chemical complexity and deuteration. Ionization sources include stellar photons, cosmic rays (CRs), and short-lived radionuclides (SLRs). Each process has widely differing energies and physical regimes. X-rays dominate the inner 50 AU, whereas CRs and SLRs are important further out. Molecular ions present in the cold gas as seen in sub-mm emission allow us to trace ionization in the dense midplane. Within the CO snow line, HCO+ is the preferred ionization tracer, whereas N2H+ provides insight at larger radii. As a result, these lines can be used in tandem to measure ionization on all radial scales. Guided by our work on ionization processes, we have isolated IM Lup as the ideal target for a resolved ionization study with ALMA. The IM Lup system has a gas-rich and extended (R~700AU) disk, along with an X-ray stable star. The proposed set of observations allows us to directly trace midplane ionization and its source as a function of distance from the parent star via sensitive

H13CO+ and N2H+ resolved observations.

2013.1.00700.S

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Title

The atomic to molecular phase transition in the Magellanic Stream

Abstract

We propose to measure the molecular fraction of the Magellanic Stream, the closest example of a gaseous accretion stream, to constrain the formation rate of molecular hydrogen in low-metallicity environments and resolve microphysical gas properties leading to star formation. Recent studies show that the Stream contains rich atomic hydrogen structure with highly patchy and weakly-excited molecular gas, suggesting that absorption-line spectroscopy will provide the best observational constraints on its molecular abundance. We propose to search for absorption lines from HCO+, HCN, HNC and CCH in the direction of 14 radio continuum sources known to be bright at 100 GHz. We require high sensitivity (optical depth<<1), and ALMA, even in its current phase, is the only instrument that can accomplish this. The detection of dense gas tracers like HCO+ in the Stream would imply the existence of a significant cool-gas reservoir and would have huge implications for the mass and evolution of the Magellanic System, as well as provide important clues about molecular content and star formation in the first galaxies in the Universe.

2013.1.00704.S

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Title

Deep dust continuum observations of giant Lya nebulae at z=3.1

Abstract

We propose band 7 dust continuum observations of 4 giant Lya nebulae (LABs) at z=3.1 with different morphological types (2 spherical and 2 filamentary LABs). The spherical LABs could be made from gas outflows (superwinds) from starbursts induced by frequent galaxy-galaxy mergers, while the filamentary LABs may trace continuos gas inflows (cold streams) along the underlying dark matter filaments.

To test this interpretation, we request 350 GHz continuum observations down to a sensitivity of rms=0.04mJy to identify any associated dusty starbursts with star formation rate, SFR > 25 Msun/yr. The angular resolution of 1.1" (8kpc at z=3.1) achievale with the most compact configuration is small enough to examine if the starburst regions exceed the SFR surface density threshold for superwinds, 0.1 Msun/yr/kpc^2, which can drive substantial gas outflows within the LABs.

With 4.6 hours of observations we will identify the key processes forming these giant Lya-emitting clouds, which may be more widely relevant for galaxy formation and the large-scale gas circulation between galaxies and the surroundings.

2013.1.00708.S

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Title

Probing Dust and Gas Evolution in Disks: The pivotal Chamaeleon II association

Abstract

Dust in Protoplanetary disks dissipates with typical timescales of ~3 Myr. By 10Myr, very few disks are detected and little primordial material is left. The formation of gaseous planets must be complete by then. However, this is based almost entirely on measurements of the continuum, of dust, and it assumes that the gas dissipates on the same timescale. Very little information is available regarding the gas dispersal timescale. The Cha II association has an estimated age of about 3-4Myr. The disk detection rate in Cha II, as seen by continuum, is down to ~50% for KM stars making Cha II a perfect place to study disk evolution at the critical time when they evolve rapidly. For comparison the same fraction is ~80% in the 1-2Myr Taurus and Rho Oph.

We propose to survey all known K&M stars with disks of the Chamaeleon II association to measure the band 6 continuum and resolve the disk sizes. We also propose to observe three CO isotopologues to search for the presence cold gas. The sample is carefully selected in stellar mass and will be readily comparable, including gas for the first time,with younger associations with minimum biases.

2013.1.00710.S

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Title

Constraining the Episodic Accretion of Protostars

Abstract

The traditional picture of building stars by the steady disk accretion is challenged by results from the Spitzer ``Cores to Disks" survey. The episodic accretion of protostellar disks has been proposed, which may revolutionize our understanding of various aspects of star and planet formation. The most dramatic episodic accretion events in YSOs are FU Orionis and EXor outbursts. In order to understand the outburst mechanisms, we propose to carry out a band-6 survey of nearby FU Orionis (3 targets) and EXOr objects (5 targets) in Orion with 0.2” resolution to measure the gaseous disk mass (from the 13CO and C18O line intensities) and the dust continuum structure. All 8 objects are within 10 deg of each other in the sky and can share phase calibrators. The program can thus be completed in only 1.6 hs.

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Title

An ALMA 1.3 mm spectroscopic survey in the Hubble Ultra Deep Field

Abstract

We propose to obtain an unbiased, deep CO/[CII] spectral scan and (parallel) ultra-deep continuum imaging toward a region in the Hubble Ultra Deep Field (UDF) using ALMA in band-6. We aim to encompass a region of 1 arcmin^2 in a 7-point mosaic, covering the entire band-6 through frequency scans, thus comprising the main epoch of galaxy assembly at 0<z<4 for CO line emission and 15 newly discovered Lyman break galaxies at 6<z<8 for [CII]. We expect to detect at least 25 CO emitters and 30 continuum sources down to an H2 mass limit of 2.5x10^9 Msun and FIR luminosities of 1x10^11 Lsun (5-sigma). These observations will allow us to measure the CO luminosity function, and thus H2 mass function, well below its knee, providing unprecedented constraints on the evolution of the cosmic density of molecular gas. Most importantly, this unique study will open new unexplored regimes by detection of serendipitous CO line emitters at 0<z<4, and may represent the only means to confirm redshifts for several galaxies at z=6-8, which have proven extremely difficult to obtain through optical/NIR spectroscopy.

2013.1.00725.S

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Title

Interferometric mapping of magnetic fields in the W43 mini-starburst

Abstract

The immediate objective of this proposal is to map polarized dust emission in the 6 most intense clumps in the W43 mini-starburst at sub-arcsecond resolution, in band 6, with ALMA. W43 has been found to contain two of the largest cloud groups of the first Galactic quadrant at the interface of the Galactic bar with the inner Scutum spiral arm. From the whole region, the W43-MM1 is the largest clump likely forming a large cluster of high-mass stars. W43-MM1 has already been mapped in polarization with BIMA and recently by the SMA at 4 and 2 arcsec resolution respectively. Both results suggested pinched morphologies for the field and slightly super-critical equilibrium conditions. Thus, we would like to extend these results to whole mini-starburst by mapping our sample with ALMA to derive the magnetic field morphology and to estimate the field strength on the plane of the sky allowing us to evaluate the dynamical equilibrium of each clump. Additionally, we will get, as a by-product, an exquisite Stokes I continuum image for each source in our sample, which we will use to study the fragmention process inside the clumps selected in the W43 mini-starburst.

2013.1.00726.S

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Title

Probing magnetic fields in the inner envelopes of Class 0 protostars via dust polarization

Abstract

We propose ALMA Band 7 dust polarization observations of 3 Class 0 protostellar cores in Serpens in order to infer their magnetic field morphologies. These sources were previously mapped at CARMA with 2.6" angular resolution. The CARMA maps showed that in 2 of the 3 cores the magnetic field is poorly aligned with both the large scale field in the surrounding molecular cloud and with the bipolar outflows from the protostars. With 0.36" resolution, the ALMA observations will test the hypothesis that the magnetic fields in these sources are wrapped up toroidally by core rotation on scales of a few hundred AU. Such field wrapping could help to resolve the problem of the "magnetic braking catastrophe" that impedes the formation of Keplerian disks. Band 6 molecular line observations with comparable angular resolution of the same sources will be used to constrain outflow directions and core rotation axes.

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Title

Effects of active galactic nucleus and starburst in the nearby galaxy NGC 1068: High spatial resolution images of neutral carbon (CI)

Abstract

We propose to obtain high resolution (~0".5) images of neutral carbon (CI) at 492 GHz toward the nearby Seyfert galaxy NGC 1068.

Abundances of molecules and the understanding of physical and chemical processes are fundamental information for the astrophysics and astrochemistry. In galaxies one of the interesting topics is the effect of X-rays from AGNs (active galactic nuclei) on interstellar matter.

We obtained images of several molecules with ALMA band 3 toward NGC 1068 from our cycle 0 observations (2011.0.00061.S, PI S. Takano) covering the nuclear region and the surrounding starburst ring. The images demonstrated distributions of molecules in one or both of these extreme regions. These images are excellent for the study of physical and chemical processes.

Encouraged by these results, we propose to observe images of CI with the new capability of band 8. Since the field of view is ~12”, the nuclear region and two positions in the starburst ring will be observed. The distribution will provide valuable data to study the effects of X-rays, cloud age, and relation to carbon-chain molecules. This study will also be useful as a template to interpret CI in high-z galaxies.

2013.1.00735.S

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Title

Revealing Interstellar Matter Structure at the Heart of NGC 253

Abstract

We propose a high spatial resolution observation of a hydrogen recombination emission line (H26alpha) toward the center of nearby starburst galaxy NGC 253 in the ALMA Cycle 2. Based on an ALMA Cycle 0 data, a hydrogen recombination emission from NGC 253 at (sub-)millimeter wave was turned out to be sufficiently bright and powerful tool to investigate properties of ionized interstellar medium. We found peculiar motion of ionized gas around the center of NGC 253. The gas have larger velocity width than molecular gas, and show totally different kinematics.
High spatial resolution (<0.''2) and sensitive observation of H26alpha line simultaneously with molecular emission lines will be able to catch ionized shells of compact molecular cloud in the heart of starburst region. The H26alpha data also provide clue to the H40alpha peculiar velocity structure because the shells might be the origin of large velocity width.

2013.1.00736.S

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Title

Probing the Inward Motion in the Class 0 Protostar NGC 1333 IRAS 4A

Abstract

Although gravitational collapse has been widely accepted from the theoretical viewpoints of star formation, the observational study of infall motions is usually a challenge. A major issue is that such kinematic features at relatively low velocity are easily contaminated by other star formation activities. We request ALMA observations towards NGC 1333 IRAS 4A to explore gas kinematics down to a scale of 50 AU. Together with the previous investigations over relatively large scale infall motions in IRAS 4A, we aim at establishing a comprehensive picture of the infalling motions from large to small scale in this region. Thanks to the new capability in Cycle 2, we can simultaneously capture five H2CO transitions with various energy levels, which trace different layers of infall motions. We expect to extract with radiative transfer models the physical parameters of the infalling gas from the observed spectra, determine whether the spatial distribution of infall speed is consistent with free-fall, and explore the role of forces other than gravity (such as magnetic field) in affecting the collapse dynamics.

2013.1.00740.S

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Title

Unveiling Merger-driven Gas Physics in the Nucleus/Overlap Regions of Mid-stage IR-bright Merger VV114

Abstract

Numerical simulations have demonstrated the importance of galaxy mergers in triggering starbursts and fueling the AGN in the host galaxies. An observational test of gas response requires mapping both the diffuse and dense ISM in merging U/LIRGs at high resolution. We obtained ALMA cycle 0 HCN/HCO+/CO data toward the mid-stage merger VV114 in order to test this scenario. From this study, we found an unresolved component which may be surrounding an AGN, and ~10 dense gas clumps associated with extended starbursts. Furthermore, we used a radiative transfer model to characterize the physical conditions across the merging system. However, our data were limited in resolution and we could only

derive the gross properties. In addition, our cycle 0 CO image was suffering from severe dynamic range issues, and only the highest peaks were mapped reliably. Therefore we propose 6.4 hours of ALMA Cycle 2 time to map the HCN, HCO+ and CO lines at the highest resolution offered through Cycle 2 (~ 48 pc). Our aims are to identify the dense clumps at GMC-scale, and to clearly differentiate the AGN and SB components using spatial and kinematical information along with radiative transfer models.

2013.1.00742.S

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Title

A comprehensive view of the role of molecular gas content in main-sequence galaxies at z>2

Abstract

We propose to conduct deep CO line observations of star-forming galaxies at z=2.5 in an exceptionally unique field, CANDELS-UDS-SXDF. Two pointings include 12 main-sequence galaxies at z=2.5 which are selected by our narrow-band Ha emitters survey with Subaru Telescope. They are clustered and embedded in a filamentary structure traced by far-infrared images (SPIRE/AzTEC), suggesting the presence of dusty star-forming populations. Therefore, the targets are very suitable for cycle-2 capabilities in terms of observational efficiency and feasibility. Moreover, we have been accumulating extensive datasets in this field, including existing HST images , KMOS multi-IFU data, and ALMA 1.1mm imaging.

The proposed observations allow us to exploit the molecular gas content of galaxies to lower stellar mass for the first time. Our goals are to derive their gas fraction and depletion timescale, and relate them with stellar mass, specific SFR, mode of star formation, morphology, and environment. This will give us critical information to characterize the variation of star formation activities with respect to the main-sequence on the SFR-M* plane and address the origin of the main-sequence.

2013.1.00745.S

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Title

Assessing the nature of the ISM at high-z through multiple detections of fine-structure lines

Abstract

The physical and chemical properties of the interstellar matter (ISM) and their redshift evolution are crucially important to understand the evolution of galaxies. Rest-frame optical diagnostics are not useful at z>3.5 due to the limited NIR atmospheric transmission window, that prevents us from investigating the quantitative assessment of the ISM in high-z galaxies. However, the superb sensitivity of ALMA enables us to observe some fine-structure lines at high redshifts, that can be used to study the nature of the ISM. Here we focus on a strong [CII] emitter, BR 1202-0725 at z=4.69. Thanks to its high [CII] luminosity and optimal redshift, we can observe [NII]122, [OI]145, and [NII]205 (in Band 8, 7, and 6) within a realistic observing time. By comparing the obtained emission-line flux ratios with our theoretical models, we will investigate the gas density, metallicity, and possible truncation of the PDR, in this system. Since this system consists of a SMG and a QSO, we can also study the possible AGN effects on the ISM properties. This project will bring us brand-new clues to understand the baryonic evolution of galaxies and the IGM cosmic reionization.

2013.1.00749.S

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Title

Dynamical Properties of Dusty Star-Forming Galaxies in the Peak Epoch of Star Formation

Abstract

Dusty star-forming galaxies (DSFGs) at high redshift are thought to be dominantly highly dissipative mergers of gas-rich galaxies that represent extreme, short-lived starbursts. This picture is supported by studies of gas dynamics, but unfortunately, the resolution of these past studies remained limited to 3-4 kpc even for the best handful of cases (with only a single exception), which is barely adequate to resolve the galaxies. Using the advanced capabilities of ALMA in cycle-2 (in particular band 8 and the longest baselines) and the magnifying effect provided by gravitational lensing, we here propose to study the [CII] gas dynamics in a large, carefully-selected sample of 14 Herschel-selected DSFGs covering the peak epoch of galaxy formation down to 100-500pc resolution. Based on uv plane lens modeling and dynamical models, we will investigate the occurence rate of major mergers vs. disks in our sample, measure dynamical masses, and constrain the physical properties of individual gas clumps down to physical scales that will only become accessible with full ALMA in unlensed galaxies at these distances. This comprehensive investigation thus will remain unrivaled for years to come.

2013.1.00760.S

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COI	Randall, Scott	NA	United States	Harvard-Smithsonian Center for Astrophysics
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Title

Measuring the Most Energetic Event in the Universe

Abstract

Galaxy clusters are the largest gravitationally-bound objects in the Universe and, according to the hierarchical picture of structure formation, are the most recent to form. A crucial aspect of their formation is through mergers, which violently dissipate most of their kinetic energy in shocks. The merger in 1E0657-56 -- a.k.a. "the Bullet Cluster" -- is one of the cleanest astrophysical labs for shock physics and may be the single most energetic event in the visible Universe since the Big Bang itself. The Bullet Cluster provides direct evidence that clusters are dominated by cold dark matter through the large spatial s eparations between the gas and lensing peaks. We propose to use ALMA+ACA Band 3 observations to provide the first sensitive (~7.6 uJy/bm), high-resolution (<8") Sunyaev-Zel'dovich effect measurement of the shock front in the Bullet Cluster. We will jointly model the ALMA measurements of the shock with deep X-ray data from the Chandra and NuSTAR X-ray telescopes, and compare these measurements to existing arcminute-resolution measurements to place more direct constraints on the shock energetics and better infer the line of sight distribution of the gas.

2013.1.00764.S

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Title

Probing Accretion Flow Dynamics of Sgr A* on Scales from 1 to 1000 Schwarzschild Radii with ALMA Polarimetry

Abstract

Sagittarius~A* is the nearest supermassive black hole and presents an exceptional opportunity for detailed examination of accretion physics. The polarimetric capabilities of ALMA are poised to transform our understanding of Sgr A* by uncovering variations associated with the accretion environment and dynamics. Whereas previous efforts have constrained variability in rotation measure over a timescale of years, ALMA has the potential to uncover changes in both the intrinsic polarization and the subsequent Faraday rotation on timescales of minutes. With the impending impact of the G2 gas cloud, the potential information from both short and long timescale variations is especially rich, and can enable dynamical tomography of the accretion flow. Finally, a single long pointing with ALMA can resolve the polarimetric signature of intra-hour variations seen at submillimeter wavelengths, suggestive of quasi-periodic orbits and associated with dynamical activity of the accretion flow on event-horizon scales. These signatures can probe the relative contributions of coherent and turbulent magnetic structures in the innermost accretion flow.

2013.1.00773.S

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COI	MacGregor, Meredith	NA	United States	Harvard University
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Title

Spatially Resolving the Planetesimal Disk around HD 95086 - A Young Analog of HR 8799

Abstract

HD 95086 is a younger analog of HR 8799 based on the similarity in their planetary configuration -- the warm and cold debris produced from the leftover planetesimals that are dynamically sculpted and perturbed by the directly imaged giant planets. The resembling is further enhanced by the discovery of a disk halo in HD 95086 through re-analysis of Herschel resolved images. This exciting discovery suggests that the formation process of such a system might be common, and provides a unique opportunity to address the questions about such system's formation and evolution. Millimeter-wavelength observation of the debris disk with ALMA can provide a unique new window into the structure and dynamics of the HD 95086 system. By spatially resolving the cold debris disk at high signal-to-noise for the first time, we

will better understand the nature of the extended halo of small dust grains observed at far-infrared, and place valuable dynamical constraints on the mass of HD 95086 b, assess the the presence of other unseen planets, and determine the prospects for long-term dynamical stability of the system.

2013.1.00781.S

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Title

Bright End of Number Counts Revealed by ALMA

Abstract

We propose 1.1 mm (band 6) observations of 333 bright submillimeter/millimeter-bright galaxies (SMGs) in our AzTEC 1.1 mm source catalogs in three deep survey fields. In the previous observations of SMGs with single dish telescopes, it is highly possible that multiple sources were detected as a single SMG due to the coarse angular resolution (~15"-30").
In our proposed observations, we will obtain the constraints on number counts at bright end with high angular resolution observations (0.5") by separating multiple sources. We will reveal the fraction of multiplicity for SMGs detected in single dish surveys, and create true number counts by using a large sample of SMGs. Our AzTEC source catalog contains the largest number of 1 mm-selected sources to date, and is best suited for studying the bright end of dusty star-forming galaxies.

2013.1.00783.S

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Title

ALMA Identification of An Accreting Disk in a Proto-Brown Dwarf Candidate, L328-IRS, and Its Implication

Abstract

L328-IRS as a Very Low Luminosity Object (VeLLO) is believed to be a proto-brown dwarf forming like a normal star and it may be one of the best example for studying the origin of the brown dwarf. Because a CO outflow from this source is discovered, its accreting disk is expected to exist as a main path for the accretion flow onto the proto-brown dwarf and also a launching ground of the outflow. We propose to make the first search for a disk structure in a proto-brown dwarf in C18O and 13CO 2-1 with ALMA. Finding a possible Keplerian disk and precise measurement of the dust envelope around L328-IRS from 1.2mm continuum observation will enable to discuss whether L328-IRS is a bona fide proto-brown dwarf and how the disk of a proto-brown dwarf is similarly forming compared with those of ordinary protostars.

2013.1.00786.S

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Title

Using [CI] to determine the distribution and heating mechnanism of H2 in a z=4.8 star-forming disk

Abstract

In cycle 0, we identified a large, 8 kpc rotating [CII] disk in
a strongly star-forming galaxy at z=4.8, ALESS73.1. Its [CII] emission extends
well beyond the host galaxy, but the gas it traces (atomic or molecular)
is unknown. Here we propose matched-resolution imaging of the
[CI] (1-0) and (2-1) lines (and simultaneous high-J 12CO and 13CO) to: a)
test a new method to determine the full extent and mass of its H_2 gas disk,
its velocity field, and enclosed dynamical mass, b) look for potentially
serious biases of the very luminous [CII] line in tracing the H_2
gas in galaxies, and c) determine if FUV photons from its starburst
can maintain the thermal state of the dense H2 gas
The answer to the latter directly impacts on the initial conditions of
star-formation and whether they can be dramatically reset in such disks
Thanks to its fortuitous redshift, allowing both [CI] lines, [CII] and
high-J CO lines to be observed with ALMA, its unlensed and isolated
nature, ALESS73.1 is the ideal target for this complete and spatially
resolved study of the molecular and atomic ISM tracers.
This [CI]-based H2-tracing method can be applied throughout
0<z<8.6, bypassing the X_CO factor.

2013.1.00788.S

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Title

Measuring Crucial Parameters of the First Known Stellar Merger

Abstract

Nova Sco 2008 was recently identified as the first definite merger known between two convective stars. Stellar mergers are thought to be a significant factor in the evolution of stellar clusters and galactic centers, as well as possibly the origin of several types of unusual stars, but they are poorly understood because of a lack of data until now. One critical parameter for both dynamical modeling of the merger and predictions of the nature of the merger remnant is the amount of mass expelled from the merger during the outburst. Infared data of the merger remnant show that there is a substantial amount of dust in the ejecta. We propose to estimate and constrain the mass of the dust using standard techniques of millimeter astronomy. Our measurements will also constrain the nature of the dust, and form an essential component to modeling the ejecta material for the first time.

2013.1.00793.S

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Title

The ALMA edge: Gas and Dust in Edge-on TTauri disks

Abstract

We propose to resolve the largest and brightest edge-on disk in Taurus,2MASS J04202144+2813491,in CO 3-2 isotopologue emission lines and in band 6 and 7 continuum. The edge-on geometry allows to directly measure (i.e. without any modelling) a number of key physical and chemical properties of T Tauri disks, in particular the vertical (and radial) extension of the disk in gas and dust, and the abundance of molecules in the UV-shielded parts of the midplane, where ice formation should lead to a dramatic decrease of the gaseous concentrations. The ALMA data about the distribution of the gas and the large dust particles in the disk will be complemented by new auxilliary near-IR scattered light image data which probe the distribution of small grains. By comparing the gas distribution to the distibutions of small and large dust grains, we will draw conclusions about the disk shape, the validity of hydrostatic equilibrium, and the settling and radial migration of solids in disks with unprecedented detail. All are key issues for a better understanding of the physical and chemical processes during the early stages of planet formation.

2013.1.00798.S

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Title

Characterising the gas and dust distribution in the disc surrounding IM Lupi

Abstract

The first steps of planet formation are believed to be the growth of initially small, micrometric dust grains and their decoupling from the gas phase via vertical settling and radial migration.

IM Lupi is an ideal laboratory to validate and quantify these theories. It is a southern T Tauri star with one of the best characterised protoplanetary disc. We have performed extensive modelling of the currently available data and showed that the disc displays strong evidence of dust evolution: grain growth and vertical settling.

We propose to obtain band 3 and band 6 continuum and CO isotopologues observations to map the spatial distribution of the millimetre-sized dust grains and molecular gas and to
compare them with the spatial distribution of micrometric grains observed in the near-infrared. The disc is large, bright in the molecular lines and at an intermediate inclination (50 degrees) making it an ideal target to accurately locate both the dust and gas components. These observations will allow us to unambiguously constrain the degree of radial migration of the dust grains and determine how strong is the dynamical coupling between gas and dust.

2013.1.00803.S

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Title

Probing the Embedded Disk of the Giant Elliptical NGC 5128 (Centaurus A)

Abstract

Many large elliptical galaxies contain embedded disks of dust and gas, remnants of a merger with a smaller gas-rich galaxy. The physical properties of such disks, and the resulting initial conditions for star formation are very different from those in disk galaxies and starburst galaxies. We will study these in detail by modelling the molecular gas in the embedded dusty gas disk ('dark band') of the only nearby giant elliptical, NGC 5128 (host of the radio source Centaurus A). We will apply PDR and radiative transfer models to the optically think 12CO and the optically thin 13CO and C18O J=1-0 and 2-1 transitions in maps of 18 pc resolution over the inner several kpc of the galaxy. From the maps we will deduce the mass and temperature, for individual clumps and as a function of radius, of the gas in the extended disk, and investigate the relation of the dense molecular gas conditions to the enhanced star formation in the disk.

2013.1.00806.S

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Title

Needles in the Cosmic Haystack - A Hunt for Massive Starless Cores

Abstract

Massive star formation remains an important unsolved problem in astrophysics. Better observational constraints on its initial conditions are needed. Very few good examples of massive starless cores are known that are on the verge of star formation, i.e. scaled-up versions of highly-deuterated, centrally-concentrated low-mass pre-stellar cores. After searching four infrared dark cloud (IRDC) clumps with ALMA in Cycle 0, we detected one bona fide example in N2D+(3-2) (Tan et al. 2013). The source, C1-South, has a booming signal in this emission line. Here we propose an efficient survey of 32 more IRDC clumps to find more massive starless cores: we expect this will yield a sample of about 10 such cores, the beginnings of a statistical sample.

2013.1.00812.S

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Title

Hiding in the Shadow of Giants: Low mass cores in massive (proto)clusters

Abstract

Most stars form in clusters, yet basic aspects of how this occurs remain unknown, including the relative birth order of high and low mass stars. In clump-scale "competitive accretion"-type models, massive stars and their surrounding cluster of lower mass stars form simultaneously. Thus a key, testable prediction of

these models is that centrally condensed low-mass cores should exist within the accretion reservoir of a forming massive star. Using the unprecedented sensitivity and dynamic range of ALMA, we propose to test these models by searching for the 1.0 mm continuum emission from the low-mass core population associated with two young massive (proto)clusters that show strong evidence for recent shocks, active outflows, and hence ongoing accretion (both GLIMPSE Extended Green Objects, EGOs). By imaging the full extent of the associated (sub)mm clumps (~0.8 pc diameter), we will characterize the entire low-mass core population of our target clusters, down to 0.1 Msun. To measure the kinematics of these cores, we also target the N2H+(3-2) line.

2013.1.00813.S

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Title

Mapping Warm Molecular Gas in Luminous Infrared Galaxies: Arp 220 and NGC 6240

Abstract

Herschel observations of nearby star-forming galaxies have determined that the warm component of the molecular gas traced by the high-J CO lines dominates the luminosity and hence the energy budget. Our high spatial resolution ALMA observations of the CO J=6-5 line in Arp 220 resolved the morphology of the warm molecular gas for the first time on a much finer scale than ever before, revealing interesting and unexpected features. Multiple components are seen in the resolved ALMA observations, clearly suggesting that modeling galaxy-integrated CO rotational lines is inadequate for deriving the detailed excitation and physical conditions of the gas. High spatial resolution observations of multiple CO transitions are therefore needed to compare the morphology for different CO transitions and model the various components of the molecular gas on a pixel-by-pixel basis. Therefore, we request maps of CO J=4-3 in Arp 220 and CO J=6-5/3-2 in NGC 6240; due to its similarity to Arp 220, this galaxy will allow us to determine whether the warm gas morphologies that we are seeing are peculiar to Arp 220 or may be characteristic of merging luminous infrared galaxies.

2013.1.00814.S

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Title

Probing the Formation of Nuclear Stellar Cusps

Abstract

We propose observations with ALMA to spectroscopically map the molecular gas and dust that is associated with the build up of nuclear cusps in late merger stages of Luminous Infrared Galaxies (LIRGs). Our Hubble Space Telescope (HST) near-IR imaging program of the GOALS survey has recently spatially resolved the nuclear stellar structure in 88 LIRGs and revealed an increasing fraction of strong cusps towards late merger stages. ALMA will spatially resolve the morphology of the gas components of the cusp on a scale comparable to that of the HST. We have selected the five strongest cusp galaxies in our sample and a well matched comparison sample of five pre-cusp galaxies. The aim of this proposal is to unveil the molecular gas morphology (CO) and mechanisms associated with cusp formation and to accurately measure how much gas mass is involved in the build-up of stellar cusps. The decomposition of the gas kinematics will provide an unprecedented spatial measurement of the mass-to-light ratio of nuclear cusps and cores, providing a crucial test whether the central dark matter distribution is affected by the cusp/core evolution as seen in the stellar component or not.

2013.1.00815.S

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Title

Are low metallicity and dust mass common in high-redshift, UV-luminous starbursts?

Abstract

ALMA has great potential for studying the interstellar medium in the most distant galaxies. The [CII] line is expected to be the strongest line observable at z>5 and will be used for accurate redshift determination, probing the dynamics of the ISM and the physical conditions in star-forming regions. However, the non-detection of the z=6.6 UV-luminous star-forming galaxy Himiko casts into doubt whether most high-redshift star-forming galaxies have high enough metallicity and dust mass to be detectable with ALMA. We propose a study of three UV-luminous z=6 star-forming galaxies to determine whether the far-IR properties of Himiko are typical of this class of objects or instead related to its unusual extended Lyman alpha halo. These observations are important for understanding the future role of ALMA in high-redshift studies.

2013.1.00824.S

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Title

Sub-millimeter H2O Megamasers in AGN Accretion Disks

Abstract

Water-vapor megamasers at 22 GHz provide the only means for directly mapping gas in AGNs on sub-pc scales. In about 20% of megamasers, the emission originates in thin, edge-on accretion disks within a parsec of the central black hole and traces Keplerian rotation within the black hole sphere of influence. These disk masers yield "gold standard" masses of the supermassive black holes plus, in a few cases, angular-size distances to the host galaxies and a direct measurement of the Hubble constant. AGNs are expected to produce water masers at sub-mm wavelengths as well, but they are largely unexplored. For the first time, ALMA provides the sensitivity needed to study extragalactic sub-mm water masers. We propose to observe 321 GHz, 325 GHz, and 658 GHz water masers toward 3 galaxies with 22 GHz Keplerian maser disks. These sub-mm maser species can sample gas at different temperatures and densities than the 22 GHz lines, and they might trace the accretion disk much closer to the black hole than the 22 GHz lines. If they are bright, the sub-mm lines may greatly increase the power of megamasers to measure black hole masses, distances, and physical conditions in accretion disks.

2013.1.00826.S

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Title

Forensic pathology of the extreme ULIRG F00183-7111

Abstract

A radio-loud AGN has just switched on in the centre of ULIRG F00183-7111 and radio jets are boring their way through the galaxy, heating and disrupting the cold molecular gas and eventually quenching star formation. In ALMA Cycle 0 we successfully observed CO(1-0) in this source. Here we propose to use the high resolution of Cycle 2 ALMA to image the CO(3-2) around the super-massive black hole (SMBH) to see how the gas is interacting with the jets and the SMBH, testing the standard model of AGN feedback.
The ALMA resolution requested here, corresponding to 750pc at the redshift

(0.329) of 00183, will enable us to observe heating and deposition of kinetic energy into the gas close to the jets.
Finding evidence for this is the primary goal of this proposal, and will be a fundamental test of AGN feedback models.

2013.1.00828.S

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Title

Circumnuclear Disks and Black Hole Masses in Nearby Radio Galaxies

Abstract

It has long been anticipated that ALMA will provide new measurements of central black hole (BH) masses in active galaxies, and we are now at the threshold of an exciting new era in which these measurements are just becoming feasible. The goal of this proposal is to examine the molecular gas distribution and kinematics in two nearby radio galaxies, NGC 4261 and NGC 4374 (M84). Both galaxies are already known to harbor rotating circumnuclear gas disks on 100 pc scales, and the black hole masses in these galaxies have previously been measured via HST observations of the ionized gas kinematics of the disks. However, the interpretation of ionized gas kinematics is complicated by the large turbulent velocity dispersion observed in the ionized component, while the cold molecular gas is likely to be more quiescent and a better tracer of the central mass distribution. We will use ALMA observations of CO(2-1) at subarcsecond resolution to determine the spatial and kinematic structure of the disks, to examine the relationship between the molecular and ionized gas kinematics, and to carry out dynamical modeling of the disks to derive new constraints on the BH masses.

2013.1.00831.S

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Title

Imaging the Disk and Gas Accretion around Young Massive Star in S255 IR

Abstract

The answer to how massive stars acquire their large mass is essential to our understanding of the massive star formation process. There is growing observational evidence suggesting that like their low-mass counterparts, newborn massive stars accrete through similar disk-outflow interaction as a

scaled-up version of the standard disk-envelope paradigm. Detailed characterization of this process has been greatly hindered by the fact these disks/toroids were barely resolved in previously observations. We propose ALMA observations to investigate the elusive disk in the nearby massive star forming region S255 IR with unprecedented high sensitivity and angular resolution. At an angular resolution of 1.3", direct high quality imaging of dust continuum, and more importantly, molecular line emission will allow us to resolve the disk and determine its physical and kinematical structure. The observations will enable us start addressing whether such disks or toroids around massive young stellar objects are Keplerian and stable; how the disks participate in the accretion process; and how the disks and outflows interact.

2013.1.00832.S

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Title

A CO Study of An Exceptionally Cold Cloud in the LMC

Abstract

We propose to use ALMA to image the molecular gas emission from an remarkably cold and quiescent dust cloud at the southern edge of the Large Magellanic Cloud (LMC). This cloud falls outside the area of the NANTEN CO survey and was detected as a decrement in dust temperature in the 4' resolution Planck map. More recent follow-up with the Mopra Telescope reveals strong CO(1-0) emission (T_b ~ 3 K at a physical resolution corresponding to 10 pc). The location of this cloud, near the region of greatest compression by ram pressure due to the LMC's space motion, and the lack of massive star formation activity suggest that it may have recently condensed from HI. We will make a complete map of the main body of the cloud, covering an area of 20 x 50 pc, in order to reveal the density and velocity structure down to a scale of <1 pc. Our main goal is to compare the density and velocity structure of the cloud with predictions from theory and observations of actively star-forming clouds. We will also assess the dynamical state of the clumps within the cloud, i.e. their balance of kinetic and gravitational energy, as a function of spatial scale.

2013.1.00833.S

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Title

Using CI to Map the Real Structure of a Low-Metallicity Starburst

Abstract

Low-metallicity environments frequently exhibit starburst behavior, forming most of their stars in massive clusters. The physical conditions in the molecular ISM must dictate this distinct mode of star formation. Unfortunately, our typical tracer of the molecular ISM -- CO emission -- is confined to the densest parts of molecular clouds. Instead, much of the molecular gas is colocated with atomic carbon. We propose using CI to characterize molecular gas using ALMA's superior resolution (both spatial and spectral) and surface brightness sensitivity to map the bulk of the molecular clouds in the nearby low-metallicity starburst NGC 5253. In this low metallicity environment, we expect a larger fraction of the molecular gas to be traced by the CI instead of the CO. With these data, we will (1) measure the properties of molecular clouds in a low metallicity starburst and (2) establish the connection between the molecular ISM and the rich population of young clusters imaged by Hubble.

2013.1.00834.S

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Title

High Velocity Masers in the Galactic Center: A New Probe of General Relativity

Abstract

We propose to conduct a search for high-velocity circumstellar SiO masers close to the Galactic central black hole (Sgr A*). Position and velocity tracking of maser-emitting stars within 0.1 pc of Sgr A* will provide multiple direct probes of the metric (stellar motion plus light propagation) and will enable numerous tests of general relativity not possible with binary pulsars. If SiO maser-emitting stars are identified close to Sgr A*, then the exceptional spatial and spectral resolution of the complete ALMA can test the equivalence principle, the "no-hair" theorem of black holes, and frame-dragging. While previous surveys for low-velocity masers have been done, the proposed survey will be 10 times more sensitive and will have 100 times the bandwidth to detect high velocity stars deep in the gravitational potential of the central black hole. Our maser survey requires a single pointing and tuning and only 38 minutes of on-source integration (1.21 hours total). The proposed observations will resolve stellar positions down to 0.01 pc from the central black hole and identify high-velocity stars at distances as small as 0.001 pc.

2013.1.00839.S

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Title

Revealing the Low-Mass End of the Core Mass Function in Rho Ophiuchus Star Forming Region

Abstract

The origin of the stellar IMF is a fundamental unresolved problem in star formation. Recent millimeter and submillimeter observations of the rho Ophiuchus cluster-forming region uncovered prestellar cores with a mass spectrum (hereafter, CMF) that resembles the Salpeter IMF. The implication is that the IMF may be determined to a large extent by the core mass distribution from cloud fragmentation.

However, the low-mass ends (< 0.1 Msolar) of the CMFs remain to be elucidated observationally because of the lack of high spatial resolution observations. In order to clarify the link between the CMFs and IMF, it is crucial to derive the low-mass end of the CMFs. Here, we propose mosaic observations toward the dense regions of the nearst cluster-forming region, rho Ophiuchus, at a distance of 120 pc.

2013.1.00843.S

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Title

Sunyaev-Zeldovich mapping of an extreme cool core in the galaxy cluster RXJ1504-02

Abstract

The massive, relaxed galaxy cluster RXJ1504 hosts one of the most extreme X-ray luminous cool cores. Cool cores are a balancing act of several physical phenomena -- the radiative cooling is offset by some heating mechanism(s) with a feedback loop to keep the cluster stable. Cooling depends on the gas spatial structure, while heat can have several sources, whose efficiency depends on poorly understood physical properties of the intracluster plasma. We recently obtained a Sunyaev-Zeldovich map of the RXJ1504 core with CARMA at 12" and 44" resolutions to study the distribution of its gas pressure. While there is large-scale agreement, we found that the peak of the SZ signal does not coincide with the X-ray peak, but instead sits at the tip of a subtle sloshing gas filament. It is very difficult to generate small-scale pressure nonuniformities in a non-merging cluster; something significant must be missing from our understanding of the cool core physics. Several interesting possibilities exist. We propose to resolve the structure of our 20" SZ peak with ALMA's 4.5" beam in order to elucidate its possible nature. This would be the first high-resolution SZ study of a cluster cool core.

2013.1.00854.S

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Title

Torsionally-Excited CH3OH Line as a Direct Tracer of First Cores

Abstract

We propose ALMA observations of first core candidates B1-bN and B1-bS, and a Class 0 protostar B1-C in torsionally-excited and ground-state CH3OH (vt=1 and 0; J_K=5_K-4_K; K=0-4; 241 GHz) lines as well as CO (2-1) and DCN (3-2) lines, and 1.3-mm dust-continuum emission, at the highest spatial resolution (~0.25") Cycle 2 offers. The primary purpose of this project is to directly see the first core itself in the vt=1 CH3OH lines. The excitation condition of the vt=1 lines (nH2 >~ 109 cm-3 and Tk >~300 K) well matches the expected physical condition of first cores. Our excitation calculations and Cycle 2 ALMA simulations show that the vt=1 CH3OH lines are originated from the first core itself without contamination from the surrounding envelope and can be detectable with ALMA. We will also study the temperature in the inner r<40 AU regions with the multi-transitional vt=1 and 0 CH3OH lines, the velocities and opening angles of the outflows from the first cores, outer envelopes, and their differences between the first core candidates and a Class 0 protostar. Thus, even in the case of negative vt=1 line detection we can advance our understanding of early-stage star formation.

2013.1.00857.S

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Title

The Density (and Destiny) of the Circumnuclear Disk

Abstract

The innermost concentration of molecular gas in our Galaxy is the Circumnuclear Disk (CND), a ring of gas and dust at a radius of ~1.5 pc from the central supermassive black hole. Depending upon the mass of this gas reservoir, the fate of the CND (whether it will it form stars, or eventually accrete on the black hole) will have a substantial impact on the evolution of the central parsec of our Galaxy. Its fate depends upon its density: gas clumps with densities > 10^7 cm^-3 are stable, and can collapse and form stars, whereas unstable clumps should quickly be sheared apart and eventually accrete onto the black hole. We propose to use the resolution and sensitivity of Cycle 2 ALMA to conduct a robust probe of gas density on the scales of individual clumps (1", or 0.04 pc) via simultaneous excitation analyses of multiple tracers and the inclusion of radiative excitation. Ultimately, this study will yield the authoritative values for the CND mass and density, quantities which vary in recent literature by 3-4 orders of magnitude, and will indicate the amount of gas present in the central parsecs, and whether it will feed the central black hole or contribute to a nuclear starburst.

2013.1.00858.S

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Title

Resolving the Chemical and Physical Structure of the Disk Forming Zone in L1527

Abstract

Physical and chemical processes associated with formation of a rotationally supported disk around the newly born protostar are important target for star formation studies. In this proposal, we resolve the transition zone between the infalling rotating envelope and the inner disk in the low-mass Class 0 protostellar core L1527 at a high angular resolution to study these processes. With our ALMA Cycle 0 observations, we recently discovered a drastic chemical change in the transition zone around the centrifugal barrier (100 AU in radius). Carbon-chain molecules and their geometrical isomers reside mainly in the infalling rotating envelope, while SO preferentially traces the transition zone. Such a phenomenon has not been predicted in any chemical models. It seems to be caused by the accretion shock in front of the centrifugal barrier. Confirmation of the accretion shock and detailed exploration of the shock structure at a high angular resolution is thus an important and urgent issue for understanding the disk formation. Moreover, this observation will put a stringent constraint on chemical evolution from protostellar cores to protoplanetary disks.

2013.1.00861.S

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Title

Star formation in the outer parts of XUV disk galaxies

Abstract

Results from the UV satellite GALEX have revealed a surprising
large extension of some spiral disks of nearby galaxies. While the Hα
emission, the usual tracer of star formation, especially in the outer disks
less affected by dust extinction, drops down at the border of the optical
radius, the XUV emission extends out to $3-4$ times this radius. This provides
evidence of outer star formation and of molecular gas up to the limits of H\,I
observations.
We propose take advantage of the unique sensitivity of ALMA to map a bright UV region in M83, located at
$r_{gal}=1.3r_{25}$,
which is also rich in HI emission.
By using band 6 to observe CO(2-1) we aim to trace the faint molecular gas expected at this large galactic
radius

where star formation is more difficult to occur.

2013.1.00862.S

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Title

The discovery of molecular gas in the nearest cool core cluster of galaxies with ALMA

Abstract

We propose an ALMA Band 6 observation aimed at detecting CO(2-1) line emission from a filamentary structure of cold gas located southeast of the centre of M87, the brightest cluster galaxy in the Virgo Cluster. There are clear signs of ongoing interaction between this filament and the radio lobes of the AGN in M87. This filament was previously observed at a range of wavelengths, including [CII] line emission with Herschel-PACS, which strongly suggests the presence of molecular gas. ALMA is not only in a unique position to offer the very first detection of molecular gas from the nearest cool core cluster, but also to provide unique information about the distribution and dynamics of this gas. The filament we propose to observe has already been detected with exquisite arcsecond-resolution in Halpha and FUV images from HST, and in soft X-ray emission from Chandra. In only 3h on source, ALMA will complete the coverage of all the gas phases present in this cool-core, allowing us to test models about the origin of the cold gas and its interaction with the AGN radio lobes with truly unprecedented detail.

2013.1.00870.S

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Title

Tracing the accretion history of pre-main sequence stars through the envelope dynamics of FUors

Abstract

A long-standing problem of the general paradigm of low-mass star formation is the "luminosity problem": protostars are less luminous than theoretically predicted. One possible solution is that the accretion process is episodic. FU Ori-type stars (FUors) are thought to be the visible examples for objects in the high accretion state. FUors are often surrounded by massive envelopes, which enable the disk to produce accretion outbursts and replenish the disk material. However, we have no information on the envelope dynamics, about where and how mass transfer from the envelope to the disk happens. We propose to use ALMA to observe the envelope of an FUor in different CO rotational lines to map its density and velocity structure. The observations will be analyzed using our modeling environment including a combination of

hydrodynamical simulations and radiative transfer, which can model both the infall process and the disk accretion. It will enable us to measure the infall rate in the envelopes and calculate how often the object can produce repetitive outbursts. The results will help us to decide whether FUor-type eruptions can really be the solution to the luminosity problem.

2013.1.00877.S

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Title

Tracing Shock Chemistry in Luminous IR Galaxies: Spatially Resolved Shocks in Enhanced H2 Emitters

Abstract

Local luminous infrared galaxies are dust-enshrouded, molecular gas-rich, intense starbursts that are usually inspired by major mergers. LIRGs thus provide an ideal place for an in depth look at the affects of mergers on the interstellar medium (ISM), specifically feedback from merger-driven star formation in the form of shocks. We select a sample of LIRGs that have a so-far unexplained excess of warm molecular hydrogen as revealed by Spitzer mid-IR spectroscopy. The IR data suffer from poor spatial and spectral resolution while optical observations have difficulty probing the dense and dusty ISM. ALMA provides the best tool for uncovering shocks in these dusty starbursts and for probing the shock chemistry to determine the extent, power, and dynamics of the shocked molecular gas. We propose to map these excess H2 emitters with dense molecular gas tracers CO and HCO+ to look for evidence of shocks/outflows and to determine the scale of their contribution to heating the ISM. We will also map the shock tracers SiO and methanol (CH3OH) to diagnose the strenghth, speed, and kinematics of any observed shocks and ultimately to determine the source of the shock.

2013.1.00879.S

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Title

Ongoing or Suppressed Disk Formation at the Early Stage of Star Formation

Abstract

We propose ALMA observations toward four Class 0 protostellar sources selected from our SMA sample. Our SMA results show that these Class 0 sources exhibit little envelope rotation at 1000 AU scale, and the inferred radii of Keplerian disks in these sources are <10 AU, suggesting that they are at the early stage of formation of large-scale Keplerian disks. Therefore, these are excellent targets to study how large-scale Keplerian disks seen around T Tauri stars are formed. With the proposed observations, we aim to reveal the radial profiles of rotational velocities and hence the angular momentum transfer from the outer envelopes at hundreds of AU scale to the inner 10 AU disk-forming regions in these Class 0 sources. We

have calculated theoretical radial profiles of rotational motion including the effect of magnetic field. We will compare the observed and theoretical rotational profiles, and discuss that the growth of Keplerian disks from 10 AU to 100 AU scales at the early stage of star formation is ongoing, as expected in the conventional picture of star formation, or is suppressed, as predicted in several MHD simulations by magnetic braking.

2013.1.00880.S

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Title

A Pilot Study to Detect Dark Matter Subhalos with ALMA using Strongly Lensed submm Galaxies

Abstract

We propose to observe five strongly lensed, dusty, star forming galaxies for ~ 40 minutes per source in CO emission lines in bands 4 and 6 to detect dark matter subhalos in the lens galaxies using gravitationally-induced perturbations they cause on the images of background sources. With detailed simulations, we have shown that ALMA is capable of efficiently detecting subhalos in these systems, if the abundance of subhalos is in agreement with ΛCDM predictions. We have built and tested a complete pipeline to search for and detect subhalos using ALMA data. This proposal is a pilot study for the analysis of the large population of bright lensed dusty galaxies discovered in submm bands to detect dark matter subhalos, allowing us to measure their mass function with unprecedented accuracy and thereby resolve one of the most important puzzles in modern cosmology.

2013.1.00884.S

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Title

What impact do luminous AGN have on star formation?

Abstract

One of the outstanding issues in the formation and evolution of galaxies is a definitive measurement of the impact that AGN have on Star Formation (SF). Observationally the picture is very mixed with conflicting results arguing for all scenarios: luminous AGNs suppressing, enhancing, or having no impact on SF! A major issue is the lack of sufficiently deep FIR-submm observations to directly measure the SF properties for the majority of the AGN population. The primary aim of this proposal is to build on our ALMA cycle 1 programme, combined with our carefully deblended Herschel photometry, to measure individual SFRs for a complete sample of X-ray selected AGN over the key X-ray luminosity and redshift ranges (L_X=10^43-10^45 erg/s and z=1.5-3.2), where the impact of AGNs on star formation is thought to be most prevalent. With the proposed observations we will construct detailed SFR distributions as a function of key AGN properties to accurately measure the impact that AGN have on SF in their host galaxies. Our observations will provide a key test for galaxy formation models which employ a wide variety of different prescriptions of AGN and SF activity.

2013.1.00885.S

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Title

Resolving Conversion Factor Variations in the Center of NGC 3351

Abstract

We propose to measure giant molecular cloud masses in the center of nearby galaxy NGC 3351 using optically thin C18O emission and an excitation temperature determined self-consistently from the ratio of the C18O (2-1) and (3-2) lines. These observations will provide robust measurements of GMC masses, free from important systematic effects that typically interfere with deriving masses from optically thin CO lines. We will use these masses and 12CO (1-0) observations to measure the CO-to-H2 conversion factor (alpha_CO) for each cloud. NGC 3351 has a very low average alpha_CO in its central ~kpc as measured using dust as a tracer for total gas. With these ALMA measurements we will take the first key steps towards understanding the physical cause of alpha_CO variations---a particularly crucial issue to address now that ALMA has made CO observable across a wide range of extragalactic environments.

2013.1.00889.S

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Title

Chemical Variation between a Spiral Arm and a Bar in M83

Abstract

Establishing physical meanings of GMC-scale chemical compositions will improve our understanding of GMC evolution in a spiral arm as well as in extreme physical environments such as AGNs and starbursts. Many previous studies have shown that strong shocks occur in bar regions of spiral galaxies and suppress star forming activities. Therefore, the GMC-scale chemcail compositions are expected to be different between a spiral arm and a bar. In order to explore how the kpc-scale gas dynamics and star formation activities affect the GMC-scale chemical compsositions, we propose multi-line imaging observations toward a spiral arm and a bar in M83 with ALMA in the 3 mm band. From this observation, we would like to reveal the averaged GMC-scale chemical compositions in the spiral arm and the bar. Furthermore, the origin of the possible chemical difference is explored on the distributions of molecules in the two regions. This observation will provide us with an important and fundamental base for interpreting the physical meaning of the chemical composition in extranal galaxies.

2013.1.00897.S

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Title

Constraining the agents of change - the impact of clumpy winds on massive stellar evolution

Abstract

There is considerable evidence for structure (clumping) in the radiatively driven stellar winds of hot stars. The existence of clumping has important consequences for mass-loss rate determinations. Mass-loss rates that are not corrected for clumping provide incorrect inputs for stellar and galactic evolution models. ALMA observations are ideally suited to study the effect of clumping in the critical (intermediate) regions of the wind. We propose to measure the 3 mm continuum fluxes of a sample of OB stars in the strategically important massive stellar cluster Westerlund 1, for which we already have optical, near-IR and radio measurements. The ALMA observations will substantially increase the observational material, allowing us to uniquely constrain clumping gradients and thus advance our understanding of wind clumping and its relation to stellar and wind parameters. The quantitative information derived in this project will ultimately allow is to correct massive star mass-loss rates for clumping and put considerable constraints on the theoretical models, which is vital to our understanding of the hydrodynamics of these winds.

2013.1.00902.S

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Title

Probing the complex organic reservoir in protoplanetary disks

Abstract

The composition of ice mantles on dust grains in protoplanetary disks sets the final molecular composition of planetary atmospheres and objects such as comets. An open question is the origin of complex organic molecules in planetary systems, considered necessary for building prebiotic molecules. Methanol is the first 'rung' on the 'ladder' of molecular complexity and is formed within ice mantles on dust grains. In disks, it is released into the gas via desorption triggered by UV radiation. We propose to observe rotational line transitions of gas-phase methanol in a sample of nearby gas-rich protoplanetary disks. The detection of methanol will confirm, for the first time, the presence of a complex organic ice reservoir in a protoplanetary disk, significant because planetesimals begin to form within the ice reservoir in the disk midplane. The selected transitions are the best candidates available across all current ALMA observing bands. Our sources are those which have water vapour detections and/or show strong formaldehyde line emission. This proposal utilises the superior sensitivity of ALMA Cycle 2 capabilities which are absolutely necessary for detecting weak line emission.

2013.1.00907.S

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Title

Measuring the molecular gas mass of a high redshift galaxy with HD

Abstract

We plan to observe the ground state transition of deuterated molecular hydrogen (HD) toward a dusty galaxy at z = 5.656. The line is predicted to be detectable in emission. These observations will provide the total amount of HD molecules and, through the HD/H2 abundance ratio given by the cosmic abundance of deuterium, the total molecular gas mass, independent on uncertainties plaguing other standard methods. If successful, this data will open a new way to measure masses of molecular gas in the Universe and it can be used to calibrate the CO to H2 conversion factor and dust emission methods.

2013.1.00911.S

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Title

Molecular gas conditions and shocks in the superwind of the starburst galaxy NGC 1808

Abstract

We propose multi-line observations of the starburst galaxy NGC 1808 motivated to study the state of the neutral interstellar medium in a prototypical starburst galaxy with a superwind. The study aims to address: 1) the physical conditions of the molecular gas in the starburst region of the galaxy, which is the origin of a polar dust outflow, 2) the energetics (mass and kinetic energy) of the molecular gas in the outflow, and 3) the dense shocked gas to trace the evolution of molecular clouds in the past starburst episode. The methods consist in observations of the molecular lines of CO, HCN, HCO+, SiO, and CS, and modeling the physical conditions with radiative transfer analysis. CO(3-2), HCN, HCO+, and CS reveal the dense molecular gas, and SiO is a reliable tracer of dense shocked gas.
NGC 1808 is one of the few nearby starburst galaxies with prominent superwinds - a valuable target to address the wind feedback, while demonstrating the capabilities of ALMA.

2013.1.00916.S

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Title

Can star formation happen without cold molecular gas?

Abstract

This proposal is designed to assess the role of the cold molecular gas in the star formation process at very low metallicity. It has been recently suggested that star formation could happen in atomic clouds in quasi-pristine environments. To test this scenario, we need a proper quantification of the molecular gas content of a very low metallicity object.
SBS0335-052 is the perfect candidate for such experiment. It is the lowest metallicity dwarf galaxy (1/30 solar) of the southern sky, with active and extremely compact star formation (<0.1'', 30pc) that only ALMA can detect.
We propose to observe the CO(2-1) line at 230 GHz in band 6 to detect and locate CO in SBS0335-052. This will allow us to measure the molecular gas mass traced by CO, and, with Herschel PDR lines, assess the amount of CO-dark gas, which is expected high at low metallicities. We will relate those measurements to the super star cluster properties (e.g. star formation rate).
This project represents an important and necessary step to very low metallicities to put constraints on the Xco factor and to verify the current predictions from numerical simulations.

2013.1.00922.S

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Title

The interplay between a submillimetre galaxy and the circumgalactic medium at z=3

Abstract

Lyman-alpha Blob 1 (LAB1) in the SSA22 field is the archetypal and best-studied system of its class: a 100kpc scale emission line nebula at z~3. LAB1 epitomizes many of the key features of our current model of galaxy formation: the extended Ly-a nebula is host to two Lyman Break Galaxies and, at its centre, a SCUBA-2 850um-detected submillimetre galaxy (SMG). Our best model of LAB1 that combines morphological, kinematic and polarization observations suggests that the central galaxy is driving a cold, clumpy outflow off which Ly-a photons, leaking from the central SMG, are scattering. LAB1 is therefore a unique laboratory for studying the interplay between luminous high-z galaxies and their circumgalactic medium, the physics of which is a key part of all galaxy formation models, since this is the environment where gravitational cooling and feedback are in concert. We propose a simple experiment with ALMA to further our understanding of LAB1 by (a) pinpointing the location of the SMG relative to the surrounding Ly-a and (b) determining its systemic redshift allowing us to relate the source to the velocity structure of the extended gaseous halo.

2013.1.00952.S

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Title

Spatially Resolved Mapping of Gas in a z=2.26 Normal UV-Bright Disk Galaxy

Abstract

SDSS J0901+1814 (J0901; z=2.26) is a strongly-lensed UV-bright galaxy that we have detected in both CO(1-0) and CO(3-2). The clear velocity gradients in all images and our source-plane reconstruction show that J0901 is a rotating disk. We propose to make spatially-resolved observations of the CO(7-6) line (C34-2 configuration plus ACA observations), which when leveraged against our existing CO, optical, and infrared data will provide one of the most complete descriptions of a normal high-z disk galaxy to date. Specifically, with only 1.04 hours on the 12-m array (4.14 hours on the ACA) we will be able to (a) look for variations in the molecular gas excitation on sub-galactic scales, (b) explore excitation-related trends in the Schmidt-Kennicutt relation for a resolved high-z disk, and (c) find dark matter substructure in the lensing galaxy by identifying anomalous brightness ratios in the channel maps. In addition, we will obtain a high-resolution 1 mm continuum map useful for tracing star formation, and detect the [CI] fine structure line, which can provide an independent estimate of the system's gas mass.

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Title

Properties and evolution of embedded protostellar disks

Abstract

ALMA is already providing exciting results on how circumstellar disks form around low-mass young stars and how they evolve from the embedded through planet-forming stages. In this proposal we will attack the question: What is the relation between the formation and early evolution of circumstellar disks and the physics of the inner regions of collapsing protostellar envelopes? We will utilize ALMA's Band-7 to image a representative sample of 12 embedded protostars from the Ophiuchus star forming region in molecular lines from a selected set of isotopologues of common molecular species probing material with high temperatures and densities in the inner envelopes and circumstellar disks. This study will begin the process of assembling the key statistics required to understand the formation and early evolution of circumstellar disks, as well as provide key insight into the physics and timing of protostellar accretion.

2013.1.00960.S

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Title

The first Galaxy-scale hunt for the earliest phases of the formation of the most massive stars

Abstract

The origin of massive stars is a fundamental open issue in modern astrophysics. Pre-ALMA interferometric studies reveal precursors to early B to late O type stars with collapsing envelopes of 15-20 Msol in 1000-3000 AU. There are exceptionally few examples known to date of more massive envelopes at these size-scales. Do massive collapsing envelopes exist within this size-scale up to the 100msol regime? Do they form the same way as the so far observed 8-20 Msol regime? To answer these questions a statistical sample is the necessary next step. Here we target a well characterized sample of massive and cold clumps above 650 Msol within 4.5 kpc identified by the ATLASGAL survey in order to reveal the most massive individual collapsing envelopes on 3000 AU size scales (with 0.6" angular resolution). We will drastically increase the number of 20-100 Msol envelopes known to date. We also target molecular tracers to distinguish between pre-stellar and protostellar condensations allowing statistical life-time estimates for the elusive pre-stellar phase. This comprehensive study represents a significant leap forward in our understanding of the origin of the most massive stars.

2013.1.00965.S

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Title

Fast outflows quenching star formation at high redshift

Abstract

According to theoretical models, quasar driven outflows at high redshift clean massive galaxies of their gas content and quench star formation.
We have recently discovered powerful AGN-driven outflows by studying the velocity field of [OIII]5007 in two quasars at z~2.4. The spatial distribution of the starforming regions in their host galaxies is anticorrelated with the presence of fast outflows, providing the very first evidence of quasar feedback quenching star formation. However, this evidence is tentative as it is based only on rest-frame optical spectra.
We propose to map CO(3-2) to trace the distribution of the cold molecular gas in the two quasars, the only ones known so far showing evidence of outflows quenching star formation. The CO(3-2) maps will be compared with our [OIII] maps with similar spatial resolution: the molecular gas should be absent in the outflow dominated region, while surviving in the rest of the galaxy.
This would be the first direct confirmation of star formation quenching by quasar outflows. Our ALMA observations will then open the way for the physical characterization of quasar driven feedback in larger samples of objects.

2013.1.00967.S

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Title

Dust Opacity and Fragmentation in the Centers of Nearby Low-mass Starless Cores

Abstract

With the windfall of recent continuum observations of nearby star-forming regions using Herschel and large ground-based bolometer arrays, it is imperative that we reduce the factor of a few uncertainty that currently exists in (sub)millimeter dust opacities. This uncertainty strongly affects determination of the core mass distribution and core stability. In this proposal, we will directly address two key issues in studies of the nascent phase of star formation - starless cores: (1) what is the dust opacity index (beta) at (sub)millimeter wavelengths, and (2) do starless cores fragment on scales of 100 - 1500 AU? We shall observe a sample of 5 bright, nearby (125 pc) starless cores in the Ophiuchus cloud complex at 2.1, 1.2, and 0.86 mm at 100 AU resolution. We will determine the dust opacity index by radiative transfer modeling of the observed visibilities and compare the results to existing 160-1200 um observations. Our sample includes cores with a range of central densities (1.0e5 - 1.0e6 cm-3) and dynamical states (stable to collapsing) in which to search for fragmentation and to search for variations among the cores in the dust opacity index.

2013.1.00973.S

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Title

Spatially resolved H3O+ maser emission in starburst galaxies

Abstract

We have clearly detected emissions from H3O+ in the nuclei of satrburst
NGC253, NGC4945 and ULIRG ARP 220.
We observed two transitions for H3O+ for all the galaxies survey using APEX telescope. Transition at 364 GHz is observed with an intensity way above that predicted by LTE or non-LTE excitation based on the intensity measured in the 307 GHz line. The H3O+ molecule can be used as a tracer of the ionization rate of dense circumnuclear gas in galaxies. Either in the molecular disk surrounding
the nuclear black hole or in galactic jets molecular excitation can result in megamasers emission with large luminosities.
We aim to probe the origin of this new potentially megamaser line.

2013.1.00975.S

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Title

Dissecting the intensely star-forming clumps in a z ~ 2 Einstein Ring

Abstract

Clumps of star formation in galactic disks are common in star-forming galaxies at 1 < z < 3. This is the epoch when galaxy assembly activities peaked. These clumps could represent a pathway through which a majority of the stellar mass in the Universe was formed; understanding their evolution is central to our understanding of galaxy evolution. We propose spatially and dynamically-resolved CO(6-5) observations of a gravitationally lensed, kinematically ordered, vigorously star-forming galaxy at z ~ 2 with physical resolutions up to 60 pc. This galaxy contains two intensely star-forming clumps with SFRs of 160 solar mass/yr/clump; each of these clumps is forming stars in situ at a rate comparable to the most luminous merger-triggered starbursts in the local Universe. ALMA will provide a 3D image of molecular gas in the clumps, and search for starburst-driven outflows, whose detection in starburst clumps at z ~ 2 could provide discriminating evidence on bulge formation scenarios. Our proposed observations will provide a benchmark against which to interpret vigorous star-forming clumps in general. This object can therefore have a unique impact on our understanding of galaxy assembly.

2013.1.00976.S

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Title

The first millimeter detection of an ultracool dwarf

Abstract

Although ultracool dwarfs (UCDs; very low mass stars and brown dwarfs, >M7) are fully convective and so cannot sustain a solar-type dynamo, they are now known to be magnetically active. While radio observations have proven to be uniquely rich probes of UCD magnetism, a fundamental question — what is the radio emission mechanism? — is not satisfactorily answered. We have recently obtained multi-band (1.4–43 GHz) VLA observations of the benchmark radio-active UCD NLTT 33370 AB, confirming the unusual nature of its emission, most notably its extremely flat spectrum and variability. We propose to study a complete rotation of this object in full polarization with ALMA's band 3. The data will clarify the emission mechanism via its polarized spectrum, yield the first millimeter detection of a UCD, and characterize this object's variability at previously-inaccessible wavelengths. These results will diagnose the magnetic field strength and other physical conditions at the emission site, and potentially set the stage for spatial resolution of the binary at higher frequencies.

2013.1.00978.S

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Title

The Orcus-Vanth System: A Rosetta Stone for accretion in planetary systems

Abstract

The dwarf planets in the Kuiper belt provide one of the most compelling cases of the breakdown of the simple theory of pairwise accretion. The formation of these large rock-rich dwa
rf planets through coagulation of the population of small low density near rock-free objects appears difficult. Alternative accretion theories predict a wide variety of behaviors of the size-density relationship through the small body-large body transition. The Orcus-Vanth binary system is uniquely suited to determining the density behavior through this transition and pointing to the accretion hi
story of the solar system. The new higher resolution capabilities of ALMA in Cycle 2 allow us, for the first time, to use resolved thermal radiometry to measure the individual component sizes and, the unique capability of highly accurate relative astrometry over moderate angles will let us determine the astrometric wobble of Orcus induced by Vanth to measure the individual component masses, yield
ing simultaneous densities of two of these transitional objects and a chance to determine how solid bodies in planetary systems form.

2013.1.00988.S

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COI	Bureau, Martin	EU	United Kingdom	Oxford University

Title

Understanding AGN feedback with gas chemistry in NGC 1266

Abstract

NGC1266 is an early-type galaxy in the southern sky that has recently been shown to be expelling its molecular gas through a large AGN-driven molecular outflow. In this proposal we aim to investigate the physical and chemical properties of the ISM in the central few hundred parsecs of this extraordinary galaxy. We propose to conduct an unbiased line-survey of the 3mm band, using chemical tracers in the ISM to investigate the mechanism driving the molecular gas from this galaxy, and thus more generally constrain how star-formation can be quenched by AGN feedback as galaxies move onto the red sequence. Our data will be the deepest and highest velocity resolution line survey ever conducted in an early-type galaxy, enabling us to explore in depth the astrochemistry in high-metallicity and alpha-element enhanced environments, as well as sheding light on the mechanisms responsible for AGN feedback.

2013.1.00989.S

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Title

Probing the inner-most region of the relativistic jet in extreme TeV blazars

Abstract

We propose to observe continuum spectrum of five extreme TeV blazars, which are unique probe to study enigmatic extragalactic background light (EBL), for the first time in mm/sub-mm regimes at two frequencies. The goal of this study is to investigate whether their relativistic jets are optically thin at mm wavelengths.

Our preparatory study with ALMA shows optically thin mm-spectrum in most normal blazars, contrary to the most accepted "one-zone SED model" predicting their relativistic jets are optically thick in mm regime. In addition, our study with VLBI does not favor it also for extreme TeV blazars.

If mm emission is optically thin in also extreme TeV blazars, it requires alternative models such as the structured jet model where both of high-energy emission and mm emission can come from the jet base. It will not only give a new picture of jets in blazars, but also affect studies on EBL based on SED models.

These sources are faint for other radio interferometers. Furthermore, sequential observation in two bands is necessary for this proposal, since blazars are usually variable within days-weeks at mm/sub-mm wavelengths. Only ALMA cycle-2 can perform proposed observations.

2013.1.00991.S

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COI	Evans, Scott	NA	United States	Virginia, University of
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Title

The full anatomy of a minor merger

Abstract

Minor mergers constitute the majority of interacting events in the nearby Universe - they are important to understand galaxy evolution processes. The gas accretion and nuclear feeding mechanisms of these mergers are different from major mergers. Molecular gas may flow along the large-scale dust lanes to form polar rings in their centres, with this material acting to fuel both star-formation and nuclear accretion. Tracing this gas is vital if to understand the mechanisms of this class of mergers. NGC1614 is a spectacular example with a prominent minor axis dust lane. We propose ALMA observations of 12CO and 13CO1-0 to study the location and content of the larg-scale gas reservoir, how its molecular content changes with radius, and how it becomes funneled into the dust lane. Why is the gas in the dust lane not forming stars? How is it dynamically coupled to the starburst ring? The proposed observations will study the life cycle of the molecular gas, from its origins on kpc-scale to the nuclear region where this fuel is converted into stars. Only these ALMA observations will provide the multi-scale and high-sensitivity imaging of the gas which will fully link the distinct gas phases.

2013.1.00994.S

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Title

Resolving polarization holes in W51

Abstract

Magnetic fields are one of the key parameters in star formation theories. Major obstacles in advancing our understanding of magnetic fields are the difficulty of obtaining higher-resolution maps of field morphologies together with the difficulty of accurately measuring the field strength. We propose Band-6 0.2"-resolution dust polarization continuum observations in order to resolve polarization holes in several cores in W51 that we previously observed with the SMA. Polarization holes are often a signpost for complex underlying field structures that remain hidden in coarse resolution. As revealed from line observations, our targeted zones very likely host rotating structures. The science goals of this proposal are: (1) resolving magnetic field morphologies in rotating/accreting structures and (2) measuring the local field strength in the inner core regions in order to constrain field strength profiles and magnetic flux removal processes like ambipolar diffusion.

2013.1.00999.S

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Title

Lensing Through Cosmic Time: ALMA Constraints on "Normal" Galaxies in the HST Frontier Fields

Abstract

We propose ALMA Band 6 imaging (FWHM=1.3", 0.35mJy @5sigma) of the first 4 massive strong-lensing clusters in the HST Frontier Fields, leveraging their >5-10 magnification to study high-z galaxies over the inner ~4 arcmin^2. These clusters have a wealth of ancillary ground/space-based radio-to-X-ray imaging, 1000s of high-quality spectroscopic and photometric redshifts, and exceptional lensing-mass models. Yet these important targets lack strong submm constraints. Our observations
will allow (1) a probe of the 1.1mm number counts and luminosity function ~5-10x below published estimates, (2) individual and statistical characterization of high-z star formation via SED fitting/stacking of 10s-1000s of high-z galaxies and source reconstructions, (3) dust continuum constraints on the lensing cluster galaxies and ICM, and (4) a critical benchmark for future lensing-related projects with ALMA. The proposed data will inform us about how star formation proceeded in the early universe. This proposal is a large extragalactic Chilean key project with broad community support and funding, and considerable international expertise (including many on the CLASH science team).

2013.1.01004.S

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Title

Revealing the secrets of VLA1623: an in-depth look into the earliest star formation stage

Abstract

Multiple protostellar systems are common in the early stages of star formation. While fragmentation is agreed to be the main mechanism of formation, most of what is known comes from continuum observations but continuum alone can not answer the recurrent questions of multiple star formation: do all detected sources belong to the observed system? what are the relative evolutionary stages? what influence do companions have on each other? what is the dependence on the temperature structure of the core? In addition, of interest to star formation in general, is the formation of rotationally supported disks. Disks are crucial to star formation, but the question of when do they form and what enhances their formation still remains. VLA1623 is a triple non-coeval system in rho Ophiuchus which shows some interesting extremes in star formation: the youngest Keplerian disk and the coldest source. The proposed

observations will help us to address the questions of early disk formation, source membership in a system and temperature structure of the cloud and its effect on disk formation and fragmentation.

2013.1.01007.S

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COI	Salinas , Vachail	EU	Netherlands	Leiden University

Title

First limits on water deuteration in planet-forming disks

Abstract

Water is one of the most important molecules in planet-forming disks. It feeds the oceans of terrestrial planets and forms an essential ingredient for life. The source of the Earth's oceans can be traced via its HDO/H2O ratio of ~3e-4, which is ten times higher than the Sun and the ISM, lower by a factor of a few than most (but not all) comets, and a hundred times lower than the cold material around some protostars. Do disks inherit such high HDO/H2O from their protostellar ancestors or does the HDO/H2O evolve? This ALMA proposal aims to place the first observational limits on HDO/H2O for the only two disks with detected cold water by Herschel: TW Hya and HD100546. With ALMA we propose to search these two disks for the HDO ground-state emission line and measure the HDO/H2O in the cold gas. In 14.6 hrs of total observing time, we take the first step: confirm or reject an HDO/H2O ratio as high as 1e-2 as found in protostars. If detected, the radial distribution of HDO can be compared to that inferred from the Herschel H2O lines. If undetected, we rule out that disks inherit their water unaltered from the protostellar stage.

2013.1.01010.S

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Title

The far-infared [OIII] line emissivity of high-z low-metallicity galaxies

Abstract

Herschel observations of nearby low-metallicity dwarf galaxies have shown that the [OIII] 88 micron line tends to be stronger than the [CII] 158 micron line, while the opposite is true for normal spiral galaxies at about solar metallicity. If this holds true also for the high-redshift Universe, the [OIII] 88 micron line from z=6--7 star-forming galaxies, which are expected to have sub-solar metallicities, should be detectable with ALMA in a few hours of integration time. Here, we propose ALMA observations of two spectroscopically confirmed z~6--7 galaxies to make the first [OIII] measurements for objects in the reionization epoch. The measured [OIII]-to-[CII] flux ratios will also allow us to study the metallicity and other physical conditions in the interstellar medium of these high-z galaxies.

2013.1.01013.S

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Title

Exploring the nature of relativistic jets in neutron star X-ray binaries

Abstract

We propose to observe for the first time the mm frequency emission associated with relativistic jets in neutron star X-ray binaries. This observation will allow 1) to determine the size of the jet emission region close to the neutron star without contamination from X-ray reprocessed emission from the disc or from the companion star in the X-ray binary, thereby constraining jet production mechanisms, and 2) to study the scaling of such jet emission region in neutron stars at different accretion states and compare it to that found in black hole transients.

2013.1.01014.S

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Title

Low--Density Clouds on the Far--Side of the Galactic Center

Abstract

The Central Molecular Zone (CMZ), i.e. the innermost ~200 pc of the Milky Way, contains a number of unusually dense and massive molecular clouds. Understanding the formation and evolution of these clouds is critical for many fields in astronomy, such as star formation under extreme conditions and clouds in starbursts and the early universe.

The CMZ gas is organized in a roughly edge-on ring of ~100 pc radius. The near-side, as seen from Earth, contains ALL of the dense and massive CMZ clouds, while the gas on the far-side is rather unstructured. It has been suggested that this is due to the gravitational influence of Sgr A*, which is closer to the near-side.

Here we explore why the far-side does not host ANY significant cloud. Are there clouds at all, or does the far-side essentially represent an unstructured turbulent flow? If there are clouds, how "old" are they, based on their dynamical state? Are clouds bound and evolving towards higher densities?

This project produces the first resolved maps of far-side clouds. We will interpret the data in the context of our comprehensive Galactic Center Molecular Cloud Survey (GCMS).

2013.1.01016.S

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Title

An ALMA investigation of the environment around the young 2M1207b planetary mass object

Abstract

At the distance of only 55 pc, the TW Hyadrae association harbors one of the most intriguing astrophysical systems: a young 8 Myr-old planetary mass object orbiting a low mass brown dwarf at a radius of 40 AU. Thanks to its proximity, very young age, and angular separation between brown dwarf and planetary mass object, the 2M1207 A & b system is probably the best candidate to investigate the physical environment of a very young planetary mass object down to a fraction of Lunar mass in dust mass.
We propose to use the very high sensitivity and angular resolution provided by ALMA in Cycle 2 to search for dust thermal emission in the system.
These observations will set tight constraints on the presence of material around a planetary mass object at the last stages of its formation.
The characterization of the more massive disk known around the low mass brown dwarf will shed light on the structure of disks surrounding young objects close to the deuterium burning limit.

2013.1.01020.S

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Title

Gas Dissipation in Protoplanetary Disks at the Final Stage of Disk Evolution

Abstract

We propose to investigate the final stage of protoplanetary disk evolution with ALMA.
Our tagets (PDS~70, RX~J1604.3$-$2130, IRAS~04125$+$2902, and Sz~91)
are weak-line T Tauri stars (WTTS) that have so-called {\it transitional disks}.
The large cavities ($r>$20 ~AU) in the central disk-region around
these four objects have been imaged at both (sub-)mm and near-infrared (NIR) wavelengths,
and this imagery suggests the large-mm-size and small-sub-μm-size dust grains are dissipated
inside the cavity. Among the many transitional disks that have been discovered around
classical T Tauri stars (CTTS), these four WTTS systems are likely to be
more evolved and close to the epoch of their final stage of disk evolution.
We propose to use Band~6 observations at a maximum spatial
resolution of 0.$''$18 to measure the amount of gas inside the cavity,
in order to obtain observational evidence of gas-decreasing in transitional disks around WTTS.

2013.1.01022.S

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Title

Mass Accretion onto the Super Massive Black Hole of M 87

Abstract

We put same abstract in the first page of Scientific Justification with
larger font size and a figure.

Background:

The rate of mass accretion onto Super Massive Black Holes (SMBHs) is
an essential parameter for active galactic nuclei (AGNs).

Goal of this Observation:

With new ALMA polarization capabilities, we will derive the Faraday
Rotation Measure (RM: which is a tracer of column density) towards M 87

with 10 times better accuracy compared to our SMA pre-study. M 87 is a representative radio loud AGN.

Scientific Impact:

With 10 times more accurate RM, we will determine the mass accretion rate for the first time, while our SMA pre-study only allowed us to set an upper limit. It will enable us to discriminate accretion flow models and give us a unique opportunity to investigate the energy source of the jet (e.g., accretion or black hole spin).

Why ALMA cycle 2?:

We need to investigate polarization properties in the vicinity of the beam center, but with high sensitivity (0.015 mJy/beam at Q and U) in band 3. Our sensitivity requirements can be only achieved with ALMA.

2013.1.01029.S

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Title

Filleting the Filament: Quiescent and active gas in a high-contrast IRDC

Abstract

Herschel gave us a plethora of filamentary structures based on column density maps. For assessing the dynamics of star formation therein we need to investigate the gas motions. We conducted a Herschel study towards 45 high-mass star-forming clumps. A striking object is the filamentary IRDC 316.72+0.07, attaining high peak column densities (>10^23 cm^-2) and low dust temperatures (<14 K). The Herschel data show more chaotic column column density structures in parts of this IRDC. The ALMA observations are guided by our previous single-dish molecular line mapping. We plan to mosaic the IRDC with ALMA at 3 mm. We want to probe the quiescent gas with N2H+, and the more active turbulent gas with HCO+/H13CO+. Objectives: 1) Trace the distribution and kinematics of quiescent gas. Are there hints for coherent velocity structures, with gas gradually decoupling from the turbulent gas and proceeding with gravitational collapse? 2) Understanding the dynamics of the active dense gas. Is there infall of inter-clump material onto the dense filament on larger scales? The kinematics of the gas on scales of 4" will then be compared to numerical simulations of filament formation and converging flows.

2013.1.01034.S

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Title

Tracing the Origins of Nitrogen Bearing Organics Toward Orion KL

Abstract

A comprehensive analysis of a broadband 1.2 THz wide spectral survey of the Orion Kleinmann-Low nebula (Orion KL) has shown that nitrogen bearing complex organics trace systematically hotter gas than O-bearing organics toward this source. The origin of this O/N dichotomy remains a mystery. If complex molecules originate from grain surfaces, N-bearing species may be more difficult to remove from grain surfaces than O-bearing organics. Theoretical studies, however, have shown that hot (T=300 K) gas phase

chemistry can produce high abundances of N-bearing organics while suppressing the formation of O-bearing complex molecules. We propose here to map, in exquisite detail, the temperature structure and D/H ratio of the complex N-bearing organic methyl cyanide (CH3CN) toward the Orion KL hot core. If gas phase formation routes are significant at high temperatures, we will observe a decreasing gradient in the D/H ratio of CH3CN with increasing kinetic temperature. The proposed observations will shed light on the origin of all complex N-bearing organics in the interstellar medium.

2013.1.01035.S

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Title

Dissecting filaments with ALMA: Unveiling the dynamic properties of dense cores within a massive IRDC

Abstract

Our aim is to measure the non-thermal contribution to the velocity dispersion, as well to gain an understanding of the internal motions of massive starless cores with respect to their envelope. To do this, we have selected a massive filamentary IRDC thought to be in an early stage of its evolution. We focus on several cores within a specified region, chosen as it is at the intersection point of several dense filamentary structures. We request 7 pointings in total towards this region at 1.3'' resolution (0.02 pc, or 4000 AU). Our primary tracer will be N2H+ (3-2), which is perfectly suited to tracing dense cores in regions such as this. We have selected several other molecular lines to strike a balance between cold, dense gas and warm, shocked gas. This is to reflect the pre- and proto-stellar core population. This project will enable us, for the first time, to link to dynamic properties of cores to that of their natal filamentary envelopes, gaining an understanding of their formation and growth.

2013.1.01036.S

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Title

The role of outflows and magnetic field in star/disk formation: the HH212 test case

Abstract

We propose to take advantage of the ALMA Cycle 2 polarisation capabilities to measure (and model) the magnetic field in the bright HH212 edge-on protostellar jet system. Our ALMA Cycle 0 Band 7 data revealed a spectacular picture, showing all the crucial ingredients of the star-disk formation recipe: a compact 45 AU rotating structure in CH3OH surrounded by a flattened envelope (continuum+C17O), and driving a fast bipolar jet (SiO) opening low-velocity (CO+C34S) cavities.

We ask: (1) to image the dust polarisation in Band 7 at 0.4" scale to trace how the B-field varies from envelope to disk scales, and (2) to map the compact rotating CH3OH at 0.2" scale to clarify its kinematics and nature (keplerian disk, inner part of the infalling core).

The requested observations will provide for the first time (to our knowledge) a comprehensive set of information on the relation between infall, rotation, magnetic fields, and jets of a single (Class 0) protostar at the proposed spatial scales. We will compare the results with predictions for 3D MHD collapse simulations developed by our group to determine if the current scenario of magnetic braking during star-disk formation is valid.

2013.1.01037.S

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Title

Are there non-fragmenting massive dense cores?

Abstract

The fragmentation of massive dense cores is a crucial process at the origin of stellar cluster formation. However, observational work with pre-ALMA interferometers has revealed a clear inefficiency in the fragmentation process, compared to what is expected if it was controlled by gravity. In particular, there are clear examples of cores which intriguingly show no fragmentation at all down to 1000 AU. Although the magnetic field and radiative feedback may play a crucial role to explain these non-fragmenting cores, there is still the possibility that a hidden population of very low-mass fragments is missed by the observations due to poor sensitivity and dynamic range of pre-ALMA instrumentation. In this proposal we plan to observe two cores showing very low fragmentation levels, and two cores showing high fragmentation levels. ALMA will improve the sensitivity by a factor of 20, and the dynamic range by more than one order of magnitude, providing key information about the true nature of non-fragmenting massive dense cores. If a low-mass population of fragments is discovered in these cores, the current theoretical and numerical work on fragmentation of clouds should be revised.

2013.1.01041.S

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Title

Revealing the progenitors of SSCs through shock dissipation in the Antennae merger

Abstract

We identified a source we believe to be a progenitor of a massive SSC in the Antennae overlap region observing near-IR H2 emission tracing dissipation of its turbulent energy. We propose to look for other pre-cluster clouds (PCCs) with ALMA. To achieve this goal, we propose to map the overlap region in the SiO(5-4) and HNCO(10_(0,10)-9_(0,9)) line emission at an angular resolution of 0.5 arcsec, matched to the size of PCC sources. These molecules are known to be shock tracer in dense gas. The proposed ALMA observations have the combination of sensitivity and spectral and spatial resolution needed to identify several PCC sources and estimate their formation timescale.

2013.1.01042.S

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Title

Revealing the Physical Properties of Molecular Gas Associated with the Magellanic SNR N132D

Abstract

In supernova remnants (SNRs), the interaction between the shock waves and the ambient interstellar gas is an essential process which affects evolution, high-energy emission, and relativistic particle acceleration. Therefore, it is important to study the detailed physical properties of the interaction between SNRs and interstellar gas, in order to understand the underlying processes. N132D is the brightest SNR in the Large Magellanic Cloud (LMC) and is thought to be associated with the molecular clouds. Most recently, we found the interacting molecular gas by using the Mopra 12CO(J=1-0) dataset. However, we could not reveal the detailed structures and the physical conditions. We propose to observe N132D and its surroundings with 12CO(J=1-0) line emission by ALMA and to determine the physical properties of molecular clouds interacting with the shock waves. ALMA's sensitivity and spatial resolution will allow us to study in detail the CO gas interacting with the "extragalactic SNR" for the first time.

2013.1.01046.S

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Title

A combined study of comet 67P/Churyumov-Gerasimenko with Rosetta and ALMA

Abstract

The Rosetta mission will explore in situ (at a distance of 5 to 200km) comet 67P/Churyumov-Gerasimenko, nominally from July 2014 to December 2015.
Comet 67P will reach perihelion on 12 August 2015, during the ALMA Cycle 2 period. On the basis of the ESA adopted activity level of the comet, the main molecular species should be detectable with ALMA during the high activity phase of the comet from April to October 2015. We propose to observe at three different epochs, pre and post-perihelion the key species HCN, CH3OH and CO to derive their total production rates, the gas temperature, their spatial and velocity distribution on the resolution scale (500-1500km) accessible with ALMA.
At the same time Rosetta and especially the MIRO and VIRTIS experiments will be observing the same species in situ.
As Co-Is of these Rosetta experiments we will have the opportunity to establish a ground truth for the outgassing activity that has been observed over two decades in over 40 comets. We will connect the measurement obtained on the ~1000 km scale from Earth with the activity observed and quantified in situ (from the nucleus surface to beyond 100km) by Rosetta experiments.

2013.1.01051.S

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Title

A high-resolution band-7 continuum survey of SMGs in the field of five SZE-selected galaxy clusters.

Abstract

We propose to obtain band-7 continuum mapping at ~1 arcsec spatial resolution for a sample of 39 submillimeter galaxies (SMGs) detected with LABOCA (~18"/beam) in the field of five galaxy clusters originally detected through their Sunyaev-Zel'dovich Effect decrement signals at 148 GHz. The selected targets have 870 micron (345 GHz) flux densities ranging from 3.7 to 36.9 mJy, but our current

photometric accuracy is compromised by blending of point source and extended SZE emission, and plausibly of multiple fainter SMGs within a single LABOCA beam.

To secure detection of all targets and their possible sub-components at the 4 sigma level, we require a point-source sensitivity of 0.3 mJy. To achieve this observational goal, we require a total observation time of 2.2 hours including overheads.

2013.1.01052.S

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Title

Tracing the Star Formation at z=6.11 with [OIII]

Abstract

The cosmic star formation near and beyond z~6 was actively taking shape and evolving through the assembly of normal galaxies eventually to merge into the larger more luminous systems. Probing the ISM in some of the earliest star-forming galaxies is ALMA's flagship. We propose to use ALMA to probe a z=6.11 galaxy of low mass and low metallicity using the 88 micron [OIII] which is the most luminous of the FIR fine structure lines in low-metallicity galaxies. The 88 micron [OIII] line follows tightly the star formation rate and has recently been calibrated as a star formation rate tracer in low-metallicity galaxies. Together these properties highlight the [OIII] line as the best probe of the high-z, low metallicity Universe. Additionally, we propose to observe the 158 micron[CII] line to benchmark the use of the [OIII]/[CII] ratio as an important probe of the structure of the ISM in high-z galaxies and to place constraints on the structure in terms of neutral phodissociation/molecular gas and ionized low density gas.

2013.1.01057.S

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Title

Band 3/4 spectral scan in the central filament of merging LIRG VV114

Abstract

Investigating local merger-driven starbursts is important to understand physical processes involved in the formation and evolution of galaxies. Our cycle 0 observations toward mid-stage merger VV114 revealed that the merger-induced filamentary structure (including the AGN, starbursts, and shock-induced overlap) shows the chemical differences at each region for the first time, while our detected lines could not fully explain driven physics of such molecular diversity. We thus propose 8.3 hours observations of mid-stage IR-bright merger VV114 through well-studied 84 - 111 and 127 - 154 GHz to provide comprehensive picture of chemical diversity among AGN, starburst, and shocked regions in the dense gas filament simultaneously. Using band 3 and 4, we can detect 33 molecular lines and classify them three chemical types (AGN-dominated, SB-dominated, and shock-dominated) by mapping them with 1".0 resolution enough to resolve specific regions. Moreover, we will constrain the temperatures and column densities of given molecules easily by rotation diagram, and compare their chemical/physical conditions with other extragalactic molecular line survey to explain driven chemistry of VV114.

2013.1.01058.S

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Title

Irradiated Shocks and Ionisation Sources in the Central Parsec of the Milky Way

Abstract

We propose to study the origin and nature of the irradiated shocks in the interstellar environment surrounding SgrA*, the very centre of the Milky Way. We will use ALMA to resolve the spatial structures and kinematical patterns associated with the high-velocity CO line emission at the interface between the circum-nuclear disk and the inner central cavity. This component is beam diluted in our single-dish Herschel observations of the complete CO rotational ladder but can be inferred from the line profiles. Our observations using all 3 instruments on board Herschel have also revealed the presence of overabundant H2O and OH, as well as unexpected hot CO in the vicinity of SgrA*. We wish to understand the origin of this high velocity gas, and its heating and ionisation sources, using ALMA to search for the key missing information and to determine both the spatial structure and the ionization fraction using well established molecular tracers (HCO+, HOC+ and SO+).

2013.1.01061.S

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Title

Examining the molecular coma of comet C/2012 K1 (PanSTARRS)

Abstract

Cometary ices contain pristine material from the formation of the solar system, and studies of their composition provide unique information regarding the physical and chemical conditions of the early Solar Nebula. Use of gas-phase coma observations as probes of cometary ices requires a complete understanding of the gas-release mechanisms, but previous observations have been unable to ascertain the precise origin of fundamental coma species CO, H2CO, HCN, HNC and CS, and details regarding their possible formation in the coma are not well understood. We propose to obtain spectrally and spatially-resolved sub-mm emission maps of these molecules in the coma of comet C/2012 K1 (PanSTARRS), which will reach peak activity around perihelion in August 2014. The proposed 3D maps, including multiple spectral lines from CH3OH and the other species of interest, are required in order to determine the excitation, and therefore the precise distributions, of molecules in the coma. These measurements will provide quantitative tests of release models for the species of interest and will be vital in assisting the interpretation of our ALMA data on comets ISON and Lemmon (obtained in 2013).

2013.1.01064.S

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Title

A dusty dwarf galaxy at z=7.37

Abstract

A1689-zD1, a star-forming galaxy lensed by the foreground cluster A1689, is the brightest z>7 galaxy candidate known. We have recently discovered its redshift to be z=7.37 using very deep near-infrared continuum spectroscopy of the Lyman break. We request an observation of the source with ALMA to characterise the dust mass and infrared star-formation rate and to detect the [CII]158μm line to determine the redshift to high precision. Cycle 0 observations of the lensing galaxy cluster serendipitously detected the source in band 6 at modest significance, showing a significant, but low, dust mass. We expect a clear detection of both the [CII] line and the continuum in 4 bands in this modest, UV bright galaxy only 700 Myr after the big bang.

2013.1.01065.S

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Title

Star Formation in a Highly Turbulent Massive Clump in the Galactic Center

Abstract

It is widely believed that turbulence effects on the star formation in the central molecular zone, both forbidding and accelerating star formation.
In particular, cloud-cloud collision initiated by the bar-driven inflow of molecular clouds or by feedback from past active star formation may be efficient formation process of stellar clusters cluster.
Recently we detected a peculiar molecular clump not associated with major star forming GMC complexes. The clump CO-0.30-0.7 has a extremely large velocity width of 120 km/s, indicating that the entire clump is disturbed by shock possibly caused by interaction with an adjacent large expanding shell.
Interestingly, the clump also has a compact core of 300-500 solar masses with narrow line width (20 km/s), which is virialized and hence capable of forming stars. At present no sign of star formation is detected toward the clump, and we speculate this is a region where cloud-cloud collision has just started, which may possibly lead cluster formation, or destruction of cloud cores.
We propose imaging of this clump to resolve small-scale structures of this clump and investigate how turbulence effects on the physical properties of them.

2013.1.01070.S

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Title

Direct Imaging of Vertical Structure in an Edge-On Protoplanetary Disk

Abstract

Protoplanetary disks are proposed to be characterized by radial and vertical gradients in density, temperature, ionization, radiation flux and chemistry. Spatially resolved ALMA SV and cycle 0 observations of molecular lines have confirmed the presence of radial temperature and chemical structures in disks, while constraints on the vertical structures remain scarce. We propose to exploit the exceptional spatial resolution of ALMA and the viewing geometry of the edge-on disk AA Tau to obtain the first direct imaging constraints on the vertical chemical and ionization structure in a protoplanetary disk. We will target molecules and ions proposed to trace the disk atmosphere, warm molecular layer and cold midplane to benchmark our understanding of how disk structures and chemistry depend on disk height.

2013.1.01075.S

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Title

Protoplanetary Disk Evolution in Spatially Resolved Pre-Main Sequence Binaries: Chamaeleon I

Abstract

Stars frequently form in binary systems. Our observational knowledge about the evolution of protoplanetary disks in binary stars, however, currently leaves many questions unanswered. For example, while theory predicts how the sizes of circumstellar disks are truncated in the presence of a binary companion, an observational confirmation is still required and the impact of truncation on the evolution of the inner disks is unknown. We propose to acquire high-angular resolution band 7 continuum observations of 26 binary stars in the Chamaeleon I star-forming region. The inferred disk masses and sizes will be correlated with stellar and binary parameters from our extensive near-IR binary investigations of the target sample. This is the first study dedicated to measuring the correlation of hot inner disk material and cold outer dust around binary star components to investigate whether the evolution of a truncated binary star disk is significantly different from that of singles. It will triple the current amount of data to observationally test the theoretically predicted truncation radii of disks in binaries, with many applications in the fields of star and planet formation.

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Title

Physical Properties in ``Hot'' Rings around Protostars

Abstract

We propose the ALMA Cycle 2 observations toward three protostars to reveal the physical properties in ``hot'' ring regions. ALMA Cycle 0 observations with the angular resolution of 0.8 arcsec have revealed that SO emission shows PV diagram, which is explained by rotating ring. This feature is quite different from that of C18O emission, which shows Keplerian rotation at the innermost region. The SO molecules might be heated above the sublimation temperature by accretion shock. In the ALMA Cycle 2, we will observe three transitional lines of SO emission in Band 6 and 7, which allow us to perform LVG calculations to investigate the physical properties in the hot ring region. We can distinguish the hot ring from other region with the angular resolution of 0.2 arcsec. We will also observe C18O lines to derive column density toward these regions. C18O also provide the measurements of Keplerian rotation with better resolution. If the hot rings are actually in shock condition, it will be the first example for directly imaging the accretion shock region. ALMA Cycle 2 observations are the first opportunity for approaching the detailed physical conditions in protostellar envelopes.

2013.1.01099.S

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Title

First interstellar detection of the H2F+ ion and fluorine chemistry in the z=0.89 molecular absorber toward PKS1830-211

Abstract

By using new laboratory transition frequencies of the H2F+ ion, we propose a search for the ion and observations of HF and CF+ in the z=0.89 molecular absorber toward PKS 1830-211. The detection will contribute to understanding the fluorine chemistry through determined abundances of fluorine bearing molecules. So far H2F+ has not been detected in space. From chemical reaction, the ion is expected to be abundant in diffuse cloud. The molecular fractional abundances of PKS 1830-211 are found in-between those in typical Galactic diffuse and translucent clouds. The condition is suitable for H2F+ production. The rotational temperature of strongly polar molecules is equal to Tcmb=5.14 K at z=0.89, so the absorption spectrum is not too crowded (only low-energy levels are populated), and line identification is easy. HF and CF+ are known to be abundant reservoir of fluorine, and the observations are important for understanding chemical reactions in low temperature cloud.

2013.1.01102.S

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Title

Highlighting the Centrifugal Barrier in Protostellar Envelopes by Chemistry

Abstract

In star formation studies, one of the most important issues is when and how the rotationally supported disk is formed around a protostar. In this proposal, we approach this problem by chemistry. With our ALMA Cycle 0 observations toward the low-mass Class 0 protostar L1527, we discovered a drastic chemical change in the transition zone between the infalling rotating envelope and the inner disk. Carbon-chain molecules as well as CS mainly exist in the infalling rotating envelope, whereas SO selectively trace the transition zone. This drastic change seems to originate from the accretion shock in front of the centrifugal barrier. Thus, chemistry can highlights the transition zone. Moreover, the protostellar mass and the specific angular momentum can easily be derived by the radius of the centrifugal barrier and the rotation velocity there. Based on this success in L1527, we apply this method to 5 low-mass protostellar sources in the Class 0 and I stages with different chemical and physical characteristics to verify the applicability of this method. This observation will open a new avenue to study the physical and chemical evolution associated with disk formation.

2013.1.01110.S

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Title

Probing the origin of flux-ratio anomalies in quadruple lenses with ALMA

Abstract

The number of satellite galaxies in our Galaxy is by far smaller than expected from theory. This is so-called the 'missing satellite problem'. Quadruple lens systems showing the anomalies in their flux ratios of lensed images have long been thought to be caused by such small-scale CDM subhalos with a mass of ~10^(8-9) solar mass residing in a host lensing galaxy. However, recent theoretical work provided an alternative mechanism for the origin of the anomalies caused by mini-structures (mini-halos/voids) in intergalactic space with mass scales of < 10^8 solar mass. In order to distinguish between these two scenarios, we propose to carry out high-resolution observations of dust continuum emission from the region surrounding a QSO that shows anomalous flux ratios. If mini-structures in the line-of-sight are indeed the main cause of the anomalies, then this will set important constraints on the abundance of CDM subhalos in a lensing galaxy, which eventually limits the nature of dark matter itself. Based on the flux measurement of lensed images with unprecedented accuracy O(0.01) mJy on sub-arcsec scales, ALMA will provide us fundamental information on the nature of dark matter.

2013.1.01113.S

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Title

Probing the physics and chemistry of the candidate first-hydrostatic core Chamaeleon MMS1

Abstract

The First Hydrostatic Core (FHSC) constitutes one of the first milestones in theoretical models of low-mass star formation. This proposal aims to elucidate the nature of the low-luminosity infrared source Chamaeleon MMS1 (Cha-MMS1), to help resolve the dichotomy of whether it is an FHSC or merely a low-luminosity Class 0 protostar (VeLLO). We propose to map at high angular resolution the spectroscopic signatures theorised to be characteristic of FHSCs and VeLLOs, including CO and CS emission from the outflow and H2CO, CH3OH and HC3N emission from the hot core. Based on current numerical simulations, the detection of a spatially compact (<200 AU), low-velocity CO outflow will consitute strong evidence in favour of Cha-MMS1 being the first confirmed FHSC. On the other hand, the detection of H2CO and/or

CH3OH inside the core will provide evidence for the presence of a (>100 K) hot corino, which would instead identify Cha-MMS1 as a Class 0 protostar. High spectral-resolution CS line profile observations will provide information on the infall and outflow properties of the source. HC3N will be observed as a probe of carbon-chain chemistry.

2013.1.01114.S

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Title

Control of Star Formation in Massive Filamentary Clouds: Orion

Abstract

The Herschel mission has revealed omnipresent filamentary structures in molecular clouds. Such structures possibly govern the entire star formation process in the interstellar medium. In this picture, high-mass stars and star-clusters form preferentially in massive filaments whose properties differ from those of low-mass ones, demonstrating a strong environmental dependence. What is crucially missing is the knowledge of how massive filaments fragment and collapse to form stars. With ALMA, we will fill this knowledge gap by describing the fragmentation of the most nearby massive filament, the Orion filament, in great detail. We will observe the filament in 110 GHz continuum and C18O line emission. These data, together with our Herschel and LABOCA data, will provide the highest-fidelity column density data ever obtained for a molecular cloud, from several-parsec scales to 1700 AU scales. We will determine the fragmentation mode of the filament with our novel techniques that recover both the volume density and kinematic structure. We will then connect this analysis with our protostellar census, establishing how filament fragmentation connects to the protostars within.

2013.1.01119.S

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Title

Unveiling the nature of the reddest submillimeter sources in lensing cluster fields

Abstract

We propose to unveil the nature of very red submm sources discovered in four out of 10 Herschel Lensing Survey (HLS) clusters followed up at 870microns with LABOCA. Undetected in the Herschel bands, these sources may be the first dusty galaxies with moderate intrinsic luminosities (LFIR<10^12 Lsol) detected at very high redshifts (z>5) or low luminosity cold dusty galaxies with Td<25K. Measuring their luminosities and redshifts will put important constraints on the density of normal dusty star forming galaxies beyond z=4 and on the fraction of dusty star formation occuring in cold galaxies at lower redshift.

Mapping these sources at 1.1mm with ALMA to a sensitivity of 0.1mJy will allow us to detect them with S/N>10 as well as any other lensed galaxy with an intrinsic LFIR>10^11Lsol up to z=10, and enable us to unambiguously identify their counterparts, estimate their redshift, and constrain their FIR luminosity and dust temperature. The core of massive galaxy clusters are the site of many astrophysical processes, and the data would further serve a number of ancillary purposes that we discuss in the text.

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Title

Measuring the Kinetic Temperature of Massive Star Forming Clouds in the LMC

Abstract

The optically brightest, nearest, and with respect to angular scales most extended external galaxy, the LMC, undergoes vigorous star formation and contains a large number of molecular clouds. It is thus strange that there exists so far only a single published measurement of the kinetic temperature of its dense neutral gas. This proposal aims to fill this gap by mapping the 218 GHz para-H2CO line triple toward the massive star forming regions N113 and N159W, where APEX data reveal detections. The observations aim (1) at mapping the kinetic temperature for the first time in two prototypical massive star forming regions of low metallicity, (2) at providing badly needed temperatures as input for density estimates from other tracer lines, and (3) at identifying characteristic gradients in kinetic temperature, which are expected on both observational and theoretical grounds. Mapping the gas temperature in the two sources will for the first time allow us to obtain the kinetic temperature stratification of the dense neutral gas in a low metallicity environment irradiated by young massive stars.

2013.1.01139.S

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Title

Dust Filtration in Protoplanetary Disks at the Plant-Forming Era

Abstract

LkH${\alpha}$~330, GM~Aur, and SR~21 are known to have large cavities of $r>$20 AU in their protoplanetary disks at sub-mm wavelengths (mainly tracing mm-size, large dust grains). We propose to investigate these cavities with Band 7 at high-spatial resolution (0.$''$13) to detect fine structures of gas and dust grains within their cavities. In our SEEDS observations at near-infrared wavelengths (mainly tracing sub-μm-size, small dust grains), no expected cavities have been detected in these three cases, which together with another dozens of disks compose a unique sample, in which NIR and (sub-)mm observations disagree dramatically on the existence of the central cavity.
Theory has predicted this different appearance of cavities between small and large dust grains, `dust filtration'. To test whether dust filtration could be at work, high-sensitivity and high-resolution gas observations are required. Our ultimate goal in this proposal is to obtain firm observational evidence of

dust filtration by detecting (a) different gradients of
the surface density of gas, and (b) different dust-to-gas mass ratios
inside and outside cavity, respectively.

2013.1.01142.S

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Title

Embedded young cluster survey in the Giant Molecular Clouds in the Nearby Spiral Galaxy M33

Abstract

We propose 100GHz-band continuum observations at 8pc resolution
toward the 75 giant molecular clouds (GMCs) in
the nearest spiral galaxy, M33, for the purpose of searching for obscured
young clusters.
Radio emission at around 100GHz from star-forming galaxies is
expected to be strongly
dominated by the free-free bremsstrahlung component due to
ionizing radiation from massive, short-lived stars.
Many studies on external galaxies have widely used the 24micron
dust emission as the tracer for obscured star formation.
However, the spatial resolution of 24micron data is limited to,
for example in case of Spitzer, 6 arcsec.
This is not comparable that of the molecular gas images anymore,
which can be resolved at sub-arcsec resolution in the ALMA era.
With the 100GHz-band continuum data, we aim to obtain a catalog of
the obscured star clusters in the GMCs, including size,
cluster mass and accurate star formation efficiencies out of a parental GMC.
We also check the validity of the star formation rate (SFR) from the
the 100GHz-band continuum by comparing with classical SFR measurements,.
This will become the new standard method to derive SFR.replacing infrared
observations.

2013.1.01147.S

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Title

Planet formation at a critical age: debris disks with gas in the 8 to 20 Myr range

Abstract

The η Chamaeleontis association and the β Pictoris moving group of young low-luminosity nearby stars, represents an ideal laboratory to study planet formation at a critical age range: between 8 and 20 Myr. This stage is regarded as post protoplanetary/primordial disk, hence they are assumed to be young debris disks. We propose to conduct ALMA band 6 observations of 10 systems with clear excesses of emission at long wavelengths, evidencing the presence of circumstellar disks. Some of these systems may also contain disks with inner cavities (based on SED studies). The aims of this proposal concern mainly the determination of disk masses, sizes and detect primordial gas. Recent studies have shown evidence that some of these 'debris' disks might still contain appreciable quantities of gas, challenging the idea that most disks lose all their gas at a rather early age (2-10 Myr).

2013.1.01151.S

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Title

Tracing the Chemical Evolution of Active Galaxies

Abstract

To trace the chemical evolution of galaxies, a detailed knowledge of abundance patterns is fundamental. Isotope ratios play a key role in such studies and are, almost exclusively, a domain of radio and (sub-)mm astronomy. So far, the extragalactic space beyond the Magellanic Clouds is almost unexplored. What ratios can be found, when observing objects beyond the Local Group, which drastically differ from those in the Miliky Way and the LMC? Is the Galaxy typical for its class or are its isotopic properties exceptional? And what does this imply for its evolutionary track? Such questions can only be tackled when using the extreme sensitivity of ALMA. Here we propose to measure carbon (and oxygeni) isotope ratios in three outstanding star forming galaxies beyond the Local Group.

2013.1.01153.S

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Title

Revealing Major Mergers Among the Extreme Star Forming Hosts of the Fastest Growing Super-Massive Black Holes at z~4.8

Abstract

We propose a pilot study to probe the host systems of fast-growing Super-Massive Black Holes (SMBHs) at z~4.8, which would likely become the most massive BHs known (M_BH>=10^{10} M_sun) before z~4.
Our Herschel observations show that these sources are hosted in two types of extreme star-forming (SF) galaxies: one with SFR>2000 M_sun/yr, indicative of major mergers as the common triggering mechanism for both SF and AGN activity,
and another group with SFR~450 M_sun/yr, that may be related to secular evolution, or to AGN-driven feedback.
The proposed ALMA observations will test this scenario, by probing the distribution of gas and SF, at scales of ~2 kpc, in the host systems of three objects in each group.
The luminous [CII]157.7 um line, which may be detected in most of the sources, would probe the dynamics of the hosts and will provide a clear test for the occurrence of major mergers.
The [CII] line would also allow us to estimate the dynamical masses of the hosts, and thus estimate the M_BH/M_dyn ratio at z~4.8.
Thus, ALMA can probe the relevance of major mergers, possible feedback or secular growth for a well-defined sample of high-redshift, fast-growing BHs and host galaxies.

2013.1.01155.S

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Title

ALMA Observations of the Most Luminous Young Stellar Object in the Large Magellanic Cloud

Abstract

We propose to probe the dense circumstellar environment of the most luminous young stellar object (YSO) in the Large Magellanic Cloud (LMC) and among the most luminous forming stars detected in any galaxy. Our recent Herschel Space Observatory key program HERITAGE performed a uniform far-IR survey of the LMC, and using these observations we identifed thousands of YSOs in the LMC, including the proposed target, which we have determined to have a total luminosity of approximately 10^6 L_sun, making it the most luminous forming star in the LMC. To understand how stars with such tremendous masses form, we must observe them during their short-lived formation stages. We propose band 3 ALMA observations of this massive YSO of CO, 13CO, C18O, HCO+, HCN, and 1 mm continuum to 1) determine its multiplicity, 2) accurately determine the physical properties of the star-forming clump/core(s) (masses, densities, line

widths, etc.), and 3) measure the feedback from the massive star into the surrounding medium. We will use 12CO to trace the high velocity, low density outflow, while C18O, 13CO, HCN, and HCO+ will be used to trace the low-velocity, high-density gas perturbed by the wind.

2013.1.01157.S

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Title

IRAS 15398-3359: Very Low Mass Class 0 Protostar?

Abstract

In star-formation studies, an important target is to understand when and how the rotationally supported disk is formed around the protostar. In order to address this question, we recently conducted the ALMA observations of the CCH (N=4-3) and H2CO (515-414 etc.) lines in Band 7 toward the low-mass Class 0 protostar IRAS 15398-3359 at a resolution of 0."5. We detected a beautiful outflow feature as well as a flattened envelope around the protostar. From the analysis of the outflow structure, the inclination angle of the envelope is estimated to be 10 degree (i.e. almost edge-on). Then, the velocity structure of the envelope is analyzed, and the mass of the protostar is roughly estimated to be as low as 0.02 Msun. Furthermore, the H2CO emission shows a sign of a Keplerian disk. These results will be an important clue to understanding the initial stage of disk formation processes, if confirmed. We here propose to observe the CCH (N=3-2) and H2CO (515-414 etc.) lines in the Band 6 and Band 7 at the resolution of 0."23 and 0."16, respectively. This observation will provide us with a deep insight into the initial stage of disk formation in Class 0 protostars.

2013.1.01158.S

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Title

A Signpost of Planet Formation: Eccentricity of Protoplanetary Disks

Abstract

We propose to observe the protoplanetary disk in GM Aur with ALMA at high angular (~0.2") and high velocity (~0.05 km/s) resolutions in the CO (3-2) line. The goal of this project is to constrain the existence of a gas giant planet by studying the tidal interaction between planets and disks. Submillimeter continuum observations have shown that GM Aur exhibits an inner cavity with a radius of 28 AU (~0.2"), suggestive of the existence of a massive gas giant planet. We have calculated hydrodynamic simulations, and found that protoplanetary disks harboring a massive (>5-10 Mj) gas giant planet can become eccentric and has an unique feature in its gas kinematics. We have conducted imaging simulations on our model disks, and found that such feature can be identified with ALMA cycle 2 observations. In this project, we aim to measure the difference in motional velocities of eccentric and circular orbits and to provide a new signpost of a gas giant planet.

2013.1.01161.S

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Title

From Bars to CMZs and YMCs

Abstract

We propose subarcsec-resolution wide-field imaging of the entire stellar bars in two prototypical barred spiral galaxies. Our main goals are (1) the gas dynamics in bars to channel molecular gas to the central molecular zones (CMZs), and (2) ISM reactions to the bar-driven gas dynamics in the bars and in the star-forming CMZs including cloud formation leading to the formation of young massive clusters (YMCs). Our targets, M83 and NGC 1365, have face-on stellar bars of large ~4 arcmin extent on the southern sky. They will be fully mapped in CO(2-1) at linear resolutions of 10 and 50 pc, respectively, without missing any extended emission. Their CMZs will be imaged at twice higher resolutions through additional targeted observations. This project is going to reveal unprecedented details of the molecular gas behavior in galactic bars of moderate and large lengths (~5 and 20 kpc, respectively) and uncover the relation between gas dynamics, molecular cloud properties, and star cluster formation.

2013.1.01165.S

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Title

Probing the Most Extreme Starbursts of Non-Interacting Nature

Abstract

We propose high-spatial resolution observations with ALMA to spectroscopically map the molecular gas and dust in non-interacting extreme star formation environments (with rates larger than 50~M_sun/yr). Our HST imaging program of the Great Observatories All-sky LIRG Survey (GOALS) has recently spatially resolved double nuclei and tidal features in 88 nearby (U)LIRGs, corroborating the picture that most high-IR luminosity LIRGs in the local universe are major mergers. In this proposal we will focus on the few non-interacting LIRGs above L_IR > 10^11.6L_sun which may be more representative for extreme star formation environments at high red-shift. ALMA will spatially resolve the morphology of the gas components on a scale comparable with that of the HST. This will allow us to measure streaming motions and gas mass infall rates due viscous and gravitational torques exerted by nuclear spiral arms and bars. We will compare the star formation morphology and infall rates to those in normal star forming galaxies

and low-luminosity AGN as probed by the NUclei of GAlaxy (NUGA) survey as well to those of interacting LIRGs.

2013.1.01166.S

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Title

Towards an evolutionary sequence of molecular gas in young debris disks: the hybrid disk candidate HD131835

Abstract

Most young stars harbor circumstellar disks which evolve from gas-dominated primordial disks to debris dust disks in about 10 Myr. In ALMA Cycle 0, our group discovered a disk around the 30-Myr-old HD21997 that links the primordial and the debris phases. The CO lines detected in HD21997 suggest large amounts of cold primordial gas, while the dust component is clearly secondary debris. In order to find more such "hybrid disks", we carried out a survey with APEX. Here we propose to obtain spatially resolved ALMA continuum and CO line observations of our most promising candidate, the debris disk around HD131835, where we detected CO with an intensity suggestive of a hybrid disk. From the observations we will (1) investigate the shielding and lifetime of CO molecules, (2) determine the co-location of the gas and dust components, and (3) decide if the gas is the remnant of the primordial disk, or secondary material produced from icy planetesimals. A primordial origin would suggest the existence of a whole new class of hybrid disks. The presence of primordial gas around >10 Myrs stars contradicts the current paradigm, and provides longer time for the formation of gas giant planets.

2013.1.01167.S

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Title

Exceptionally Bright Cluster-Lensed SMGs at z=2.0 and 4.7

Abstract

In the course of our large Herschel program, "The Herschel Lensing Survey (HLS)" (PI: Egami), we have discovered two exceptionally bright cluster-lensed submillimeter galaxy (SMG) at z=2.04 and 4.69. Their exceptional brightnesses (50-60 mJy at 870 um) and large magnification factors (x30 and x130) make them excellent targets for ALMA to conduct detailed observations. Our goal is to resolve these galaxies into individual star-forming regions with a spatial resolution of ~100 pc, comparable to the size of local giant molecular clouds (GMC). Scientifically, the first question to ask is the following: "Are GMCs in high-redshift IR-luminous galaxies super-sized versions of local GMC dense cores as shown by Swinbank et al. (2010) for the Eyelash galaxy?" By measuring the sizes and brightnesses of detected continuum sources and correcting the measurements for lensing magnification, we should be able to address this question directly. We will also probe the internal structures of various gas components, and will examine how the different phases of the ISM relate to each other (and to continuum), which will lead to a better understanding of the properties and origin of these galaxies.

2013.1.01172.S

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Title

CO isotopic ratio enhancement of Pa alpha-selected merging luminous infrared galaxies

Abstract

Elevated CO(1-0)/13CO(1-0) line ratio from 20 to 50 is often observed in the nucleus of infrared-bright merging galaxies. The mechanism is not fully understood yet although CO and 13CO emission are most useful extragalactic gas tracers. Our cycle 0 observations toward mid-stage merger VV114 demonstrated that high CO/13CO abundance ratio is more important to the elevated CO/13CO intensity ratio than low optical depth of the CO emission in the intense star-forming regions of the system. To develop the results for other galaxies, we propose 5.3 hours of ALMA cycle 2 time to obtain 1".0 resolution high-S/N CO(1-0), CO(2-1), 13CO(1-0), and 13CO(2-1) maps for 2 gas-rich merging galaxies, NGC 1614 and NGC 3110, enough to estimate gas conditions using an excitation analysis.

2013.1.01175.S

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Title

The origin of the small scale CO outflow in HH 30

Abstract

The small collimation and acceleration scales (< 50 AU) in protostellar jets are currently best explained by magneto-centrifugal ejection from the inner AUs of the accretion disk. If confirmed, the MHD disk wind paradigm has strong impact on disk structure and evolution. However directly resolving the atomic jet launching regions (<5 AU) is beyond current resolution capabilities in the optical/near-infrared. The recent detection of small scale molecular outflows in Class II sources opens new perspectives to test launching models. Indeed chemical modelling of MHD disk winds predict the flow to remain molecular for launching radii >1-3 AU. Alternatively these outflows could originate from thermal photo-evaporated flows.

We propose to mapp in 12CO(2-1) at 0.25'' angular resolution the launching regions of the compact low-velocity molecular outflow around the prototypical Class II jet source HH 30. Cycle 2 capabilities offer the opportunity to directly resolve the launching region of the HH30 CO outflow, search for wiggling signatures and put firmer constraints on its specific angular momentum, allowing to discriminate between

a purely thermal or magnetic origin for the wind.

2013.1.01178.S

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Title

Uncovering the gas reservoirs of absorption-selected galaxies

Abstract

Decades of research using absorption-line techniques have characterized the physical properties of neutral gas in the Universe, and established a link between absorbers and galaxies. However, efforts to identify the absorbing galaxies themselves have been stymied by insufficient sensitivity and/or spatial resolution. We propose to use the ALMA Band-3 and Band-4 receivers to search for redshifted CO(1-0) or CO(2-1) emission from four high-metallicity, damped Lyman-alpha absorbers at z<1, the best current candidates for a search for CO emission. The proposed observations will allow us to (1) obtain the first detections of molecular emission in damped systems, (2) derive the star formation efficiency in the absorbers, by comparing the SFR with the molecular gas mass, and (3) compare the gas dynamics revealed through metal-line absorption, H-alpha nebular emission and CO molecular emission. This pilot program will establish whether deep sub-mm observations may provide mass, size, and dynamical constraints for high-z galaxies detected in absorption. This would represent the first, critical step to resolving the physical connections between HI gas in absorption and modern galaxies.

2013.1.01180.S

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Title

Bulge Asymmetries and Dynamical Evolution (BAaDE)

Abstract

We have initiated the largest ever survey of red giant SiO masers in
the Galactic bulge and inner Galaxy. At the 43 GHz and 86 GHz frequencies of the SiO maser we are not hindered by
extinction, and accurate stellar velocities (<1 km/s) and positions
are obtained with minimal observing time. The detection of up to
~35,000 red giant SiO maser sources will yield numbers comparable to
optical surveys, but with the additional strength of a much more
thorough coverage of the highly obscured inner Galaxy. The number of
sources will be large enough to trace complex structures and minority
populations. The velocity structure of these tracers is to be compared

with the kinematic structures seen in gas, complex orbit structure in the bar, or stellar streams resulting from infallen systems. Modeling of the bar and bulge dynamics will be done using the new kinematic information in the inner Galaxy region. Our survey will also yield luminous SiO masers suitable for orbit and parallax determination using VLBI.

We are successfully observing with our calibration scheme using the VLA at 43 GHz; we here propose to demonstrate its feasibility with ALMA in the southern sky at 86 GHz.

2013.1.01188.S

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Title

A resolved view to star-forming Hα galaxies at z = 1.47-2.23: exploiting the synergy between ALMA and AO-IFU

Abstract

This proposal aims to obtain spatially resolved imaging of the dust content in 8 high-z Halpha galaxies taken from two redshift slides, z = 1.47 & 2.23, of the HiZELS survey. The targets have been recently observed with VLT/SINFONI and Gemini-N/NIFS, both AO-aided, up to an exquisite resolution of 0.2" equivalent to ~kpc-scales at those redshifts. All targets are normal `main sequence' galaxies that show thick disks co-rotating with massive clumps of star-formation. These clumps have typical star-formation rates (SFRs) that are ~ 15x higher than that seen in local HII regions. The combination of ALMA and the available IFU-AO data provides a unique and novel approach to describe the star-formation rate using two gold-standard tracers at matched ~0.2" resolution in high-z galaxies. Mapping the dust with ALMA is key to constrain the extinction suffered by the star-light, i.e. critical to account for the obscured star-formation activity. High resolution ALMA observations for this new AO-aided sample are key to provide a decisive argument on the nature of the clumpy structures, therefore essential to understand how star-formation is being triggered at high-z.

2013.1.01192.S

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Title

Spectral Line Survey toward Young High-Mass Protostar Candidate NGC 2264 CMM3

Abstract

Spectral line survey is of fundamental importance for astrochemistry and astrophysics, which has brought many new discoveries on target sources and chemical processes. Unbiased comparison of chemical compositions among different sources allow us to make secure discussions on evolutionary trends and/or an origin of chemical diversity. In this proposal, we propose a spectral line survey toward the young high-mass star forming region NGC 2264 CMM3 in Band 7. This source invloves a deeply embedded high-mass protostar(s), which launches a very compact outflow. The 10” region of this source shows a complex physical and chemical structure which resemble the prototypical high-mass protostellar source, Orion KL. For instance, the distribution of HCOOCH3 is apart from the protostar, just as the case of the compact ridge in Orion KL. We observe the chemical compositions and distributions of this infant high-mass protostellar source in an unbiased way, and critically compare them with the Orion KL case. We explore the chemical evolution associated with high mass star formation, and establish a robust base for chemical diagnostics of high mass star forming regions.

2013.1.01194.S

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Title

A CF+ survey of the diffuse medium in the inner galaxy

Abstract

Herschel and Planck data confirm the presence of diffuse ISM gas that is not well traced by the usual atomic or molecular probes, ie H I or CO. It can be followed in C+, in emission at 1.9 THz, but we propose a more accessible probe of C+ by following gas-phase fluorine into HF and CF+.

When H2 is present, fluorine concentrates into HF exothermically via F+H2->HF+H and forms CF+ via C+ + HF->CF+ + H, making CF+ the 2nd largest fluorine reservoir where C+ and H2 coexist. Since HF tracks H2, CF+ is a perfect tracer of the H I-> H2 transition.

Recent observations toward the Horsehead and the bright QSOs BLLAC and 3C111 illustrate this in the science case. We propose to use ALMA to perform an exploratory survey of CF+ absorption in the inner galactic plane using well characterized sight-lines towards continuum sources studied in the Herschel PRISMAS survey and other means. We target HOC+ simultaneously because HOC+ forms in the reaction of C+ and H2O. By comparison with the existing data, we will determine the fraction of diffuse gas in molecular form and investigate the relative contributions of atomic, molecular and ionized gas to the C+ budget.

2013.1.01195.S

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Title

Unveiling the central 1000 AU of a pre-stellar core

Abstract

Pre-stellar cores (PSCs) represent the initial conditions for the process of star and planet formation. Although their overall structure is well known, their central few thousand AU are completely unexplored. The best tracers of regions with densities larger than 10^6 cm-3 (and temperatures around 7 K) are deuterated species. Because of its compact emission and brightness, we show that N2D+(3-2), observable with ALMA in Band 6, is the ideal tracer. ALMA Cycle 2 offers the first and unique opportunity to peer into the PSC central regions and study the birthplace of stars and protoplanetary disks at size scales of a few hundred AU. These observations will test recent models of the dynamical evolution of pre-stellar cores and the propagation of cosmic rays within them.

2013.1.01202.S

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Title

Heating effects within the HH46/47 outflow

Abstract

How energy is transported across outflow cavity walls onto the cold surrounding cloud material is virtually unknown. Although existing observations readily show the cavities and the cavity walls, they lack the spatial resolution to study the precise location and structure of the surface PDR through observations of the warm molecular and/or atomic gas.
Clear variations in the gas distributions along the flows have been revealed. A large number of possible scenarios have been proposed for the heating effects. Most likely, multiple scenarios actually coexist within one flow, depending on local conditions and internal UV radiation.
The best-studied outflow to date is HH~46/47. We propose to use ALMA to observe 17-21 positions along its red lobe. By targetting the CO 6-5 and [CI] 1-0 transtions at 0.3" spatial resolution, the emission profiles of both the molecular and atomic gas located within or behind the surface PDR and within the cavity will be spatially and spectrally resolved. This allows us to directly image the structure of the cavity

wall, unambigiously determine the gas distribution of the PDR layer(s) and thus derive how energy is transported across the cavity wall.

2013.1.01207.S

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Title

Constraining H0 with ALMA imaging of the gravitationally lensed quasar RXJ1131-1231

Abstract

The tension between previous measurements of the Hubble constant, H0, and that recently derived by the Planck collaboration highlights the need for multiple independent measurements. The tension, if not attributed to systematic effects, would challenge the standard LambdaCDM paradigm.

We propose to measure H0 by observing the CO(J=2-1) emission from the spectacular gravitational lens system RXJ1131-1231. By velocity resolving for the first time the CO(J=2-1) emission from the prominent Einstein ring at z=0.658, we will constrain our lens mass models with unprecedented accuracy for cosmography. Specifically, the spatially- and velocity-resolved ALMA images will allow us to measure H0 with an accuracy of ~3-4% from this single gravitational lens system. This is similar in precision to, and completely independent from, the current best measurements from the local distance ladder. Such an independent measurement on H0 based on our proposed ALMA observations is crucial for assessing the current tension between different H0 measurements, which could signal new physics.

2013.1.01215.S

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Title

Small scale structure of the IRC+10216 CS shells, a key to the mass loss process and chemistry

Abstract

IRC+10216/CW Leo, the closest high mass-loss star, is the best place to investigate the mass loss from TP AGB stars, a key, poorly known process that provides 3/4 of the matter recycled by stars. It is surrounded by an extended spherical envelope expanding at 14.5 km/s. Large angular size, uniform expansion and rich chemistry makes it a readable record of mass loss history and an unique probe of time-dependant chemistry. The envelope has been fully mapped in the CO(2-1) line emission, the best single tracer of the molecular gas, with the SMA and the IRAM 30-m single dish telescope. The resulting map shows a series of nearly concentric shells resulting from mass loss events separated by 800 yr. However, the limited dynamics of the SMA observations precludes the study of CO emission at radii closer than 30" from the star (i.e. during the last 1600 yr), a region dominated by very strong emission from the star. The inner region is of key importance for understanding the mass loss mechanism. We propose to map with ALMA its CO(2-1) emission at a resolution of 0.2" (10 yr). Adjacent lines of the key chemical species CN, CS, 30SiS, C4H and H13CC2N will be observed simultaneously.

2013.1.01225.S

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Title

Accretion matter onto the central engine of the nearby radio galaxy NGC 1052

Abstract

We propose observations of molecular (CO, HCO+, HCN, and SiO), dust, bremsstrahlung, and recombination lines (H26alpha and H30alpha) toward the center of the radio galaxy NGC 1052 to understand mass accretion processes from the host galaxy onto the central engine of active galactic nuclei (AGNs). Mass accretion is a key process to characterize AGN activity and evolution of super-massivi black holes (SMBHs), while it is poorly understood in terms of controling parameter of accretion rate, the origin of accretion matter, and mechanism of angular-momentum transfer. We aim to identify the accretion matter in the transition region where is the boundary between the SMBH gravisphere and galactic rotation. NGC 1052 is the best target because of proximity (20 Mpc) and evidence for mass condensation in plasma, HI, and molecular gas such as H2O, OH, CO, HCN, and HCO+, within the SMBH gravisphere. ALMA will reveal (1) distribution of accretion matter in dust, molecular gas, ionized gas, and plasma, (2) velocity fields and then accretion rate in the transition region. The results will unveil the origin of the accretion matter and discriminate mechanisms of angular-momentum transfer.

2013.1.01230.S

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Title

Winds, dust, and gas in three of Planck's Dusty GEMS: Boosting ALMA's capabilities with the most powerful gravitational telescopes in the sky

Abstract

The brightest, most strongly gravitationally lensed galaxies on the FIR/sub-mm sky provide unprecedented insight into the fine spatial details of the most vigorously star-forming galaxies in the early Universe. The Planck all-sky survey, complete down to 600 mJy (~5x10^13 L_s at z=2.5) and in combination with Herschel/SPIRE photometry, has enabled us to identify the brightest gravitationally lensed high-redshift galaxies on the sky, at spectroscopic redshifts z=2.2-3.6. As part of our comprehensive multi-wavelength follow-up of these extraordinary sources, we wish to use the ALMA 12-m-array to map the [CII] in the 3 sources observable from Chajnator, and to search
for OH119, an excellent absorption-line probe of molecular outflows in G244.8, potentially the single brightest high-z lensed galaxy on the FIR sky. [CII] will provide us with the total UV heating budget and provide a base for a plethora of line diagnostics, including gas densities and radiation fields, when combined with various mm lines. Velocity gradients and line profiles will constrain gas turbulence and rotation, and may indicate a merger or winds.

2013.1.01231.S

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Title

The Fine Structure of an Extreme, Lensed Starburst Galaxy at z=5.7

Abstract

We propose to observe a full diagnostic suite of five far-IR fine structure lines in an extraordinary starburst galaxy at the end of cosmic reionization. Through the power of gravitational lensing, our observations will measure the metallicity, radiation field, density, kinematics, and AGN effects with effective resolution of a few hundred parsecs, which has only been possible to date in the nearest star-forming galaxies. SPT0346-52, at z=5.7, already has high-resolution maps of the dust continuum and low-J CO emission, as well as integrated measurements of mid-J CO, [CII], and full radio-to-IR SED coverage. These observations effectively complement Herschel studies of local ULIRGs, and extend the study of these lines to the first Gyr of cosmic history. The high sensitivity, high resolution studies made possible by ALMA will address several key questions about the first stages of galaxy evolution, including the production of heavy elements, stellar and AGN feedback mechanisms, the energetics of the ISM, and the dynamics of the first galaxies.

2013.1.01239.S

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Title

Probing the z=1.0 Kennicutt-Schmidt law by combining ALMA and VLT KMOS observations

Abstract

It is vital to our understanding of galaxy formation and evolution to determine if the prescriptions for star formation, such as the Kennicutt-Schmidt law, are applicable to the rapidly evolving inter stellar medium of gas-rich, high-redshift galaxies. To test this, spatially resolved observations of both the star formation and the cold gas that fuels it, for typical high redshift, star forming galaxies, are required. We propose to measure the cold molecular gas masses for 11 z~1.0 star forming galaxies for which we possess spatially resolved Halpha derived star formation rates and dynamics from our ongoing VLT KMOS programme.

We will infer the gas masses for our sample (via gas-to-dust ratios) with ALMA Band 7 continuum observations of the dust emission from the optically thin region of the Rayleigh Jeans tail. This approach does not rely on the uncertain conversion from CO gas mass to molecular Hydrogen. The other great advantage of this method is that we only require 10 minute integrations per galaxy to derive typical gas masses, which is significantly faster than the >1 hour required to obtain this measurement from CO line emission.

2013.1.01241.S

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Title

Detecting [CII] in two strongly lensed z~6 star-forming galaxies

Abstract

We propose to conduct deep ALMA observation of two z~6 sub-L∗ star-forming galaxies to detect their [CII] emission line and derive from the line flux their star formation activity. These two Lyman-break galaxies are unique multiple image systems found in the massive cluster lenses Abell 383 and MS0451-03 at redshift 6.027 and 6.703 respectively. Their lensing magnification is ~11 and 100 respectively thus allowing to probe the properties of "normal" low luminosity galaxies at early times in the Universe. The proposed observation will lead to a secure [CII] detection. However, would we not detect [CII] the upper limit we can derived will have strong consequences on our understanding of star formation in the early Universe advocating for unexpected strong evolution in the galaxy formation models.

2013.1.01255.S

		Exec	Country	Institute
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Title

Probing Cool Dust in the Type Ia Supernova Remnant 0509-67.5

Abstract

In this proposal, we aim to detect thermal continuum emission from cool Fe grains that were formed in the innermost ejecta of Type Ia supernova remnant (SNR) 0509-67.5 in Large Magellanic Cloud. The goals of this proposal are (1) to obtain the millimeter images of the central diffuse region of SNR 0509-67.5 in Bands 7 and 6, and (2) to measure accurately the thermal emission fluxes from dust grains in the central

region. For Fe grains with the mass of 0.1 Msun and the temperature of 30 K, the expected fluxes are higher than 0.18 mJy in Band 7 and 0.07 mJy in Band 6. The proposed observing time is 6.1 hours in total, which enables us to detect Fe grains of 0.1 Msun with 5 sigma confidence both in Band 7 and Band 6. Because this sensitivity is based on a conservative estimate, it is highly possible to detect cool Fe grains in SNR 0509-67.5. By determining the mass and typical radius of Fe grains from the measured fluxes, we will solve a long-standing problem whether Type Ia supernovae are sources of Fe grains in the Universe or not, and provide insights into the origin and evolution of interstellar dust, as well as the dependence of dust formation process on the type of supernovae.

2013.1.01258.S

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Title

Tomography of a Galaxy Protocluster at z=5.3

Abstract

Cosmological simulations suggest that massive galaxies at present day formed in the densest regions in the early universe, predicting the existence of massive protoclusters of intensely star-forming galaxies at high redshift. We have recently identified such a unique region within 1.1 billion years of the Big Bang, hosting an extreme starburst and at least 13 normal star-forming (Ly-break) galaxies, within a narrow redshift interval (dz=0.002). This environment is a "smoking gun" for early massive galaxy formation through hierarchical buildup, giving key importance to understanding the physical properties of its member galaxies in detail. Building on our efforts in cycle-0, this proposal aims to add an essential missing piece to our comprehensive dataset on this region by mapping it out in [CII] and far-infrared continuum emission, and by imaging the cycle-0 targets down to 850 pc resolution. This will critically constrain the interstellar medium content, excitation, distribution and gas dynamics of the protocluster members, constituting their fuel for star formation, and dust-obscured star formation rates. This will be the first detailed ISM study of Ly-break galaxies at z>3.

2013.1.01262.S

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Title

Quasars Probing Quasars: CO observations of projected quasar pairs

Abstract

We have compiled a large sample of close projected QSOs pairs, with small transverse separations (<100kpc) but large line-of-sight separations, such that the QSOs are physically unassociated. In these unique sightlines, optical absorption lines in the background QSO spectrum encode information about the

state of cold gas in the foreground QSOs ISM/halo. Our measurements indicate that QSOs at z~2 are surrounded by significant reservoirs of cold gas on ~30-100 kpc scales, with extreme kinematics. This could be the first detection of the so-called cold mode of cosmological accretion, proposed as the primary mechanism for fueling galaxy formation. In this proposal, we request sensitive CO(3-2) observations to measure molecular gas masses and kinematics in three of these systems. This will allow us to connect for the first time the small scale molecular gas reservoirs of galaxies to their larger scale ~30-100 kpc supply of cold gas. These measurements will provide critical constraints to the mechanisms responsible for the supply of cold gas in massive galaxies.

2013.1.01268.S

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Title

3D mapping of the CO snow surface in a planet-forming disk

Abstract

Snow lines affect the planet-forming capacity of disks and influence the C/O ratio of extrasolar planets and Solar System bodies. ALMA has successfully imaged the CO snow line in the midplanes of the disks of TW Hya and HD163296 via emission of N2H+ and DCO+. The DCO+ line is ideally suited to map out the 3D structure of the snow surface away from the midplane that is set up up by the combined radial and vertical temperature gradients. DCO+ is only present in a distinct layer that envelopes the CO freeze-out zone, with temperatures between ~21 K (where deuteration becomes significant) and ~19 K (where its parent species CO freezes out). This ALMA proposal aims to use DCO+ to map the CO snow surface throughout the HD163296 disk. In this inclined disk (i~45 deg) emission from different heights is separated in velocity channel maps, as shown by ALMA Science Verification data of CO in the same disk. With the proposed DCO+ observations, we can measure the vertical location of the DCO+ layer, and from there the CO snow surface, across the HD163296 disk. Comparison with CO, H2CO, DCN, and N2D+, obtained simultaneously, places constraints on vertical and radial mixing across the snow line.

2013.1.01271.S

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Title

Testing feedback scenarios and clump life times in a prototypical z~2 galaxy

Abstract

Theoretical models predict that key aspects of galaxy evolution including bulge formation, black hole accreation and quenching may be regulated by the dynamics of large star forming clumps which are almost ubiquitous in the gas rich ISM medium of normal high redshift galaxies. The effective relevance of this scenario depends on the longevity and the possibility of "rejuvenation" of such instabilities, both of which can be observationally constrained by probing the amount and distribution of cold gas at the clump scales.
We thus propose for ~8h high resolution mapping of molecular gas content in HUDF 6462, a well studied and typical star forming z~1.5 clumpy galaxy.
We target the CO(5-4) emission line in Band 6 using a 0.4" beam width for resolving individual clumps. The requested frequency range covers the rest-frame 500micron thus also offering the possibility of measuring continuum dust emission. These new ALMA data, combined with the state of the art data set available for the proposed target, will offer strong constraints on the above key questions.

2013.1.01274.S

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Title

High-angular resolution dust polarization of proto-brown dwarf harbouring core - L328 SMM2

Abstract

We propose high-angular resolution observations of sub-millimeter polarized emission of an isolated dense core L328 where a proto-brown dwarf is currently forming. The proposed observations would probe magnetic field morphology for the first time around a proto-brown dwarf. This observations would help us to provide constrains on theoretical models of cloud collapse to form sub-stellar objects.

2013.1.01282.S

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Title

Polarimetric Observation of Centaurus A: Poloidally-dominated magnetic field vs. Toraoidally-dominated magnetic field in the Innermost Jet

Abstract

We propose band-7 polarimetric observation of the nearby radio galaxy Centaurus A. The polarimetric observation is the unique tool to investigate the magnetic field structure of the extragalactic jets. In particular, the magnetic field property in the innermost jet is a key ingredient to understand the jet formation and acceleration. However, the innermost magnetic field structure has been hardly explored so far. The major problem is that polarized emission cannot be detected in parsec scale because of strong depolarization effect at centimeter wavelengths. Mm/submm observation is essential to avoid such a depolarization and to investigate the polarized emission from the innermost jet. Our ALMA band-7 observation will firstly unveil the magnetic field structure in the innermost jet of Centaurus A. From this observation, we will distinguish whether the magnetic field is poloidally-dominated or toroidally-

dominated. This is highly important to understand the role of magnetic field for the jet production since the jet production state is expected to be dependent on the magnetic field morphology based on the recent general relativistic magnetohydrodynamical simulations.

2013.1.01286.S

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Title

Magnetic Field and Rotational Motion in Proto-circumstellar Disk Formation

Abstract

We propose dust polarization continuum observations at an angular resolution of 0.2" and Band 7 toward four protostars, L1527 IRS, TMC-1A, L1551 IRS 5, and L1551 NE. We have been studying the gas motions in our target sources with our SMA and ALMA observations, and have detected Keplerian disks and the transition from the infalling envelopes to the disks. The Keplerian disks in these sources have radii ranging from 50 AU (~0.4") to 300 AU (~2"), and are excellent targets to image the magnetic field in the disks. In addition, we have calculated theoretical simulations of disk formation in collapsing cores with different ratios between magnetic field strength and angular momenta, and found the degree of the alignment between the disk elongation and the disk magnetic field is related to the relative importance of rotational motion and magnetic field in disk formation. In this project, we will compare observed structures of magnetic field in the Keplerian disks, our observational results of rotational motion, and our theoretical models of disk formation to study the role of magnetic field and rotational motion in the formation of large-scale (~100 AU) Keplerian disks.

2013.1.01292.S

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Title

An ALMA survey to unveil the main mode of star formation in the early Universe

Abstract

In recent years, convincing evidence have been accumulated that galaxies built up their stellar mass through a steady, diffuse and inefficient gas conversion dominantly taking place in non-interacting disk dominated galaxies. This has been confirmed at least up to z~3, beyond that even the deepest Herschel and JVLA surveys are not able to probe deep enough in L_IR sensitivity to detect normal massive galaxies. Thanks to exceptional ALMA sensitivity we are now in the position to easily detect a statistical sample of normal star forming galaxies at z~4 and test, for the first time, if the secular mode of stellar mass growth extends over all cosmic time.

2013.1.01295.S

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Title

The nature of the elusive mid-infrared excess sources in the Large Magellanic Cloud

Abstract

The nature of the elusive mid-infrared excess sources in the Large Magellanic Cloud

Dust production and injection into the interstellar medium (ISM) is a vital process that governs galaxy evolution.

We propose ALMA observations -- ^{12}CO J(3-2) and 860~μm continuum at 1$\arcsec$ resolution -- for ten sources in the LMC chosen to span the range of MIR colours expected for the most evolved carbon stars to efficiently and uniquely distinguish between AGBs, i.e., "spherical" outflow sources, and non-outflow sources. Because the predicted submm continuum fluxes and CO line profiles of disk-like sources are very distinct, these ALMA observations can make an unambiguous ruling on the nature of the observed sources. If many of these sources are indeed mass-losing AGB stars, the GLOBAL injection rate for the ENTIRE LMC may currently be underestimated by a factor of 2!

2013.1.01299.S

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Title

ALMA Observations of z~6.7-6.8 Galaxies with Strong Optical Nebular Emission: Re-Evaluating ALMA's Potential for Detecting z>6 Galaxies

Abstract

Recently, Ouchi et al. (2013) has reported that they could not detect one of the brightest Ly-alpha emitters at z=6.595 (named Himiko) either in continuum or in [CII] despite their deep ALMA integrations. Considering the large star formation rate (SFR) of ~100 Musn/yr derived for this galaxy from the rest-frame UV/optical observations, this means that this galaxy is abnormally deficient in [CII] and far-infrared luminosities, suggesting the possibility that galaxies at such high redshifts may be quite poor in dust and metal. Although this is exciting news, if such conditions are prevalent at high redshift, this would severely limit ALMA's potential for detecting z>6 galaxies. Here, we propose to make similar observations for two comparably bright z=6.7-6.8 galaxies. These galaxies are cluster-lensed, so their intrinsic SFRs are ~10 Msun/yr or less. Also, they show a sign of having strong nebular emission in the rest-frame optical. Together, these factors may increase the chance of [CII] and dust continuum detections, thereby shedding new light on the properties of z>6 galaxies.

2013.1.01302.S

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Title

Resolving CO and Dust Emission in the Phoenix Cluster - The First Bonafide Cooling Flow?

Abstract

Early observations of galaxy clusters predicted that the hot intracluster medium should cool at rates of 100-1000 Msun/yr, fueling extreme starbursts in the clusters' cores. This phenomenon went unobserved for decades. Recently the Phoenix cluster was discovered at z=0.597, harboring an 800 Msun/yr starburst at its center - the highest star-formation rate ever observed in a central cluster galaxy by a factor of 5. Here, we propose to obtain data at redshifted CO(3-2) with 0.7" resolution in order to determine: i) the morphology of the cold molecular gas; ii) the kinematics of the cold gas, searching for evidence of outflow/disruption; and iii) the IR-derived star formation rate, free from AGN contamination. The kpc-scale distribution of the cold gas and dust can only be studied with the superior resolution and sensitivity of ALMA. This program compliments recently-approved programs with HST, Chandra, and Gemini, allowing us to track the hot ICM as it cools over 7 decades in temperature, ultimately into fuel for star formation, and shedding new light on this uniquely extreme system in which cooling appears to be briefly dominating over feedback.

2013.1.01305.S

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Title

Witnessing the Origin of the Interstellar Turbulence: Rapidly moving Small Scale Structures in Multi-Phase Interstellar Medium

Abstract

We propose ALMA observations to detect small scale (~ a few 100 AU) cloud structures at the periphery of a molecular cloud as the origin of ubiquitously observed super-sonic turbulence driven by thermal instability. Such small scale structures are predicted by theoretical studies, and we aim to observe a direct evidence of the two-phase medium model. The preceding observations with the 45m telescope at the edge of a nearby molecular cloud have discovered small scale (a few 1000 AU) structures in 12CO (1-0) with the line width of ~ 0.6 km/s, which is significantly smaller than the typical value of 12CO in molecular cloud. It suggests that molecular cloud is composed of small-scale dense and cold structures and their overlapping effect makes it appear to be a turbulent entity as a whole. The theoretical model suggests that the cloudlets grow by coalescence of even smaller structures. It is very likely that fainter and smaller CO clouds exist but not resolved by the 45m beam. The aim of this project is to detect many small scale structures down to a few 100 AU, which will be the observational evidence supporting the theoretical two-phase turbulence model.

2013.1.01307.S

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Title

Beyond megamaser disks: understanding AGN central engines

Abstract

Extragalactic water masers in AGN central engines (so-called megamasers) probe either the AGN accretion disk at radii < 1 pc from the supermassive black hole, or the AGN jet -- ISM interaction, or in some targets both. They tend to be found in Compton-thick Seyfert 2 objects, and, because they can be mapped with milli-arcsecond resolution using radio VLBI at 22 GHz, they have proven to be very useful tools for determining the structures in the central parsecs of their host galaxies. In this proposal, we request to observe two megamaser galaxies with the goal of exploring the AGN Unified Model. In addition, we aim to determine if we can utilise a new mass determination method for measuring the super-massive black hole masses in these galaxies.

2013.1.01312.S

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Title

Wide-field imaging of dense gas in the nearby barred galaxxy M83

Abstract

We propose to make a sensitive mosaic observations of the nearby barred galaxy M83 in HCN (J=1-0).

The cycle0 observations of M83 in 12CO (1-0) enabled us to identify ~200 giant molecular clouds (GMCs) over wide range of galactic environments. Comparison with the HII regions indicated that progress of star formation strongly depends on the ratio between two time scales, namely free-fall time and crossing-time. In addition, by adopting a star formation law (SF-law) which relates, SFR, gas mass, and the two time scales, excellent agreement between the observation and the model were obtained for the radial distribution based analyses.

Motivated by this finding, we aim to investigate the formation process of dense gas in terms of it's environmental dependence, with the deep HCN observation. Since gas clouds denser than 1e4 cm-3 is known to be the basic unit of star formation, to verify the environmental dependence of SF-law, it is more essential to clarify the formation process of such dense gas.

By comparing the deep HCN data with the CO data, and with the already available working hypothesis (time scale dependence of SF), we will address the formation process of dense gas.

2013.1.01329.S

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Title

Feeding and Feedback in the central region of NGC 613

Abstract

We propose to observe the central region of the nearby galaxy NGC 613 (17.5 Mpc) in Band 3 (HCO+ and HCN 1-0, CS 2-1, SiO 2-1 and 100 GHz continuum) and in Band 7 (HCO+ and HCN 4-3, CS 7-6 and CO 3-2) with 0.25” (21 pc) and 0.5” (42 pc) resolution, respectively.
We detected hot gas in the central region.
ALMA observations resolve the circum-nuclear disk, nuclear ring and jet/outflow.
It observationally reveals following important topics of fueling process of AGN.
1. We reveal inflow gas from nuclear ring to center by kinematic analysis of CO 3-2 assuming circular rotation of the nuclear ring.
2. We estimate kinematic energy of the outflow gas using the identified direction of the outflow from the nucleus.
3. We identify heating source (X-ray, shock) of the hot gas in the circum-nuclear disk using distribution of shocked gas traced by SiO and physical condition of the gas derived from intensity ratio of HCN, HCO+, CS and CO.

2013.1.01330.S

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Title

Resolving the Cosmic Snake, a typical L* galaxy at z=1.036

Abstract

We propose to obtain CO emission map of the Cosmic Snake, a lensed, typical L* galaxy at z=1.036, dominated by ordered disk rotation. The requested spatial resolution (0.19") is comparable to HST in order to resolve the spectacular clumpy structure revealing 20 multiple imaged clumps with 0.15" radius. Thanks to lensing magnification we will resolve these clumps down to intrinsic radii of 0.01" or 100 pc. Deriving the molecular gas properties and kinematics of star-forming clumps at sub-kpc scales, below the expected scale-length for the Toomre gravitational instability of clumps in gas-rich turbulent disks, will be a first for a typical L* z~1 galaxy. The combination of ALMA data with the wealth of ancilliary data including Halpha kinematics will allow a complete characterization of the physical properties for each clump enabling us to test the Kennicutt-Schmidt law at sub-kpc scales in a z~1 galaxy, and the universality of the Larson relations for giant molecular clouds. We will also explore the variation on physical parameters of CO-H2 conversion and compare the derived kinematics with predictions from simulations putting constraints on the origin and fate of these clumps.

2013.1.01331.S

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Title

Direct Observation of Gas-Phase Methane: A Search for CH$_3$D in the WCCC Source, L1527

Abstract

Methane (CH4) is the most fundamental organic molecule, and is an abundant constituent in interstellar clouds and planetary atmospheres. In addition to this general importance, we recently found its important role in some low-mass star forming regions, called warm-carbon-chain-chemistry (WCCC) sources, where CH4 evaporated from grain mantle near the protostar triggers efficient production of various carbon-chain molecules. In this proposal, we aim at the first definitive detection of deuterated methane (CH3D) by observing its the J=1-0 and 2-1 lines in Band 6 and 8, respectively, in the WCCC source L1527. L1527 is an ideal source for this purpose because of a high expected abundance of CH4 and a warm and dense condition for rotational excitation. We have recently reported the tentative detection of CH3D in L1527 by a long integration observation with the single dish telescope (HHT), and hence, we would like to confirm this detection definitively with ALMA by observing the two rotational lines. This observation will open a new window to the CH4 science in star and planet forming regions. It will also be a definitive proof of the WCCC mechanism in L1527.

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Title

Galaxies in (and behind) two massive high-redshift clusters

Abstract

We propose continuum, CO(4-3), and [CI] observations of 70 galaxies in the two highest redshift members of a mass-selected Sunyaev-Zel'dovich effect cluster sample. By observing the merging z=0.87 cluster ACT-CL J0102-4915 "El Gordo" and the more regular z=1.06 cluster ACT-CL J0546-5345, we will be able to study how total gas content (for which dust mass is a proxy) and molecular gas content vary with galaxy property, environmental density, and dynamical state in the most massive clusters to be assembled at early times. In addition (particularly for "El Gordo," recently the subject of exquisite strong and weak lensing models), we will be able to characterize the properties of "ordinary" dusty background galaxies that have been gravitationally lensed by the clusters.

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Title

Investigating the origin of the IMF and constraining SFR models in the W43-MM1 mini-starbust ridge

Abstract

Studying extreme protoclusters is necessary to test if
the IMF origin and SFE can be independent of cloud local characteristics.
The W43-MM1 ridge, being extreme in terms of cloud concentration and star
formation activity, is a case-study to confront star formation models. It
consist of a very dense and cold mass reservoir of 20 000 Msun. We discovered that it hosts a cluster of
11 massive dense cores.
With untested assumptions regarding the
fragmentation of massive dense cores into protostars and the shape of the
stellar IMF, we expect more than 2000 stars to form, with a SFR of 6000
Msun/Myr reminiscent of starburst galaxies. A preliminary study of the mass
distribution in the W43-MM1 mini-starburst ridge suggests that statistical SFR models
do not apply to ridge clouds. We propose to investigate the
fragmentation of W43-MM1, down to the now well-defined protostellar size of 2000
AU. We especially want to 1) look for protostars and prestellar cores able to
form early O-type stars, 2) define the size/density inside/above which the core
mass function does not mimic the IMF anymore, and 3) accurately measure the SFE
correlation to the cloud density and turbulence level.

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Title

Impacts of a global dust storm on Martian atmosphere

Abstract

The most striking phenomenon on Mars is a planet-encircling storm, so-called "Global dust storm". Once it occurred, dust covers the whole atmosphere, and heats the atmosphere via absorption of solar radiation for more than one month. Our simulations predict that atmospheric temperature rises more than 20 K at 10-60 km altitude over the planet under the dust storms. Such a drastic heating in the atmosphere induces water vapor to remain without condensation, and accelerates dynamics. Moreover, Atreya et al (2006) predicted the amount of H2O2 could increase due to triboelectric filed under a global dust storm. The goal of this proposal is to evaluate how much change is induced in thermal structure, dynamics, water vapor abundances, and H2O2 amounts due to a global dust storm.
We propose simultaneous observations of CO, HDO, and H2O2 using the ALMA band-7 during/after a global dust storm as a ToO observations. Through conscious monitoring of dust opacity by Mars Express spacecraft, we can trigger to carry out the observation in real-time. A new sensitive observation of dust-covered Martian atmosphere with ALMA will provide essential understanding in the Martian meteorology/climate.

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Title

On the dominant stellar feedback mechanism in massive super star clusters

Abstract

The Antennae Galaxies hosts one of the most massive super star cluster known, SSC B1. From VLT/SINFONI observations, we find that this cluster is associated with bright compact ionized and molecular gas emission. It is an ideal source to investigate the impact of massive clusters on their surrounding gas. We propose to observe the CO(3-2) line emission at 10 pc resolution. This resolution is needed to probe molecular clouds very near the cluster itself up to those in the frontiers of the local environment of the cluster. By determining the distribution of the molecular gas and measuring the velocity dispersion, we aim to constrain feedback mechanisms and molecular cloud properties in regions where SSC form.

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Title

The Jets of the archetypal Galactic Microquasar SS433

Abstract

We propose to make an exquisitely detailed investigation at cm and mm wavelengths in order to understand the energetics of jet launch and propagation in the archetypal Galactic Microquasar SS433.

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Title

Testing magnetic braking in the Class 0 B335

Abstract

The absence of detected rotational motions in B335, as well as our recent SMA detection of polarized dust continuum emission suggest an efficient magnetic braking at work in this very young protostar.
As a first step towards characterizing magnetic braking at work in protostellar envelopes and assess its effect on re-distributing the envelope angular momentum outwards, we propose to carry out a detailed continuum polarization map of B335 with ALMA in Band 6. The resulting ALMA polarization map will also have enough signal-to-noise to be compared in details with outcomes of MHD simulations.
Thanks to detailed information on both the magnetic fields spatial distribution and the envelope kinematics probed by SMA high angular resolution observations, we will be able to put strong constraints on the role of magnetic braking to drive angular momentum transport, and regulate the accretion rate, disk formation in B335.

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Title

Star formation in extreme environments: ram-pressure stripped gas in the "cosmic skidmark''

Abstract

We propose 2.86 hour ALMA Band 3 line and continuum mapping of a z=0.18 ram-pressure stripping candidate and the surrounding 20,000kpc^{2} to investigate environmentally-driven galaxy evolution and star formation within extreme environments. This target, caught in the act of galaxy transformation as it accretes onto a group, shows evidence of an extended, gaseous plume extending over 55kpc from the galaxy core. High-resolution VLT-IFU data show [OII], [OIII] and Hβ emission indicative of star formation throughout the plume, whilst deep g-band optical data reveals a complex structure of gaseous

knots. Through simultaneous CO (1-0), CN (1-0) and SiO(3-2) line-emission mapping of this field, {\bf ALMA will reveal the location and properties of molecular cold gas reservoirs within this enigmatic system}. Continuum measurements will yield estimates of the [FIR] luminosity in order to characterise the dust within the tail. ALMA will provide a detailed outlook into the fate of a galaxy's cold gas supply when it interacts with the Intra-Cluster Medium (ICM).

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Title

Measuring Velocity Structure of MHD Wind from a Protoplanetary Disk

Abstract

We propose to observe line transitions of CI, CN and 13CO at bands 7 and 8 with high velocity resolution and high sensitivity in order to measure velocity structure of the MHD wind from a protoplanetary disk around TW Hya. Recent MHD simulations suggest that angular momentum transfer and mass accretion in the disk surface will be induced by magnetocentrifugal wind rather than magnetorotational instability. Our observations of a disk wind will give us information on mass accretion mechanisms, which is essential to understand gas dispersal from the disk and then planet formation processes.

The wind velocity is not easy to measure since it is small compared with the Keplerian rotation velocity. Here we propose to detect the disk wind velocity, using PDR species (CI and CN) as disk wind tracers and 13CO as a tracer of Keplerian rotation. The difference in the maps of intensity weighted velocity field between the lines give us clear evidence of the disk wind. In addition, the difference in the maps of intensity weighted velocity dispersion will show the radial distribution of wind velocity and give us information of how angular momentum transfer is controlled in the disk surface.