2011.0 - Proposal Author Affiliation

2011.0.00010.S

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Title

The Physics and Chemisty of Gas in Centaurus A and its Host

Abstract

Centaurus A with its host NGC5128 is the most nearby radio galaxy. Its molecular spectrum exhibits three prominent features: a) gas that is located in the outer disk and dust lanes, b) absorption lines that are supposedly close to the central AGN, and c) gas in emission from the nucleus. We propose to observe the absorption system in a variety of molecular lines. The molecular lines are chosen to be tracers of column and volume density, temperature, photon- and X-ray dominated regions (X-ray dominated regions are a crucial marker for gas close to the supermassive black hole), shocks and excitation conditions. This will allow us to derive the physical state of the gas at each spectral component as well as the chemistry involved. Our goal is to derive the origin and physics of each absorption component, reaching from the central black hole, through the region that supplies the supermassive black hole with material, regions of possible infall or outflow, the stellar disk and the outer dust lanes. This ALMA proposal will complement a comprehensive survey of the 1.2cm and 7mm lines of an approved ATCA program, which contains tracers of temperature and also lower transitions of the molecules to be observed with ALMA. Together, the ALMA and ATCA data will form a truely unique spectral survey for a radio galaxy and will much likely become the template for all searches of molecular tracers in similar objects at all cosmic epochs.

2011.0.00017.S

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Title

Expanding the frontiers of chemical complexity with ALMA

Abstract

The search for complex pre-biotic and biotic molecules in the interstellar medium (ISM) will be a primary focus of ALMA science. The molecular inventory of meteorites found on Earth includes more than 80 distinct amino acids (the building blocks of proteins), and their composition suggests an interstellar origin. The key search site for new complex organics in the ISM is the hot dense core Sgr B2(N), due partly to its high column density. However, the firm identification of new molecules requires a robust spectral model to unweave the emission lines of weakly-emitting, more complex, species from known molecules. We have already constructed a unique model of this kind, using our previous single-dish line survey, which has already allowed our team to uncover several new species.

We propose to use ALMA Early Science to perform a deep, unbiased line survey of Sgr B2(N) in band 3 (8 hours observing time). The proposed survey will improve the detection threshold for complex organic molecules by nearly a factor of 20 compared to our previous survey of this source. Such a sensitivity improvement should lead to the firm detection of a few, perhaps a dozen, new complex organics, while the adaptation of our existing spectral model will allow a rapid turn-around from detection to publication. The use of our team's cutting edge chemical models will allow the broader implications of new discoveries to be understood, and place strong constraints on chemical formation pathways.

The discovery of biologically-relevant molecules in the ISM will be of high scientific impact, and is of broad appeal to the public and the media. The combination of ALMA's unique spectral sensitivity with our established methodologies will provide an efficient showcase of ALMA's capabilities in this field.

2011.0.00020.S

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Title

Molecular line flux ratios and AGN feedback in gas/dust-rich galaxies

Abstract

We propose multiple submillimeter molecular line observations of well-calibrated nearby gas/dust-rich infrared luminous galaxy nuclei dominated by AGN (a mass-accreting supermassive blackhole) and starburst activity. Our scientific goal is to establish a solid method to differentiate the effects/feedback from elusive AGNs and starbursts deeply buried in gas/dust, based on the flux ratios of submillimeter molecular emission lines which probe the same gas phase in galaxies. Our targets are nuclear emission dominated and the relative energetic contributions from AGNs and starbursts have been quantitatively and consistently derived, thus serving as an excellent laboratory to understand the physics behind the observed molecular line flux ratios. Our proposal best matches to the ALMA cycle 0, because (1) we need line flux ratios (i.e., spectroscopy) of compact sources, and (2) the ALMA 16 x 12m antennae first enable us to observe multiple sources at multiple submillimeter molecular lines within several hours (1/500 required exposure time, compared to SMA). In the future ALMA full operation era, our rest-frame submillimeter energy diagnostic method can be applied to the distant universe (z > 1), where gas/dust-rich infrared luminous galaxies are known to dominate the cosmic energy budget, and so has a huge potential to understand the history of star-formation and supermassive blackhole mass growth in the early

universe. Our observational result can also contribute to the public promotion of ALMA, by demonstrating the power of ALMA submillimeter observations to prove deeply buried active supermassive blackholes (which are interesting objects to non-astronomers, but cannot be studied in the most popular optical wavelength).

2011.0.00028.S

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Title

The Effect of Extreme Environment on Protoplanetary Disks in Orion

Abstract

Protoplanetary disks, or "proplyds" are the sites where new Solar systems are born. While disk studies to date have
focused on regions like Taurus and Ophiuchus for their proximity, stars rarely form in such isolated environments.
In fact, there is clear evidence that our own Sun formed near a clustered OB association like Orion. To understand
how planets form it is imperative that we study disk properties in regions representative of their origins. For this
reason, we propose to survey 41 protoplanetary disks ("proplyds") in Orion in order to study fundamental disk
properties in a massive star forming region. ALMA is uniquely capable of imaging dust and gas emission from the Orion
proplyds with its combination of high frequency, sensitivity, resolution and spatial filtering properties. We will
measure the masses and survival timescales of numerous disks, we will spatially resolve the dust emission to determine
surface density profiles of the largest disks in the region, and we will attempt to detect molecular gas in Orion disks
for the first time. The results of such observations will provide the first detailed view into how the clustered
environment and UV radiation affect disk properties and evolution, and ultimately, allow us to assess the potential
to form Solar system analogs in massive star forming regions.

2011.0.00039.S

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Title

The ALMA view of the cool dust in an extreme low-metallicity starburst

Abstract

We propose Band 7, extended configuration, continuum observations of the most metal-poor starburst in the local universe, SBS 0335-052E. The starburst in SBS 0335-052E occurs in extreme conditions, dominated by Super Star Clusters (SSCs) which have formed in a relatively pristine interstellar medium (ISM) (12+logO/H=7.2). ALMA's superb sensitivity and spatial resolution can for the first time probe the cool dust in this tiny galaxy, and help understand how metal enrichment and dust production proceed in early stages of galaxy formation. Our analysis of the spectral energy distribution (SED) of this SBS 0335-052E suggests that the dust mass and dust-to-gas ratio (DGR) is highly uncertain; compared with the HI mass, the dust-to-gas ratios (DGRs) range from 3e-7 to 2e-5, much lower than predicted by a linear extrapolation of the DGR variation with metallicity. However, the SED fits are unconstrained, because there have been no detections of cool dust so far. We are likely missing a large fraction of dust mass traced by the cool dust which ALMA can now measure. SBS 0335-052 hosts six Super Star Clusters, spread over roughly 2.6 arcsec in diameter. Most of the star-formation activity occurs in the two brightest clusters, which host almost 10000 O stars in a compact region unresolved by the HST. With ALMA, we can assess the effects of feedback of the massive stars on the dust morphology and the clumping scale of the cool dust in an extreme unenriched ISM. Ultimately, our proposed observations can open a new window on the transition from metal-free star formation in the early universe to the chemically evolved massive galaxies typical of the current epoch.

2011.0.00059.S

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Title

GG Tau: the Ringworld revisited by ALMA

Abstract

Studying planet formation in the context of multiple stellar systems is fundamental because a large fraction of the stars form in multiple systems. However, there are only a few PMS (Pre-Main-Sequence) binaries which allow detailed analysis of the dynamical and physical properties of their circumstellar and circumbinary material. Thanks to its distance (140 pc), and brightness (800 mJy at 1.3mm), the spectacular "Ring World" circumbinary ring around GG Tau A (a 0.25" separation binary system of two TTauri stars of 0.6 solar masses) provides a unique opportunity for a multi-wavelength, spatially resolved study of the physics of mass accretion onto a central binary (e.g., through cool gas/dust detected at mm wavelengths, dust distributions from optical/IR scattered light, and near IR tracers of warm gas). We propose to use the unique sensitivity and resolving power of ALMA to obtain continuum and line images of the GG Tau A young binary star and circumbinary disk system in order to test, for the very first time, theories of accretion onto the host stars. Using Band 9 and the extended configuration, we would like to observe the system in continuum and in CO J=6-5 simultaneously. Our imaging simulations show that the outer ring and the streaming material will be observable in a single primary beam. Only ALMA, even in cycle 0, can achieve such a project. The spectacular images at resolution at 3-4 times better than now available and unprecedented sensitivity will enable significant advances in astronomical study of the evolution of young binaries and the dynamic sculpting of their disks.

2011.0.00061.S

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Title

Imaging study of molecules in the nearby galaxies NGC 1068 and NGC 253: Effects of active galactic nucleus and starburst on the shock/dust related molecules SO, HNCO, CH3OH, and CH3CN

Abstract

We propose to observe shock/dust related molecules SO, HNCO, CH3OH, and CH3CN toward nearby galaxies NGC 1068 and NGC 253 at 3mm and 1mm wavelengths.

So far more than 40 molecular species have been found in external galaxies. The study of their molecular abundances and the understanding of physical and chemical processes are a fundamental for astrophysics and astrochemistry of galaxies. One of the interesting topics is the effect of X-ray produced by AGN (active galactic nucleus) to molecular abundances. We carried out molecular line survey observations toward the nearby galaxy NGC 1068 with AGN and the prototypical starburst galaxies NGC 253 and IC 342 with the Nobeyama 45m radio telescope. Based on these results, we propose an imaging study with efficient frequency settings covering astrochemically important shock/dust related molecules SO, HNCO, CH3OH, and CH3CN.

The effect of X-ray is not yet well understood. We study whether these molecules are efficiently produced in gas close to AGN or in gas with starburst. For this purpose we obtain images and abundances of these molecules. We need at least two transitions for each molecule to obtain the abundances without assuming the excitation temperatures. Therefore we observe images at both 3mm and 1mm wavelengths.

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Title

Clustered Massive Galaxy Formation around a z=5.3 Submillimeter Galaxy

Abstract

Cosmological simulations suggest that massive galaxies at present day form in the densest regions in the early universe, predicting the existence of massive protoclusters of intensely star-forming galaxies as their progenitors at high redshift. We have recently identified such a unique region within 1.1 billion years of the Big Bang, hosting an extreme starburst galaxy (the most distant submillimeter galaxy (SMG) identified to date, forming stars at 1800Msun/yr), and at least twelve normal star-forming galaxies (LBGs, the bulk are spectroscopically confirmed, and have 1-2 orders of magnitude lower SFRs than SMGs), within a narrow redshift interval of only dz=0.002. This most distant protocluster region known is a "smoking gun" for early massive galaxy formation through hierarchical buildup, giving key importance to understanding the physical properties of its member galaxies and the three-dimensional structure of the region in great detail. This proposal aims to add an essential missing piece to our comprehensive dataset on this proto-cluster by mapping out its core region in [CII] and rest-frame far-infrared continuum emission, using the ALMA early science array. This will critically constrain the neutral interstellar medium (ISM) content, excitation, distribution and kinematics of the central six LBGs (which, including the SMG, are situated within a single ALMA primary beam FWHM), constituting the fuel for their star formation, and dust-obscured star formation rates. This will also yield unprecedented constraints on the star formation law at z=5.3, and will enable the first direct ISM studies of LBGs at z>3. The [CII] measurements will give an order of magnitude more precise redshifts, substantially constraining the 3D structure of the protocluster.

2011.0.00083.S

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Title

The footprints of SF and AGN activity in NGC1068: a case study for ALMA

Abstract

We propose to map the emission of a set of dense molecular tracers (the 3-2 and 6-5 lines of CO, and the 4-3 lines of HCN and HCO+) in the central ~1.5kpc of NGC1068 using the unique spatial resolution (0.25"-0.50") and sensitivity capabilities of the extended configuration of ALMA in bands 7 and 9. NGC1068 is a prototypical Seyfert 2 galaxy with an inner circumnuclear molecular disk (CND) and a starburst (SB) ring at larger radii. These maps will spatially resolve the gas flows in the CND and the SB ring with unprecedented sensitivity. This will be a key ingredient for the dynamical models developed by our team that study AGN feeding mechanisms. Furthermore, combined with the available interferometer images obtained in the low-J transitions of these molecular species by our group, the ALMA maps will be used to study the spatial variations of the SEDs of CO, HCN and HCO+. A set of diagnostic line ratio maps will be interpreted in the light of new chemical models, developed inside the team, which address the feedback of star formation and AGN activity on molecular gas. Besides yielding a high scientific output, these observations will test key ALMA performances during cycle 0. These include the ability to build moderately large mosaics of >10 fields, and testing the reliability of observations done in band 9 with the extended configuration of the array.

2011.0.00084.S

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Title

The V4046 Sgr Disk: A Benchmark for Planetesimal Evolution

Abstract

We propose a 2-hour "compact" configuration observation of the CO 6-5 line and 700 GHz continuum emission from the unique, nearby (73 pc), and "old" (8-20 Myr) disk around V4046 Sgr. The proximity and age of this massive, gas-rich disk offer a rare opportunity to observe the subtle effects produced by the growth and migration of its solid contents with high sensitivity and
spatial resolution. The proposed ALMA observations will be used in tandem with our SMA data (CO 2-1 and 230 GHz continuum) to make two key measurements: (1) use the resolved CO 6-5/2-1 line ratio to determine the gas temperature profile and effective size of the gas disk relative to the dust, a key indirect diagnostic of the radial variation in the gas-to-dust ratio that
should be induced by the inward radial drift of solids; and (2) compare the continuum emission morphologies at 700 and 230 GHz to search for evidence of the particle size segregation expected in solid migration models. Although studying these effects is a relatively new topic enabled only now with the start of ALMA science operations, the size and spatial evolution of disk solids is perhaps the most fundamental aspect of the early stages of planet formation. The V4046 Sgr disk is an ideal proving ground for planning future
observations of these effects, as well as for highlighting how ALMA data permit rapid, significant progress toward more sophisticated analyses of circumstellar disk evolution and the formation of planetary systems.

2011.0.00097.S

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Title

Evolution of the ISM Contents of Massive Galaxies z = 2.2 to 0.3

Abstract

The interstellar medium in galaxies, specifically it's mass, is one of the major determinants of the galaxy characteristics (e.g., star formation rate and stellar population), yet the evolution of the ISM contents of galaxies over cosmic time is only loosely constrained by observations. We propose measurements of the dust continuum at 345 Ghz (Band 7) for 120 mass-selected galaxies from the COSMOS survey in three redshift bins from z = 2.2 to 0.3 to track this evolution -- a technique entirely independent of the uncertainties plaguing CO measurements, much quicker and probably more robust.

2011.0.00099.S

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Title

Reformation of Cold Molecular Disks in Merger Remnants

Abstract

It has been long predicted from numerical simulations that a major merger of two disk galaxies results in a formation of the spheroid-dominated early-type galaxy. Contrary to this classical scenario of galaxy merger evolution, recent high-resolution simulations that include more realistic gas physics have shown that not all of the major mergers will become an early-type galaxy, but some will reemerge as a disk dominated late-type galaxy. Here we propose to obtain sensitive and high resolution CO(1-0) maps toward 20 optically selected advanced merger remnants with well studied stellar hosts. The main purpose of this study is to identify the presence of molecular gas disks formed through a merger of two galaxies, and to examine the dependence on the stellar mass and structure in a statistically significant sample of merger remnants. We already have a tentative evidence that disk formation is common in merger remnants from our own analysis of archival interferometric data. If CO(1-0) is detected in all of the proposed sources, the new ALMA observations will triple the number of CO maps for a robust statistical analysis.

2011.0.00101.S

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Title

Shedding Light on Distant Starburst Galaxies Hosting Gamma-ray Bursts

Abstract

Studies of distant starburst galaxies hosting gamma-ray bursts (GRBs) offer unique insights into extreme star-forming
regions during early epochs. We propose to carry out a pilot program to observe the 345 GHz continuum from the host
galaxies of GRB021004 and GRB080607 at z > 2 with ALMA. The selected targets show contrast examples in the host galaxy
population in the observed neutral gas surface mass density in front of the GRB birth site. The host galaxy

of GRB080607
exhibits a large gas surface mass density of ~ 400 M_sun pc^-2, including a large molecular gas column density in the
afterglow spectrum. In contrast, the host galaxy of GRB021004 exhibits ionized ISM and complex velocity field in the
afterglow spectrum. Both hosts have been identified with associated stellar light in late-time HST images and have
constraints for the ISM metallicity from afterglow absorption-line measurements. In addition, the early-time afterglow
spectra of the GRBs have revealed the presence of strong Mg II absorbers at z ~ 1.5. We aim to obtain a deep sub-mm map
of the fields around the two GRB host galaxies with a 5-simga limit of 0.5 mJy in the 345 GHz waveband. This sensitivity
limit is an order of magnitude improvement from previous single-dish observations of these fields that yielded null
results. We expect that the proposed observations will allow us to resolve the extragalactic background light in the
sub-mm and to constrain the dust luminosity of these luminous GRB host galaxies. The proposed pilot program will offer
important insights into both the progenitor environment and the contribution of dusty starburst galaxies to the GRB host
population at z > 2. It will also allow us to examine the dust luminosity of strong Mg II absorbers in the foreground.

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Title

X-ray irradiated dense molecular medium in the active nucleus of NGC 1097

Abstract

We propose to study the physical and chemical properties of dense molecular gas in the central kpc region of the nearby active galaxy NGC 1097 at 110 pc (1".6) resolution. NGC 1097 hosts a type-1 Seyfert nucleus with a circumnuclear starburst ring with a radius of 10". Furthermore, the nuclear molecular gas condensation exhibits unusually elevated HCN/HCO+ brightness ratios in both J=1-0 and 3-2 transitions and CO(2-1)/CO(1-0) ratios, which are never seen in starburst galaxies. Therefore, NGC 1097 is one of the best showcases demonstrating the physical and chemical diversity of the dense molecular medium as a function of heating sources, i.e., AGN and starburst in ~100 pc resolution even in cycle 0 ALMA.

We have selected a set of key dense molecular tracers to describe physical and chemical aspects of AGN and starbursts, i.e., HCN, HCO+ , CS, and SiO, which can be efficiently observed in Band 3 and 7, thanks to the superb spectroscopic capability of ALMA. With these measurements, we will address the following issues: (1) abundance ratio variations of HCN, HCO+, and CS: Is the elevated HCN/HCO+ ratio caused by X-ray irradiated dense molecular medium? (2) detecting the SiO emission in the active nucleus: Is the central dense gas condensation a XDR like NGC 1068? (3) search for vibrationally excited HCN emission: what is the role of radiative pumping in the 100 pc region around AGN? (4) kinematics of dense clouds: can we see the inflow of dense clouds to the nucleus, or outward motion driven by a putative jet/outflow from the nucleus?

By answering these key questions, we will renovate our current view on the physical and chemical properties of active galaxies.

2011.0.00115.S

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Title

Demonstrating Early ALMA Capabilities with the Extremely Luminous Giant Starburst `Himiko' Discovered at the Redshift Frontier

Abstract

We propose Band 6 observations for a giant starburst, which we have dubbed 'Himiko', with a Keck spectroscopic redshift of z=6.595 discovered by our large area survey with Subaru in the UKIDSS/UDS field.
This remarkable object free from strong AGN activity is unique in many respects including its high star-formation rate (100Mo/yr), large stellar mass (2x10^10Mo), and luminous gigantic Lya nebula which extends over 17 kpc; no equivalent source at this high redshift has been found, to date. As a well-studied object at optical and near-infrared wavelengths, it is an excellent target for early ALMA science. Our HST observations reveal a complex morphology indicative of a major merger whose large ionized nebula is produced either by an energetic superwind or cold gas accretion along the adjacent filamentary large scale
structure. Given its intense luminosity we are likely witnessing Himiko during a key period of its mass assembly history. Our ALMA data will reveal the 1.2mm dust continuum and the kinematics of the [CII] 158um
line thereby addressing the origin of Himiko's remarkable luminosity and the physical origin of the gigantic ionized nebula. In conjunction with the large set of ancillary data following our original

discovery of this system, our proposed observations will provide a dramatic illustration of the capabilities of the early ALMA array by providing the first view of how the most massive galaxies formed close to redshift frontier z~7.

2011.0.00120.S

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Title

The earliest stages of star and planet formation

Abstract

Pre-stellar cores (PSC) represent the initial conditions for the process of star and planet formation. Although their overall structure is well known, the central few thousand AU are completely unexplored because high density tracers are heavily frozen onto dust grains. The best tracers of regions with densities > 10^6 cm^{-3} (and temperatures < 7 K) are light molecular ions, in particular the ground state transition of ortho-H2D+ at 372 GHz, observable with ALMA Early Science in Band 7. ALMA Cycle 0 offers the first and unique opportunity to peer into the PSC nucleus and study the birthplace of stars and protoplanetary disks at size scales of a few hundred AU.

2011.0.00122.S

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COI			
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Title

Rotation and Proper Motion of Protostellar Jets

Abstract

Proper measurements of jet rotation and jet velocity are very important, because they allow us to constrain the launching radius and thus the launching model (i.e., disk-wind v.s. X-wind models) of the jet. Here, the jet velocity can be derived from proper motion and radial velocity of the jet. HH 212 is a nearby (400 pc) collimated jet system powered by a low-mass, low-luminosity Class 0 protostar IRAS 05413-0104 in Orion. It is remarkably well defined and almost in the plane of the sky, and is thus best for jet rotation and proper motion measurements. We have mapped it at up to ~ 0.4" resolution with the SMA, with tentative detections of jet rotation and proper motion. Here, we propose to map the jet with ALMA in (1) CO J=6-5 and SiO J=16-15, and (2) CO J=3-2 and SiO J=8-7, both in extended configuration, in order to confirm the jet rotation and to measure the proper motion properly. If confirmed, the jet rotation will be the first confirmed detection in star formation, producing a big impact to the community. The proper

motion measured at high resolution will also be very useful for studying the jet motion and wiggles along the jet axis.

2011.0.00124.S

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COI

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Title

Spatially extended [CII] in a z=4.8 SMG

Abstract

We propose spatially resolved [CII] and continuum observations of the z=4.8 submillimetre galaxy LESS J033229.4-275619. This source is one of the highest redshift SMGs currently known, and its far-IR SED is not dominated by AGN emission. The [CII] emission is enhanced relative to CO, which is likely due to the lower metallicity. This may also imply that CO is missing a substantial fraction of the molecular gas, which could still be traced by [CII].

The 0.5" spatial resolution offered by the extended configuration will resolve both the [CII] and FIR emission, providing a first glimpse (in just 1 hour of total observing time!) of this ratio which is sensitive to the physical origin of the emission. This resolution is also ideally matched to our rich multi-wavelength data, and especially the HST/WFC3 near-IR imaging (as part of CANDELS) of the host galaxy stellar emission. The combined analysis will provide a direct determination of the spatial extent of the star forming regions within this forming galaxy.

2011.0.00130.S

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Title

Spectroscopy of a normal star-forming galaxy at z=2 with 300 parsec resolution: physical conditions in the cold ISM at high redshift

Abstract

We propose band 9 observations of [CII] emission and 630 GHz continuum in the lensed galaxy MACS J0451+0006 (J0451). J0451 is a normal L* star-forming galaxy at z=2.01 magnified by a factor of 49x due to gravitational lensing, such that ALMA's resolution (0.8 arcseconds) corresponds to only 300 parsecs in the source plane. Our extensive observations and accurate lensing mass model yield an intrinsic radius 2.5 kpc, stellar mass 1.4x10^10 Msun, star formation rate 18 Msun/yr, far-infrared luminosity 1.6x10^11 Lsun, and metallicity 0.6 Zsun, all typical of L* galaxies at z=2. We now seek to characterize the physical conditions, spatial distribution, and kinematics of the cold ISM via resolved observations of [CII]. Our specific goals are to
(1) determine the physical conditions of the cold ISM in a typical z=2 galaxy;
(2) determine the mode of star formation (i.e. extended disk vs. compact central starburst) via the distribution and kinematics of [CII];
(3) compare the spatial distribution and kinematics of the cold ISM (traced by [CII]) with the bright star-forming regions (traced by Halpha);
and (4) determine whether the enhanced [CII] emission seen in the most extreme, luminous high-redshift galaxies is also characteristic of fainter L* galaxies, and if so, determine the physical origin.
Our proposal will provide the first study of the cold ISM in a typical high-redshift galaxy, and the first high-resolution data necessary to determine the mode of star formation. These observations would not be possible without lensing; similar resolution and sensitivity would normally require several days of integration with the completed ALMA array. J0451 therefore presents a unique opportunity to study the cold ISM in a normal high-redshift galaxy with ALMA early science.

2011.0.00131.S

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Groenewegen, Martin	EU	Belgium	Royal Observatory of Belgium

Title

Piecing the shell together: ALMA and the detached shell around R Scl

Abstract

Spherically symmetric and very thin shells of gas and dust have been observed around about a dozen of carbon AGB stars - evidence that these stars have undergone episodes of major mass-loss eruptions. The origin of these detached shells is likely connected to the changes in mass-loss rate and expansion velocity during a He-shell flash. Recurring He-shell flashes are responsible for the chemical evolution of the star, the circumstellar envelope, and eventually the interstellar medium. We propose to observe the detached shell around the carbon AGB star R Scl using the compact configuration of the ALMA early science array in the CO(1-0), CO(2-1), and CO(3-2) transitions in bands 3, 6, and 7, respectively. The images from the ALMA observations will give unique information on the structure and evolution of the gaseous detached shell, and allow to determine the change in the physical stellar parameters during a He-shell flash. The observations will hence shed light on the origin of highly episodic mass loss and the He-shell flash phenomenon, as well as the mass-loss mechanism on the AGB and the structure of the circumstellar medium.

2011.0.00133.S

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Title

Can old protoplanetary disks be as tiny as 10AU?

Abstract

ET Cha is one of only three well-known nearby, gas-rich, TTauri protoplanetary disks with an age beyond 8 Myr (the other two being TW Hya and PDS 66), hence crucial for our understanding of late stages of disk evolution. This object is of particular interest as it has a clear near-mid IR excess, with optical and near IR line detections, but previous attempts to detect this disk in the sub-mm failed. ET Cha may be representative of a new class of small disks that have remained undetected so far with current instruments. Our previous analysis (Woitke et al. 2011), using a large collection of multi-wavelength data, suggets that this disk could be as small as 10 AU, an order of magnitude smaller than other protoplanetary disks around young stars. Using ALMA's superiour sensitivity, we propose to observe this object in 880mic continuum as well as 12CO 3-2 and 13CO 3-2 emission lines, to enable a thorough analysis with novel high-quality disk models, to determine the total gas and dust mass of the protoplanetary disk of ET Cha, as well as it's outer radius and temperature.

2011.0.00136.S

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Title

Sulfur and water mapping in the mesosphere of Venus

Abstract

We propose to map sulfur and water in the mesosphere of Venus, using the SO2 transitions at 336.089 GHz and 346.652 GHz, the SO transition at 346.528 GHz and the HDO transition at 335.395 GHz in order to study the latitudinal and day/night variations of these species. In addition we will observe the CO (3-2) line at 345.795 GHz which will constrain both the thermal profile and the CO vertical distribution and will be used for wind mapping.

2011.0.00142.S

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Title

Imaging the Birth Ring of the AU Mic Debris Disk

Abstract

Observations at millimeter wavelengths are unique for imaging debris disks because the emission is dominated by grains of large size that are minimally affected by stellar radiation and winds, and therefore trace best the dust-producing parent planetesimals as well as features resulting from the gravitational perturbations by planets. Here we propose to use ALMA to image the millimeter emission (band 6, Extended configuration) from the edge-on debris disk around AU Mic, an M-type star located at 10 pc, to reveal its hypothetical "birth ring" of planetesimals and examine its relationship to the tiny grains the dominate scattered light images. AU Mic offers a unique combination of proximity, edge-on viewing geometry, and extensive multi-wavelength archival data (including optical intensity and polarization imaging from the Hubble Space Telescope that reveal arcsecond scale features) that make it an extremely compelling testing ground for the "birth ring" theory and the origin of debris disk substructure. If the theory explaining the scattered light surface brightness profile is correct, then the proposed observations will resolve a belt of millimeter emission with outer extent 30 to 40 AU (3 to 4 arcsec), marking the source of the debris. It is also possible that these observations could show clumps or asymmetries indicative of the influence of an unseen planet.

2011.0.00150.S

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COI

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Title

Testing planet and star formation in binary systems

Abstract

The majority of stars are formed in binary systems. This means that a binary system is the typical environment both for star formation and for planet formation. The presence of a binary companion means that disks should be truncated, possibly influencing the prospects for planet formation. It is less well known whether or not the presence of a binary companion also influences the structure of the circumstellar disk or whether truncation only removes the outer disk, leaving the remaining disk with properties (e.g. surface density, grain size) similar to disks around single stars. While the structure and kinematics of disks around many single stars have been studied in detail, the effects of multiplicity on disk size and evolution are not nearly as well known. Here we propose to use the unprecedented sensitivity of ALMA to observe 17 known binary young star systems in Taurus for which the pair can be resolved, allowing us to characterize the disk properties and compare to those around single stars. These observations will test models of binary star formation, study whether disks evolve differently around the two stars in a binary system, and also examine the prospects for planet formation around individual stars in binary systems.

2011.0.00172.S

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Title

The Life Cycle of the Molecular Gas in the Nearest Nuclear Starburst: GMCs, Molecular Superwind, and Feedback

Abstract

We propose to observe NGC253, the nearest nuclear starburst,
with early ALMA: with a modest investment of ALMA ES band 3 we will measure
two key parameters fundamentally related to the evolution of starbursts:
1) the mass and energetics of the molecular gas entrained in the galactic
superwind, thought to be the main way to quench massive starbursts, and
2) the properties of Giant Molecular clouds, thought to drive
the high star formation efficiencies in a starburst. These goals require
a 7-point CO (1-0) mosaic using the compact configuration covering
the launching point of the wind and the H-alpha streamers, and a
3-point mosaic targeting high density tracers (one spectral setting)
centered on the nuclear starburst and including the nearby region of
the bar. The proposed setups will result in a >10-fold increase in
sensitivity over existing data on a significantly larger area.
The resulting images will provide a visually stunning illustration of
early ALMA capabilities.

2011.0.00175.S

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Title

Merging IR-Luminous Galaxies -- Arp 220 and NGC 6240

Abstract

We propose imaging in Band 7 (HCN, CS, H26alpha and continuum) at 0.5'' resolution and in Band 9 (HCN and continuum) at 0.25 arcsec resolution for the dense starburst regions of Arp 220 and NGC 6240. These unprecedented data will probe the distribution and dynamics of star forming gas and star formation activity in the dense disk structures to enable new theoretical understanding of the physics, dynamics, star formation activity and associated feedback in the most active and rapidly evolving galactic nuclei.

2011.0.00182.S

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Title

ALMA Exploration of Nuclear Regions of Nearby LIRGs -- Warm Molecular Gas Distribution Down to 100 pc

Abstract

We propose to obtain, using ALMA in both extended and compact configurations, high angular resolution and high imaging quality maps of the CO J=6-5 line emission (rest-frame 691.473 GHz) and the 450 micron continuum of two nearby luminous infrared galaxies (LIRGs; having LIR>10^11 Lsun): NGC34 (Sy2, D=84 Mpc, 1''=407 pc) and NGC1614 (starburst, D=68 Mpc, 1''=331 pc). These observations will exploit the best angular resolution (0.23") that ALMA can achieve in its shortest wavelength band (Band-9) available for the Early Science Call, and will resolve for the first time distributions of warm molecular gas (T>50K) and sub-millimeter dust radiation in LIRGs with spatial resolutions better than 100 pc. NGC34 and NGC1614 have recently been observed by Herschel SPIRE Fourier Transform Spectrometer (FTS) for the CO spectral line energy distribution (SLED) from J=4-3 to J=13-12. Among 125 LIRGs in the Great Observatories All-sky LIRG Survey (GOALS) that are being observed by Herschel, they are (1) the closest, (2) the brightest in CO(6-5) line flux, (3) with the best Band-9 transmission during the transit, and (4) showing strong nuclear activity. The high spatial and velocity resolutions of our proposed ALMA observations (5.02 hr in total) are crucial in distinguishing different nuclear gas configurations, e.g., outflow or inclined circum-nuclear disks. The ALMA data will allow us to address such important questions as: (i) Is the outflow strong enough to power the warm CO emission now and quench the star formation in future in both LIRGs (one starburst and one AGN)? (ii) Can the hard X-ray irradiation dominate the excitation of the warm CO around an AGN? And how large are the X-ray dominated regions (XDRs)?

2011.0.00191.S

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Title

Constraining the Formation Mechanisms of Wide-Orbit Planets: The Case of Fomalhaut b

Abstract

Fomalhaut b is one of the first planets to be directly imaged. Its separation from Fomalhaut is measured to be 115 AU, which presents a challenge to planet formation theories. Additional observations around other stars have shown that Fomalhaut b is not a rare outlier, but one of many wide-orbit planets. These objects may represent an extreme outcome of planet formation at shorter periods or an entirely separate mode of planet formation. A circumplanetary debris disk has been suggested to explain the excess optical brightness of Fomalhaut b. We propose to observe this potential debris disk as well as the known circumstellar ring, and use these observations to place strong constraints on planet formation at wide orbits.

2011.0.00199.S

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Title

Bursting Water Maser Feature in Orion KL

Abstract

In February 2011, an outburst of the 22GHz H2O maser feature in Orion-KL has started after 13-year silence. This is the third time to detect such phenomena in Orion-KL, followed by 1979-1985 and 1998. In order to explore the origin of such enigmatic burst phenomenon, we have been carrying out astrometric observations of the bursting H2O maser feature in Orion-KL with VERA (VLBI Exploration of Radio Astrometry). We found the bursting maser is located at the Compact Ridge, suggesting that the maser burst is likely to be caused by the interaction with the outflow from the radio source-I and ambient dense gas. However, the physical properties in/around the bursting maser feature are not well understood because of the lack of observational studies except for the H2O maser itself. Furthermore, it is still unclear why only the 8km/s component(s) show such outburst episodically or with possible 13 year-periodicity. It may imply a special condition to stimulate such maser burst. One of the possibilities is an existence of unknown young stellar object in Compact Ridge, interacting with the outflow from source-I. In order to investigate the physical properties of the bursting maser feature and its origin, we propose monthly monitoring observations of the submillimeter H2O maser lines in parallel to our VLBI observations of the 22GHz maser lines. Based on our multi-transition observations of the H2O lines, we will constrain the physical properties of the bursting maser feature. In addition, we search for the submillimeter dust continuum source around the bursting maser feature. The current maser burst is the best opportunity to explore this burst event that may never come again for another 13 years and hence, our project is most suitable for the ALMA cycle 0.

2011.0.00206.S

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Title

Dust continuum and [C II] line emission from quasar host galaxies at z~6

Abstract

Huge amounts of far-infrared (FIR)-emitting warm dust and molecular gas have been discovered in the host
galaxies of ~30% of the quasars at z~6, indicating the presence of massive star formation coeval with rapid
supermassive black hole (SMBH) accretion close to the end of cosmic reionization. We propose for ALMA Band 6/7 observations of the dust continuum and the [C II] 158 micron fine structure line emission toward five FIR and CO luminous quasars at z~6. The FIR dust continuum and [C II] line are the strongest probes of
star forming activity in these quasar-starburst systems at the highest redshift. The cycle 0 phase of ALMA in the extended configuration has the required sensitivity, frequency coverage, and spatial resolution (~0''.6 or 3.5 kpc at z~6) to allow a systematic study of these signatures of star formation in a large sample
of FIR and CO luminous z~6 quasars. Our goals are to investigate the general properties (star formation rate,
average surface density, and size) of the nuclear star formation traced by the dust continuum and [C II] line
emission in these earliest quasar host galaxies and study the distributions and physical properties of the dust and atomic gas components. The sub-arcsec spatial resolution will also allow us to search for possible companion starburst sources close to the optical quasar. These are the keys to probe the coeval formation of
the first SMBH and massive galaxies at the earliest epoch.

2011.0.00208.S

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Title

Feeding and feedback in two nearby Seyfert galaxies

Abstract

We propose to map the morphology and kinematics of the cold dense gas in two nearby Seyfert nuclei at the unprecedented spatial resolution of 0.45"=22-24 pc. Up to now, our NUGA study of molecular gas in AGN circumnuclear regions has shown that embedded, kinematically decoupled bars are able to feed the nuclei; however, we have been hampered by insufficient spatial resolution and sensitivity to trace the gas inside a 100 pc radius. In two Seyfert galaxies known to have embedded bars, NGC 1433 and NGC 1566 (at distances of 10 and 11 Mpc), ALMA will enable us for the first time to examine the ultimate contenders of nuclear gas fueling, (nuclear bars, dynamical friction, and/or turbulent viscosity). We will also be able to probe feedback processes driven by the AGN (entrained molecular outflows, P-cygni profiles in CO(3-2), HCO+(4-3)). We will improve our resolution by a factor ~5 (going to higher frequency and more nearby objects), and sensitivity by a factor 2, with respect to our previous results on NUGA. Finally, our complete ancillary multiwavelength data set, including high-resolution HST images, will enable us to examine with unparalleled detail outflows in ionized gas, dust emission in the mid- and far-infrared, and dust obscuration around AGN.
In total we ask for 5hours observing time, including calibrations.

2011.0.00210.S

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Title

Probing Formation of Keplerian Disks around Protostars

Abstract

We propose to use ALMA to directly image Keplerian disks forming around protostars in the innermost envelopes. Keplerian disks have been found around pre-main-sequence stars, and intensively studied because they are most probable sites of planet formation. According to the classical picture of star formation, Keplerian disks are naturally formed as a by-product of star formation. We have been using the submillimeter array (SMA) to study the disk formation around protostars, and found that rotation-law of infalling envelopes around protostars may change at the innermost envelopes, which may suggest a hint of disk formation there. However, the sensitivity of the SMA was not high enough to directly image disks forming around these protostars. We will take advantage of unprecedented sensitivity of ALMA, which is extremely better than SMA and other mm-interferometer even in cycle 0 phase, to directly image Keplerian disks forming around protostars. Observational results will be also carefully compared with theoretical calculations of the disk formation around protostars to understand the details of the disk formation mechanism.

2011.0.00217.S

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Title

Globular cluster formation: caught in the act

Abstract

Clusters are the building blocks of galaxies and the nurseries of most stellar systems. Despite their importance, even the fundamental question of whether a single mechanism can describe cluster formation across the mass range from open clusters to globular clusters remains unclear. Answering this question requires observations of a cluster's natal dust and gas well before the onset of star formation. We have identified an extreme molecular cloud that appears to be on the verge of forming a massive cluster. This cloud, G0.25+0.02, is very cold, massive, and dense with no obvious star formation and shows tantalizing evidence that it is highly substructured and, thus, may be undergoing hierarchical fragmentation. Using the ALMA early science extended configuration we aim to obtain a ~3 x 1 arcmin mosaic of the dust continuum and molecular line emission across this cloud at 90 GHz. These observations will reveal the location, mass, and kinematics of the small-scale fragments within the cloud allowing us to distinguish between competing cluster formation models. These observations can only be achieved with the order of magnitude improvement in sensitivity and dynamic range provided by ALMA. Determining whether clusters form via a single mechanism across the entire mass range has profound implications: if confirmed, this implies our knowledge of nearby cluster formation can be used as framework to understand star formation across cosmic time, back to globular clusters ~10Gyr ago. We speculate that

the cloud G0.25+0.02 may represent the precursor to a modern day globular cluster.

2011.0.00221.S

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Title

Detecting Cool Dust in SN 1987A

Abstract

Core-collapse supernovae (SNe) are considered to be production factories of dust in the Universe. However, the dust mass estimated from observations of young SNe is only 10^{-5} -10^{-3} Msun, which is a few orders of magnitude smaller than 0.1-1.0 Msun required for explaining a large amount of dust observed in the early universe. The previous observations of young SNe have been performed at near/mid-infrared wavelengths which are not sensitive to emission from cool dust with temperature below 100 K. Thus, far-infrared to submillimeter observations are necessary for uncovering the actual mass of dust formed in SNe. SN 1987A in Large Magellanic Cloud is the only supernova in which the detection of cool dust can be accomplished with the unprecedented capability of ALMA Cycle0.

In this proposal, we aim to detect the thermal continuum emission from cool dust that was formed in the ejecta of SN 1987A in Band 9 with the Extended antenna configuration. Our goals are (1) to obtain the spatially resolved submillimeter image of SN 1987A for the first time and (2) to accurately measure the flux of thermal emission from cool dust without being confused with synchrotron emission from the shocked equatorial ring. We emphasize that only the observation in Band 9 can spatially resolve the ejecta-dust as long as the dust mass is higher than 0.06 Msun.The proposed observing time is 4.7 hours, which enable us to detect silicate dust of 0.1 Msun with 5 sigma confidence in Band 9. Because this sensitivity is based on the conservative estimate, we can definitely detect cool dust in SN 1987A. Thus, the proposed observation will lead to a decisive conclusion on the importance of SNe as sources of dust in the Univese.

2011.0.00223.S

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Title

The rotating equatorial disk in the Red Rectangle

Abstract

We propose high-resolution (extended configuration) ALMA observation of the Red Rectangle in 12CO and 13CO J=3-2 (simultaneously observed in band 7) and in 12CO J=6-5 (band 9). The Red Rectangle is a well known protoplanetary nebula (PPN) surrounding a binary star that shows spectacular images in the optical and IR. It is the only PPN in which an equatorial disk in rotation has been clearly detected, by means of CO J=2-1 and J=1-0 PdBI maps. Such disks are still poorly observed, although their study is basic to understand the post-AGB evolution and the shaping of planetary nebulae. Both phenomena are thought to be driven by the ejection of very fast and collimated jets during the first post-AGB phases, which are probably due to reaccretion of circumstellar material via a rotating disk (as in young stars). High-resolution ALMA maps of CO emission, including the high-excitation J=6-5 line (a good probe of the temperature in our case), will significantly improve our knowledge of the structure and dynamics of the disk in the Red Rectangle. ALMA data will be combined with recently obtained Herschel/HIFI spectra of CO high-frequency lines. We will study in detail the distributions of density and temperature in the disk, including an accurate investigation of the origin of the evaporation of gas from the disk and a deep search for infalling gas in its inner regions. Because of the favorable conditions to the observation of this source and the expected spectacular results, we think that this project is very well adapted to the ALMA early science program.

2011.0.00229.S

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Title

A STUDY OF THE DUST FORMATION ZONE IN IRC+10216

Abstract

We propose to observe the J=3-2 and J=8-7 lines of HCN in all its vibrational states below 15000 K using the longest baselines provided by ALMA early science. These transitions of HCN will trace the physical conditions of the dust formation zone, corresponding to 5<r<20 R* (with R*=0.05"), and will permit to derive the spatial distribution of the gas around the central star. In the proposed frequency coverage of these lines (around 20 GHz for both transitions) we will also observe lines of SiO, SiS, CS, HC3N, CO, HCO+ and many isotopologues. Hence, this proposal will provide the highest angular resolution and sensitivity view of the physical and chemical conditions of the dust formation zone of IRC+10216.

Finally, the proposed observations will also provide a very sensitive view of the molecular content of the warm intermediate envelope (layers inside a radius of 6").

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Title

Does the Neutral Material Survive to within 0.1 parsec of the Galactic Supermassive Black Hole?

Abstract

Previous observations on hydrogen recombination lines toward the Galactic Center detected ionized mini spiral arms, which appear to
be the material that are gravitationally accreted toward the Galactic supermassive black hole, SgrA*. The new capabilities offered by ALMA band 9 allow us to probe the very hot neutral counterpart in the very central region. From the spatial distributions, the velocity, and the line width, we will determine how closely the hot neutral material can approach SgrA*, without being ionized. We emphasize that this is a pilot program to detect, and to constrain the excitation conditions of the hot neutral material within the ~0.1 pc radius. We argue that around the source of UV photons, which shows extended emissions from the ionized gas, the observations of multiple molecular transitions will better differentiate zones of different excitation conditions. This provides more information on the 3 dimensional structure and the kinematics of the accretion flow, than those observations of the hydrogen recombination line. The results will also help us to choose which molecular species and which excitation states to observe, when the much improved angular resolution and the sensitivity of the full array becomes available in the future.

2011.0.00236.S

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Title

The Dynamics of Massive Starless Cores

Abstract

Progress towards resolving a decade-long debate about how massive stars form can be made by determining if massive starless cores exist in a state of near virial equilibrium. These are the initial conditions invoked by the Core Accretion model of McKee & Tan (2003). Alternatively, the Competitive Accretion model of Bonnell et al. (2001) requires sub-virial conditions. We have identified 4 prime examples of massive (~50 Msun) cores from mid-infrared (MIR) extinction mapping (Butler & Tan 2009, 2011) of Infrared Dark Clouds. We have found spectacularly high deuterated fractions of N_2H+ of ~0.5 in these objects (Fontani et al. 2011). Thus N_2D+(3-2) becomes an excellent tracer of the kinematics of these cold, dark cores, where most other molecular tracers
are thought to be depleted from the gas phase. ALMA Cycle 0 Compact Configuration Band 6 observations probe this line on scales from 9" down to 2.3", well-matched to the structures we see in MIR extinction. Sharing a 5 hour track between single pointing observations to each of the 4 cores, we have the sensitivity and uv plane coverage needed to measure the kinematics of these structures and thus determine whether or not they are near virial equilibrium.

2011.0.00259.S

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Title

Testing the models for the inital steps toward planet formation: the evolution of solids in brown dwarfs disks

Abstract

The core accretion scenario for the formation of planetary systems in disks predicts that the initial phases of this process are characterized by the grain growth process. In this view, the solid components of disks (dust grains) grow to larger sizes to produce planetesimals and rocky cores of planets before accreting gas from the disk. The models for grain evolution in disks have now reached a sufficient level of sophistication that can make testable predictions. These models can explain the observations of large grains in the massive disks around solar-type young stars, but do predict clearly that the grain growth process is strongly dependent on the disk mass (density). The expected masses (densities) of disks in the substellar regime are so low that models predict no grain growth. ALMA Early Science offers the unique possibility to perform this test and verify whether grain growth can occurr in BDs disks. We propose to observe the four disks around brown dwarfs that are already known to have disks detected at millimeter wavelengths and to probe the presence of large grains by measuring the spectral energy distribution at millimetre wavelengths.

2011.0.00268.S

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Title

Metallicity of a Submillimeter Galaxy at z=5

Abstract

Metallicity of galaxies and its redshift evolution are crucially important to give constraints on galaxy evolutionary models. Although such studies at z>4 is extremely interesting to understand the early evolutionary stage of massive galaxies, optical or near-infrared observations cannot assess the metallicity of star-forming galaxies at z>4.
Here we propose a brand-new method to infer the metallicity of galaxies using a flux ratio of fine-structure lines, [NII]205/[CII]158, whose robustness is fully examined by our photoionization model calculations (taking both HII regions and PDRs into account). This new metallicity diagnostic is applicable for galaxies at z>4, where the [CII] and [NII] lines shift into the submillimeter atmospheric windows. Note that the [NII]205/[CII]158 flux ratio is insensitive to the dust reddening (unlike optical diagnostics), and thus it is applicable for dusty galaxies that are in the actively evolving phase of the galaxy evolution.
In the ALMA cycle 0, we propose to apply our new metallicity measurement method to a submillimeter galaxy at z=4.75. Our previous identification of strong [CII] emission in this object makes feasible to detect the [NII]205

emission in this galaxy using ALMA, even in the cycle 0. Based on the inferred metallicity, we examine the timescale of the early chemical enrichment in massive galaxies and the origin of the “[CII] excess” in high-redshift [CII] emitters.

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Title

SN87A: A Unique Laboratory for Shock and Dust Physics

Abstract

SN987A is a unique laboratory to study shock physics and particle acceleration, cosmic dust and element production. Despite intense observation over the last 25 years, outstanding questions remain which only ALMA can address, and signficant discoveries can already be made in Cycle 0.
We propose to image the remnant of SN1987A in the four available bands, spanning a critical transition wavelength range: At 100GHz SN1987A's flux is dominated by nonthermal emission from a shocked circumstellar ring, but by 690GHz the flux is predominantly thermal emission from dust in the central debris. The proposed observations will constrain models for relativistic particle acceleration in shocks. They will yield the first resolved images of the supernova debris at sum-mm wavelengths. They have the potential to discover molecular line emission from both the inner debris and from the circumstellar ring, and to find evidence for emission by a central compact object. The observations will be path finders, establishing a synoptic baseline for a major campaign with the full array.

2011.0.00275.S

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Title

Dissecting disks around B-type (proto)stars

Abstract

The goal of this proposal is to resolve the spatial and velocity structure of two carefully selected disk candidates around B-type (proto)stars and determine their properties. Through these observations we aim to test/confront the recent theoretical scenarios of massive star formation, that require non-axisymmetric disks with significant spatial and velocity sub-structure. In particular, we will look for non-axisymmetry, substructure, (non)Keplerian motions, and also determine physical parameters such as radii and masses of the disks. The chosen disk-candidates are associated with luminous sources, display mid-infrared dark lanes with disk morphology encompassed by wide-angle bipolar nebula. The feasibility of this experiment is justified by the presence of compact ammonia cores at the center of the mid-infrared dark lane, and the detection of broad SiO line wings and radio continuum emission coinciding with the bipolar nebulae. These targets will provide a step further in complexity and will triple the census of accretion disks round B-type (proto) stars, besides IRAS20126+4104, the unique case of Keplerian disk studied so far.

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Title

The mystery of water vapor in IRC+10216

Abstract

One of the highlights of the first year of Herschel's science program was the discovery of water vapor in the warm inner envelope of the carbon-rich Asymptotic Giant Branch (AGB) star IRC+10216 (CW Leonis). The water abundance derived from Herschel observations of carbon-rich AGB stars are typically 3 to 4 orders of magnitude larger than the photospheric abundance expected under thermochemical equilibrium. This huge discrepancy had led to the suggestions of several possible origins for the water vapor. The relative strengths of the high-excitation water lines in the Herschel data indicates the presence of warm water vapor close to the star. Only two, still competing, theories are consistent with the existence of warm water vapor: (1) the photochemistry model within a clumpy outflow (Decin et al. 2010, Nature), and (2) non-equilibrium chemistry associated with pulsationally-driven shock waves (Cherchneff 2011, A&A). However, Herschel lacks the spatial resolution needed to probe the very innermost regions of the outflow where the two competing models predict different spatial profiles. Currently, only ALMA provides the astronomical community with high enough a sensitivity and spatial resolution to discriminate between the two alternative explanations. We propose to observe vibrationally-excited water in the nu2=1 1_10 - 1_01 transition at 658 GHz. Making the first image of water in the envelope of a carbon-rich giant will stunningly visualize the capabilities of ALMA and will show the impact of ALMA on our understanding of the physics and chemistry going on in evolved stars.

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Title

More than LESS: The first fully-identified submillimetre survey

Abstract

Ultraluminous infrared galaxies, specifically submillimetre-selected galaxies - SMGs, are a significant class of star-forming galaxies at z>1. There are a few thousand SMGs known, but no sample has the complete, secure identifications needed to derive their basic properties. We propose compact Band 7 continuum observations to precisely locate the submillimetre-emitting components in a complete sample of 126 SMGs selected from the recent LABOCA survey of the ECDFS. These observations will pin-point the submillimetre-luminous components within these sources, without recourse to statistical associations using radio/mid-/far-infrared counterparts. ALMA will thus address two key shortcomings of current submillimetre surveys: (1) Source blending - many SMGs are expected to be blended at the resolution of their discover maps. To determine the true form of the submillimetre counts - a key observable constraint of theoretical galaxy formation models - we need ALMA-resolution maps of a large sample of SMGs. (2) Incomplete identifications - the radio/mid-/far-infrared data miss the most distant (and coolest) SMGs due to their K-corrections, this biases the derived redshift distribution. ALMA will identify all the SMG counterparts in the same band they were selected in, irrespective of their redshift/spectral properties, testing the validity of the radio/mid-/far-infrared identifications (when present) and uncovering the high-redshift tail of SMGs. The improved resolution of the ALMA maps will also show the relation between obscured starburst and unobscured stellar mass and AGN activity within these systems.
These 5.4-hrs of observations will provide revolutionary science - addressing fundamental questions about the nature of SMGs - in a way which was impossible before ALMA.

2011.0.00307.S

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Title

Tracing the dense, star forming gas and AGN feedback in z=2-4 galaxies via the shape of the CO line SED.

Abstract

Recent HERSCHEL observations of the CO line SED in local IR luminous galaxies have demonstrated that the CO
levels are excited at least up to the CO(13-12) transition and that the relative strengths of the J_up>10 transitions carries valuable information on the gas excitation and possibly signs of AGN heating. Our observations of z~4 QSOs support the interpretation that AGN heating has a significant influence on the shape of the CO SED at the highest CO levels but a contribution of the dense, star-forming gas is expected too. We here propose to obtain information on the shape of the CO SED for transitions between J=8-7 and 14-13 in the three best studied high redshift (z=2.5-4.1) galaxies observable with ALMA. With the observations we aim to study the effect of extreme star-formation and AGN heating on the intensities of

the J_up>10 transitions at high redshift and to investigate the underlying excitation channels. The data will provide the first comparison sample to HERSCHEL observations in the local universe in less extreme environments. Our results will have impact on prime science goals for full ALMA array such as the observability of CO lines in galaxies at the epoch of re-ionisation. This project requires relatively short integrations which make it a highly suitable project for early ALMA high impact science.

2011.0.00318.S

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Title

Probing Dust and Gas within the Gap of the Protoplanetary Disk around HD 142527

Abstract

Observations of protoplanetary disks are essential to reveal realistic initial conditions of planet building as well as to obtain valuable insights into young planets through disk-planet interactions. A gap in a disk is one of the key structures since it is closely intertwined with disk dissipation mechanism including the tidal clearing by planets. We here propose Band 7 observations for a Herbig Fe star, HD 142527, to determine the basic properties of the gap. The remarkable morphology of the disk, suggestive of a link to a planetary system, has been known by our previous observations in infrared and submillimeter. In our ALMA observations, using 13CO (3-2) and C18O (3-2) lines, we will measure the gas kinematics, estimate the gas mass, and obtain the dust-to-gas ratio even inside of the gap. HD 142527 is one of the few sources that allow us to study disk gaps in Cycle 0 with the moderate angular resolution. Even in Band 7, we will be able to probe asymmetries in kinematics and spatial distribution of disk material within the gap. Our observations will bring significant information not only to discuss the possible planetary system but also to understand the evolution of the disk.

2011.0.00319.S

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Title

Low luminosity millimeter survey behind a strong lensing cluster

Abstract

We propose to perform continuum observations at 1.3 mm (Band 6) in the strong magnification region (x > 10) of the massive cluster Abell 1689. We can cover a survey area of 4 arcmin2 down to an intrinsic (lensing-corrected) sensitivity of 0.05 mJy (4sigma). We expect to detect ~ 12 continuum sources according to current models. This will allow us to complement the studies of brighter continuum sources and derive their relative contribution to the star-formation rate and cosmic infrared background.

At the same time, we will measure the CO line flux of 3 submm galaxies at z=2.5-2.7 discovered with SCUBA in this field, and we will cover the wavelength of the CO line for a sample of 30 other sources at 2.5<z<3 from our ongoing survey of strongly magnified low mass galaxies.
At our intrinsic sensitivity of 0.05 mJy (corresponding to an L_FIR of 10^9 Lsol at z=2.5)
we will derive their rest-frame LFIR and hence probe their FIR/UV SFR and hence dust content. We will compare these values to similar submm studies of brighter LBG samples and hence estimate the differential reddening.

2011.0.00320.S

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Title

Dispersal of protoplanetary disks: study of suspected gas-poor dusty-rich sources

Abstract

Understanding how protoplanetary disk dissipates is an essential step towards the comprehension of the planetary system formation process. Young pre-main sequence stars surrounded by gas poor, but dusty rich disks may hold one of the clues towards this step. We propose here to accurately constrain the CO column density and temperature distribution in three objects which are suspected to be in such a phase: BP Tau, CQ Tau and MWC 758. Accurate CO column density measurements, obtained by a combination of multi-line 12CO study and sensitive 13CO J=3-2 observations, will prove the low CO content of these disks. Temperature measurements should unambiguously confirm their suspected warm nature, and dismiss depletion on dust grain as the cause of low CO abundance.

2011.0.00340.S

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Title

Searching for H2D+ in the disk of TW Hya

Abstract

Most of the mass in a protoplanetary disk is represented by molecular gas concentrated near the midplane, but it is exceedingly
difficult to find clear signatures of gas in such locations. Emission lines from deuterated species like H2D+ and D2H+ provide
the best - and perhaps only - diagnostics for probing gas in the disk midplane, and thereby learning about the local kinematics
and ionization fraction. We propose to search for the ortho-H2D+ 372.421 GHz line toward the well-studied, nearby disk around
TW Hya with the "compact" configuration. The proposed observation will allow us to detect ortho-H2D+ fractional abundances down
to 30 mJy km/s, more than an order of magnitude below present upper limits. This corresponds to ortho-H2D+ fractional abundance
of 1e-13 which is below any published model predictions. A detection will constrain the ionization fraction in the cold disk
midplane and help probe the gas kinematics and the viability of MRI-based disk transport physics in this region of the disk.
A non-detection will challenge the existing models, helping improve our understanding of accretion flows in the disk midplane.

2011.0.00351.S

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Title

First detection of Hydrogen recombination lines toward an ionized jet arising from a high-mass protostar

Abstract

We propose to observe hydrogen recombination line (HRL) emission from the triple radio continuum source associated with IRAS 16532-3959, thought to correspond to a luminous (7.0 x 10^4 Lsun) young high-mass protostar. The triple source consists of a recently discovered central ionized jet and two outer lobes, which signpost shocks resulting from the interaction of the jet with the surrounding medium. The capabilities provided by ALMA Early Science enable for the first time measurements of the kinematical and dynamical properties of jets and lobes and link their energetic properties with those of larger scale phenomena such as bipolar molecular outflows.
IRAS 16532-3959 is the most massive protostar known to be associated with a collimated jet and is therefore an excellent first target to be included in the much-anticipated first round of ALMA studies of

jets and outflows.

2011.0.00363.S

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Title

The ISM in a z = 2 Normal Galaxy on Sub-kpc Scales

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 epoch. Morover, the extreme magnifcation (up to 100x) further exploits the already superior spatial resolution of ALMA, probing 500-50pc in the source-plane - comparable to full-strength ALMA during the Early Science phase. Aside from providing the first detection of CII in a normal galaxy at this redshift, 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 constrains will allow us, for the fist time, to contrast the state of the star formation in normal galaxies at z = 2 with similar local systems, and understand the processes which shape the universe which surrounds us today.

2011.0.00367.S

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Title

Outflow Entrainment in HH 46/47

Abstract

We propose to study the molecular outflow from the HH46/47 flow. This spectacular outflow shows one of the best-defined cavities in the infrared and has been studied extensively in the optical and IR. However, a high-resolution map of the entire molecular (CO) outflow is still missing –essential for obtaining a complete picture of the outflow phenomenon and its impact on the cloud. The proposed mosaic will allow us to map the entire extent of the flow, using the CO(1-0) line at a ~4.5” resolution. With the data, we will study the morphology, velocity and momentum distribution of the entrained gas. Simultaneous

observations of SO2 and SO lines will probe shocks along the outflow axis indicative of episodic ejection events. We will use the ALMA data, as well as the known properties of the protostellar wind from existing optical and IR data, to model the outflow using a 3D hydro-dynamical code. This will allow us to study the outflow entrainment mechanism and wind collimation properties, and will place constrains on the wind-launching mechanism. In addition, we will test whether the asymmetry in the molecular outflow seen in single dish CO observations is in fact due to the lack of molecular gas northeast of the source or is just due to a lack of sensitivity in the single-dish observations. Simultaneous observations of C17O(1-0) will probe the impact of the outflow on the surrounding dense core gas. This study will help increase our knowledge of the outflow entrainment mechanism and the outflow impact on the surrounding dense core of a Class I YSOs –the first steps needed to fully understand the role of outflows in the core dispersal process.

2011.0.00374.S

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Title

Molecular Gas and Feedback in the Cores of Galaxy Clusters

Abstract

We request short ALMA pointings toward the brightest cluster galaxies (BCGs) in the cooling clusters Abell 1664 and Abell 1835. Both harbour more than 10^{10} solar masses of molecular gas and nuclear starbursts that rank among the largest in the low redshift Universe. No known population of galaxies exists in clusters that could have donated molecular gas at these levels. The molecular gas, which probably formed from hot gas that cooled out of their X-ray atmospheres, may be fuelling the powerful AGN outbursts commonly observed as expanding radio bubbles, shocks and sound waves in the X-ray atmospheres of clusters. The short ALMA observations will immediately reveal relationships between molecular gas, cooling X-ray filaments of gas, star formation, and circumnuclear accretion disks fueling powerful AGN. The velocity profiles and molecular gas mass distributions will provide incisive clues to the origin of the molecular gas through measurements of its angular momentum and kinetic energy content. The proposed ALMA observations will map the mysterious cold phase of the radio-mode feedback cycle, which has emerged as the ``new physics'' in galaxy formation.

2011.0.00396.S

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Title

Using the first inteferometer H2D+ observations to constrain clustered star-forming core structure

Abstract

Given that most stars in our galaxy form in clusters, understanding the process of clustered star formation has become a key goal of star formation astronomy. As a dense core collapses, however, the density progression and accompanying temperature changes result in well-documented molecular abundance variations. The consequences of this chemical evolution are twofold: first, we must select molecular tracers carefully for the conditions we are probing; and second, we can use detailed modeling of the structure, chemistry and kinematics of dense cores to determine their evolutionary history and predict their future. The molecular ion H2D+ is likely the best kinematic probe of the dense core gas most actively forming stars. Here, we propose to use the unprecedented sensitivity and resolution of ALMA to probe the kinematics and chemistry of two evolved, star-forming cores using H2D+ and N2H+ to determine observationally for the first time the H2D+ and N2H+ abundance structure across dense cores on scales of ~ 360 AU. Through detailed modeling, these data will provide much-needed constraints to dynamic chemical models of core collapse in clustered environments.

2011.0.00397.S

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Title

The most luminous heavily obscured, radio-intermediate, QSOs and the role of radio feedback in black hole and spheroid evolution

Abstract

We propose continuum snapshot observations in Band 7 (345 GHz) for 49 mid-infrared luminous, heavily obscured, QSOs from the Wide-field Infrared Survey Explorer (WISE) survey. We cross-correlated the WISE mid-infrared catalog with the NVSS radio surveys to select luminous 1 <z <4 QSOs in the transition phase from obscured QSO/starburst through visible QSO to “red and dead” spheroid as radio jet feedback disrupts the starbursting interstellar medium.The 49 sources comprise a complete sample of the most extremely luminous and highly obscured z > 1 QSOs with buried radio jets capable of triggering accretion powered feedback in 7100 square degrees. These observations make excellent use of the early array because we can unequivocally separate AGN-dominated from starburst-dominated systems due to the brightness of our sample. We can thereby characterize them by AGN-starburst evolutionary phase and radio-loudness.

The primary goal of the multi-telescope program is to understand in detail the physical and evolutionary nature of these candidate radio feedback-phase objects, which are amongst the most luminous QSOs in the universe, observed at the peak galaxy formation epoch: how do they fit onto the evolutionary sequences suggested by models such as those of Hopkins et al (2008)? Are they indeed young QSOs or are some of them older systems that are highly inclined to the line-of-sight? How is the starburst disrupted and the molecular material dispersed? What can these very rare objects tell us about the sequence of the growth of BHs and spheroids? The program lays the groundwork to prepare for more detailed mapping and kinematics of important CO and CII lines in later ALMA observing cycles, and with EVLA and possibly VLBA, after redshifts become available. Time will be also be sought with Herschel, Chandra, and HST.

2011.0.00399.S

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Title

High Resolution Spatial-Kinematic Structures of the TW Hya Disk

Abstract

Recent studies have suggested that the magnetized protoplanetary disks can have non-Keplerian kinematics. In order to examine the theoretical prediction, we propose to observe the spatial and kinematic structures of the protoplanetary disk of the bright nearby CTTS TW Hya. The proposed observations with extended configuration on optically thick $^{12}CO(3-2)$ transition line will delineate the motion of the disk surface which is most seriously influenced by the magnetic fields of the disk. We hope to obtain the most sensitive and detailed map available to date to help constrain the disk model and improve our understanding of disk kinematics in the context of planet formation.

2011.0.00403.S

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Title

Mapping the Distribution of Warm Molecular Gas in Arp 220

Abstract

Recent Herschel observations of the nearby galaxies M82 and Arp 220 show unambiguously that the high-J rotational transitions of CO (> J = 5-4) trace very warm molecular gas with a kinetic temperature > 500K. This warm component of the molecular gas dominates the luminosity and the cooling. However, Herschel cannot spatially resolve the extent, structure, and kinematics of this warm molecular gas. We propose to map the distribution of warm molecular gas in Arp 220 with ALMA using the CO J = 6-5 line. This line falls in band 9, which can provide a spatial resolution of 0.2'' in the extended configuration, adequate to resolve the two nuclei of Arp 220, which are separated by 1'', and the dust emission, which has an extent of 1.2''. Our Herschel observations indicate that the emission from the warm molecular gas and dust is predominantly coming from only one of the nuclei. Our science goals are to determine (a) unambiguously if the dust at these wavelengths is really dominated by a single thermal component, (b) the extent of the warm molecular gas, (c) accurately the source size, which will tightly constrain the mass of the warm gas, and (d) the presence of structures on scales > 0.2''. Arp 220 is one of the most important templates for high-z SMGs. Therefore, fully characterizing the physical state of the gas and dust is extremely important for understanding the observations of high-z SMGs. Using the continuum mode, the line and the continuum can be mapped simultaneously. Identifying the source of the bulk of the warm gas and dust emission is possible with ALMA early science for the first time (and does not require the full ALMA array).

2011.0.00405.S

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Title

A survey of strong absorption lines at z=0.89 toward PKS1830-211

Abstract

The z=0.89 (sub)mm molecular absorber toward the quasar PKS1830-211 offers the unique possibility to explore the molecular content in the disk of a galaxy with an age of less than half the age of the Universe.
In this ALMA Early Science proposal, we propose to observe the strong absorption lines of most common interstellar molecules, in order to determine the structure and composition of the gas along the different lines of sight toward the lensed images of the background quasar.
The detection of a large number of molecular species will demonstrate the capabilities of ALMA to study galaxies in the distant Universe and accurate measurements of their fractional abundances will provide insights into the basic interstellar chemistry in the disk of a z=0.89 galaxy.

2011.0.00408.S

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Title

Resolving a Cool, Compact Disk Around a Nearby, Late-Type Star

Abstract

Debris disks around nearby stars allow us to probe the evolution of planets and planetesimals. The Herschel spacecraft has recently detected a cold (T<20 K) disk at wavelengths from 160 to 500 microns around a nearby star system. However, the far-infrared emission is unresolved hinting at a very compact structure (<4 AU) and thus unique grain properties. Highly reflective grains, such as water ice, may be responsible for such a cold, small disk, though the true nature of the grains will be constrained by resolved imaging. This is the closest example of only a handful of Herschel-discovered disks found to be too compact for large, blackbody grains. The close proximity of the system allows ALMA early science observations to resolve this cold, asteroid belt-scale disk. We will conduct ALMA Band 7 continuum imaging to resolve the disk and establish its size, inclination, and the grain properties of the system.

2011.0.00419.S

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Title

First images of a protoplanetary disk around a very massive protostar

Abstract

One of the most important questions in the field of star formation is to test if very massive stars (i.e. stars that will become O-type stars) form by accretion from circumstellar disks (as it is the case for low-mass stars) or if other phenomena are at work. IRAS 16547-4247 is the most massive protostar found associated with collimated jets (with ATCA and the VLA) and a rotating molecular structure (with the SMA) that probably will reveal with higher angular observations as a disk. We propose to undertake ALMA observations of several tracers of dense gas that will test critically the presence of an accretion disk around this source. In particular, we may provide the first evidence of a Keplerian signature (inner parts rotating faster than the outer parts) in a disk associated with a massive forming star. The confirmation of an accretion disk around a massive forming star will not only prove that they form by an analogous mechanism than solar-type stars but it will open the possibility of studying the physical conditions of these disks and to address questions such as if they can form not only planets but brown dwarfs and even stars.

As part of the project we will also search for recombination lines from the powerful thermal jet associated with this source.

2011.0.00454.S

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Title

(Why) Is CenA a source of Ultra High Energy Cosmic Rays: Shock acceleration, jet and UHECR composition

Abstract

Ultra High Energy Cosmic Rays (UHECRs) are protons or nuclei with energies in excess of 4x10^19 eV (a few Joules). The Pierre Auger Observatory has revolutionized astronomy with UHECRs: precise arrival directions and large samples of UHECRs (which suffer the least deflections in magnetic fields) finally allow studies of the source population(s).
There is a statistically significant excess of UHECRs detected in the direction of the nearest radiogalaxy Cen A; this is not hugely surprising as radiogalaxies have long been suspected as the source of UHECRs. Many uncertainties remain including UHECR composition, their acceleration mechanisms, and the (multiple?) source populations.
We propose to study the dynamics and physical conditions of one confirmed and five probable molecular clouds in the halo of Cen A (probable remnants of the accreted spiral galaxy) which shock and deflect the northern radio jet of CenA, and form an optimal breeding ground for UHECRs.
Our immediate goals are (1) confirm the presence of molecular clouds; their high metallicities can originate seed heavy UHECRs; (2) ascertain the dynamics and masses of the clouds and thus constrain their origin and lifetimes; (3) from momentum transfer arguments constrain the jet composition (light or heavy); (4) determine the energetics of the shock fronts: are these sufficient to accelerate UHECRs?

2011.0.00465.S

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Title

Warm gas in the HD142527 planet-forming disk

Abstract

The gas-rich disk around HD~142527 highlights a large gap, from 10 to ~140AU, suggestive of giant planet formation. Is gas accretion going on through the gap? Another feature of HD~142527 is evidence for azimuthal variations in the chemical abundances. This azimuthal structure is probably linked to the same process that shaped the gap. What is the physical state and the relative distribution of the gas and dust that are affected by the gap-clearing process?

HD~142527 is a chance to observe planet formation, or its most recent wake. The gas reservoir to build a possible planet, at orbits of up to 100AU, still holds 0.1~Msun and a range of neutral and molecular phases. In particular the regions abutting the gap are expected to be warm, and best separated from the colder regions in CO(6-5). Our preliminary detection with CHAMP+ ensures signal. We propose to obtain resolved observations of HD~142527 in ALMA band 6, 7 and 9 of the dust continua and CO and HCO+ ladders. We will produce limits on the mass of gas interior to the gap, and constrain the physical conditions that occur in planet-forming systems.

2011.0.00467.S

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Title

Dense Gas and Starburst/AGN Activities in the Late-stage IR-Bright Merger VV114

Abstract

Numerical simulations have demonstrated the importance of galaxy collisions and mergers in triggering massive bursts of star formation in the host galaxies. Recent high resolution simulations that include an improved treatment of the multi-phase ISM have shown that star formation not only increases as the galaxies first collide, but it also persists at a higher rate throughout the merger process, peaking at the final coalescence. An observational test of gas response requires mapping both the diffuse and dense gas tracers in merging U/LIRGs at high spatial resolution. Here, we propose Cycle 0 ALMA observations to obtain 0.5-1.6" (200-640 pc) resolution maps of a gas-rich late stage merger VV114 in HCN(4-3), HCO+(4-3), 12CO(3-2), 13CO(3-2), 12CO(1-0) and 13CO(1-0) lines. The relative proximity, -17 deg declination, and the rich array of multi-wavelength (HST/Spitzer/Chandra/VLA) complementary data make VV114 a

particularly good target for the Cycle 0 ALMA investigation. By analyzing the new ALMA data with 5 times higher angular resolution and 10 times improved sensitivity over the existing data, we aim to map the distribution and kinematics of dense molecular gas and the dense gas mass fraction and interpret the dense gas properties and their relation to star formation and AGN activities in the context of the merger-induced response of the ISM in the progenitor disks. These new observations will allow us to characterize the gas properties of this galaxy pair that is known to harbor an AGN and have extended starbursts across the galaxy pair, likely evolving to a ULIRG in the future.

2011.0.00469.S

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Title

The cold debris disk in the unique planetary system around HR 8799

Abstract

HR 8799 is the only multi-planet system with direct imaging available, and its debris disk is a prime ALMA target to understand how planetary systems form and evolve. We propose to observe continuum emission of the cold planetesimal disk of HR 8799 at 345 GHz (Band 7) in order to (1) determine the disk structure probing for signatures of resonant structures, asymmetries and spiral structure; (2) constrain the unknown disk inclination; and (3) determine accurately the inner disk edge. We should be able to detect the various expected features, and compare the observed structure with predictions of models. Additionally, the observations will provide a first epoch for the exploration of orbital motions of the observed structures.

2011.0.00470.S

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Title

Structure of the Debris Disk around the Solar Analog HD 107146

Abstract

We propose to image the dust continuum emission from the debris disk that surrounds the star HD 107146. This star is of interest since it has the same spectral type as the Sun, but at an age of 80-200 Myr, it reflects the conditions in a primitive debris disk around a solar analog. Moreover, the debris disk is 3-5 times brighter at submillimeter wavelengths than any other known debris disk around a G-type star. Thus HD 107146 presents a unique

opportunity to image a debris disk around a young solar analog at high sensitivity and angular resolution. The debris dust is known to be distributed in a broad (80-120 AU wide) ring with a mean radius of about 110 AU, and is thus a larger and more luminous version of the Kuiper Belt. The proposed ALMA observations will detect emission from the large dust grains in the disk, the dynamics of which are affected mainly by collisions and gravitational forces. Any asymmetries observed in the submillimeter continuum emission therefore reflect structural asymmetries in the disk, possibly from gravitational perturbations from orbiting planets.

2011.0.00471.S

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Title

30 Doradus: Dense Gas in the Nearest Super-Star Cluster

Abstract

30 Doradus is the nearest super-star cluster, and an ideal laboratory in which to study the effects of vigorous star formation on molecular gas in galaxies. We propose to image the northern molecular cloud in 30 Doradus, showcasing the unprecedented power of ALMA, even in early science, to understand detailed physical conditions in extragalactic multiphase interstellar media.
We will image the entire cloud in the most commonly used extragalactic dense gas tracers including HCN 1-0, HCO+ 1-0, and CS 2-1 (and isotopologues), measure the density, mass and gravitational support of dense starless and starforming cores. We will image most of the cloud in 12 and 13CO 2-1 and other tracers of the warm interclump medium of this starburst photodissociation region (PDR), resolving the PDR structure. In combination with our Spitzer and Herschel data, and radio recombination line images obtained simultaneously with the molecular emission, we will model the physical conditions and amount of "dark molecular hydrogen" in a real starburst PDR at reduced metallicity for the first time. Finally, we will image a small region in high-excitation lines including CO 6-5 that are particularly sensitive to

conditions in the hot dense clumps of PDRs. Detailed analysis of the molecular environment of the nearest reduced-metallicity starburst will inform the interpretation of many ALMA observations, revealing the true nature of the gas emitting brightly in these lines in more distant galaxies

2011.0.00474.S

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Title

Where do massive stars get their mass from ?

Abstract

Massive stars are most likely forming at the centre of parsec scale converging accreting filaments. MHD simulations predict that the gas along these filaments can show velocity differences of few km/s according to the direction of these filaments with respect to the cloud. SDC335.579-0.292 is a unique massive-star-forming Infrared Dark Cloud (IRDC). It shows pristine dark filamentary structures converging towards two of the most luminous protostars known in the Galaxy. Low resolution (36'') molecular line studies of SDC335.579-0.292 suggest that this cloud is globally collapsing and that the dark filaments might be accreting in a similar way as in the simulations. However only high resolution (5'') observations of the velocity field can confirm such speculations. We therefore propose to observe SDC335.579-0.292 with ALMA ES at 3mm in the compact configuration in order to get the systemic gas velocity along the set of filaments which are observed in this IRDC. We expect to measure velocity differences of a couple of km/s between the different filaments. This would strongly support the dynamical picture of massive star formation.

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Title

Directly Probing Physical Processes in a H-ATLAS Selected lensed bright IR Galaxy at z~1

Abstract

The largest extragalactic Herschel survey, H-ATLAS, has provided by far the brightest sample of lensed FIR galaxies. CO-ladder redshifts from Z-Spec are available for a subset of the sources, but the lines have typically not been spatially or spectrally resolved. With ALMA we are thus positioned to study in detail the galaxies that dominate the FIR background and the star-formation-rate density at the peak epoch of starburst/AGN activity. Here we propose observations of the CO ladder (J:2-1, 4-3, 11-10, 12-11), [CI], 13CO and C18O, CS, and H2O of the z=1.027 H-ATLAS source G15v2.19.

Our immediate science goals are to (a) map the morphology and kinematics of the cold gas on sub-kpc (almost GMC) scales and thus determine the lensing model, galaxy size and morphology (merger? rotational or dispersion support?), and GMC or GMC-cluster masses, sizes and luminosities; (b) determine physical properties of PDRs and XDRs from the CO and (limited) CS and H2O ladders and dust temperature; (c) determine gas and galaxy masses, and the star formation rates and lifetimes; (d) select the optimal strategy to observe H-ATLAS samples in Cycle 1 and beyond.

This Chilean-led project, together with complementary H-ATLAS-team proposals, will build a fast-track statistically meaningful sample of high-z lensed IR galaxies over the first few ALMA cycles.

2011.0.00497.S

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Title

Eta Carinae: Continuum and H and He recombination lines

Abstract

The objective of this proposal is to observe the region surrounding the peculiar star Eta Carinae and its binary companion, in the H recombination lines H40α (99 GHz), H30α (232 GHz), H28α (284 GHz), and H21α (662 GHz), as well as in the continuum at the same frequencies. The emission arises from an elongated structure seen at cm wavelengths that extends for several arcsec and can be resolved with ALMA, even in the initial phase. Single dish observations, previously obtained with SEST at 100 and 230 GHz, showed that the continuum flux density increases with frequency, as expected from optically thick plasma. The H40α and H30α recombination lines, also observed with SEST, present strong maser emission, characteristic of plasma with densities higher than 10^7 cm^-3. ALMA is the perfect tool to study the density distribution of the material that surrounds the binary system forming the disk-like structure; in its early science configuration it will allow to compare, with the same spatial resolution, the structure at millimeter wavelengths with what was obtained with ATCA at cm wavelengths. Observations at different millimeter wavelengths will allow the determination of the volume density of ionized matter, by comparing the emission as a function of the distance to the binary system. The high frequency H21α line will be observed for the first time.

2011.0.00510.S

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Title

Probing the Molecular Outflows of the Coldest Known Object in the Universe: The Boomerang Nebula

Abstract

The Boomerang Nebula is the coldest known object in the Universe. Single dish CO J=1-0 observations show that the high-speed outflow in this object has cooled to a temperature significantly below the temperature of the cosmic background radiation. We propose to map this ultra-cold nebula to determine the origin of these extreme conditions. The Boomerang is an key member of the class of Pre-Planetary Nebulae, objects which represent a short-lived transitional phase between the AGB and Planetary Nebula evolutionary stages. Its hourglass shape as seen in optical images of dust scattered light is in sharp contrast to the roughly round shape seen in a low angular resolution (45 arcec) CO map. The Boomerang's prodigious mass-loss rate (0.001 solar masses/year) and low-luminosity (300 Lsun) lack an explanation in terms of current paradigms for dusty mass-loss and standard evolutionary theory of intermediate-mass stars. High angular resolution mapping of the molecular gas distribution in the Boomerang will help resolve the apparent discrepancy between the molecular and optical morphology, and enable us to probe the fundamental physical properties of its ultra-cold outflow.

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Title

Mapping Shock Chemistry in NGC 1266: Local Example of AGN-driven Feedback

Abstract

NGC 1266 is an S0 galaxy that was observed in multiple wavelengths as part of the Atlas3d effort which remarkably hosts 10^9 solar masses of molecular gas and has a spectrum that exhibits extended wings of up to +/-400 km/s. High resolution CARMA observations have shed further light on this galaxy and revealed that the bulk of the gas is concentrated within 100pc of the nucleus,

The presence of an AGN combined with molecular gas outflowing faster than vesc hints that this galaxy might be a local candidate for AGN feedback. The fact that the SFR is unable to support such a high energy outflow strengthens this claim. NGC1266 is the first example of molecular feedback into the IGM from a relatively normal, non-interacting galaxy. How the gas fell so deeply into the potential well, and the exact nature of the driving mechanism behind the expulsion of the gas remain mysteries.

We propose to use ALMA to map five transitions of SiO in NGC 1266 to obtain spatial, velocity, and excitation information, enabling us to study the

shock-molecular gas interface, and possibly shed light on AGN-driven molecular gas expulsion.

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Title

Resolving the massive molecular outflow G331.5

Abstract

We propose to spatially resolve and to determine the gas density and temperature for a high-velocity molecular outflow in the multiple massive star forming region G331.5-0.1. This is the core of a GMC at a distance of 7.5 kpc, in the tangent of Norma spiral arm, a counterpart to the northern W43 GMC but in the peak of the southern molecular ring. The outflow is among the most massive and energetic discovered so far (flow mass 55 Mo , momentum 2.4 e3 Mo km/s and kinetic energy 1.4 e48 ergs). The region contains 6 massive dust concentrations, mapped in the mm continuum with SIMBA and LABOCA, with a total luminosity of 3.6 e6 Lo, about 10 times larger than the typical value for massive star forming regions in the Galactic disk. The outflow was discovered and preliminary characterized through APEX and ASTE molecular line observations. The proposed ALMA observations will permit to spatially resolve the outflow; the SiO at different frequencies will allow to determine rotational temperatures and densities for the outflow; and the H13CO+ lines will yield the properties of the ambient gas.

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Title

Imaging the Most Luminous Galaxy within z=0.01

Abstract

We propose high resolution imaging of molecular gas in the most luminous galaxy within z=0.01. The merging galaxy NGC 3256 has a luminosity of Lbol=4e11 Lsun and double nuclei with a 1 kpc (5") separation (Sakamoto et al. 2006). We will use the high-resolution and high-sensitivity ALMA data to assess the dynamical and physical properties of the ISM in the merger.

2011.0.00526.S

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Title

A Survey of Circumstellar Disks around Low-mass stars in the Upper Scorpius OB Association

Abstract

The observed lifetime of circumstellar accretion disks around young stars places empirical constraints on the timescale to form planetary systems and on the mechanisms responsible for dissipating the gas and dust in disks. Current observational constraints on the disk lifetime are derived nearly exclusively from infrared observations. Because the infrared emission is optically thick and only tracers the disk within about 1 AU of the star, these observations can only place lower limits on the disk mass. By contrast, submillimeter continuum emission is generally optically thin and is a more direct tracer of the disk mass. In this proposal, we request time with ALMA to detect the gas and dust toward a complete sample of 24 solar-type stars in the 5 Myr old Upper Scorpius OB association that are surrounded by circumstellar accretion disks. Upper Sco is the nearest OB association at this age, and thereby provides an opportunity to obtain sensitive measurements of the disk masses at a critical evolutionary stage when accretion disks have nearly dissipated. By comparing the gas and dust properties of the Upper Sco sample with that observed in 1 Myr old star forming regions (Taurus and Ophiuchus), we can determine how the disk mass function around solar-type stars evolves over 5 Myr timescales.

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Title

Discovery and characterization of disk winds from a newly discovered class of protoplanetary disks

Abstract

High-resolution spectroscopy and spectroastrometry in the infrared have revealed a new class of protoplanetary disks, displaying evidence for low-velocity disk winds (namely centrally-peaked, non-Keplerian line profiles originating from AU-scale emitting regions). The disks are also characterized by high accretion rates, and especially strong molecular emission (including from CO, H2O, HCN, C2H2 and CO2). These disks are a potential evolutionary link between stage I disks with envelopes and strong ouflows, and the more quiescent stage II disks, which are the birthplaces of planetary systems. We propose to use ALMA to search for the outer disk (>50 AU) counterpart of the molecular inner disk wind in AS 205N, the prototypical disk wind source. The detection of the outer wind will confirm the models developed for the inner disk and strongly constrain the full kinematic and chemical structure of molecular disk winds, as well as the ultimate fate of the outflowing material. The confirmation of such winds could have important implications for our understanding of the dynamic nature of the planet formation environment, and our interpretation of disk observations.

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Title

Lensing Properties of the Brightest Herschel-Selected Submillimeter Galaxies

Abstract

In the past year, Herschel has revolutionized our understanding of submillimeter galaxies (SMGs), the most intensely star-forming galaxies in the early universe. Detailed studies of SMGs are important, as they represent the short, bursty phases of star formation at high redshift in which a large fraction of the stellar mass in massive galaxies is assembled. This program will closely investigate one of the most unexpected findings in large area Herschel surveys, the discovery of very rare (1-2/deg^2), extremely bright submillimeter sources, which exceed the brightness of SMGs by up to an order of magnitude or more. This population of extremely bright SMGs was previously largely unknown (due to the insufficient areas probed by ground-based submm surveys), but adds a substantial bright tail to submm number counts. Initial studies of a few, selected sources indicate that most of them are SMGs magnified by gravitational lensing, with a small contribution of blends of multiple SMGs within the large Herschel beam. This is consistent with predictions from our models of lensed SMG counts. However, our models also show that up to ~23% of these bright sources may be unlensed starburst galaxies. Such extreme SMGs would be consistent with star formation rates exceeding 10000Msun/yr, which would severely constrain models of the early evolution of massive galaxies in their most active phases. Targeting a complete, flux-limited sample of the 30 brightest southern SMGs in the HerMES survey, we here propose to use <0.5" resolution submm imaging with ALMA to systematically constrain our models of the lensing statistics and magnification factors, to determine the fractions of lensed, blended, and extremely bright unlensed sources among the brightest high-redshift Herschel sources, and (using the ample ancillary data in HerMES) to constrain the physical properties of these enigmatic systems.

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Title

Tracing Evolution of Warm Carbon-Chain Chemistry in L1527

Abstract

A thorough understanding of chemical composition of low-mass star forming regions and its evolution to protoplanetary disks is one of the central issues for astrochemistry, astrophysics, and planetary science, since it is eventually related to an origin of rich substances in our solar system. Recent discoveries of hot corinos and the warm carbon-chain chemistry (WCCC) sources demonstrated significant chemical diversity in low-mass Class 0 protostars. Now we have an important question how these two types of chemistry evolve toward the later stages. With these in mind, we here focus on the chemical evolution of the WCCC source, and investigate the molecular distributions of the prototypical WCCC source, L1527, at the high resolution (<1") with ALMA cycle 0. Since the chemical evolution would be more advanced in a more inner region around the protostar, we can trace the direction of the chemical evolution from the spatial distribution. For this purpose, we fist observe the spectral lines of carbon-chain molecules, which are characteristic to the WCCC sources, to investigate their possible depletion/destruction in the inner part. In addition, we observe the spectral lines of H2CO and CH3OH, which are known to be a good tracer of hot corinos, to search for the hot corino activity in the innermost part of the WCCC source. These results will provide us with crucial information on the chemical evolution of the WCCC source toward the Class I and later stages. They are also important for establishing our unified picture of carbon chemistry in low-mass star forming region, including hot corino chemistry and WCCC. This observation is only possible with the ALMA sensitivity and resolution, although the source is located in the northern hemisphere.

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Title

Detecting high-density compact outflow from the youngest YSO in Taurus

Abstract

Recent theoretical simulations show that low-velocity flows of ~5km/s are driven from the adiabatic protostellar core (the first core), and that most of the initial angular momentum of the natal dense cores has been transferred during this stage. It is therefore of vital importance to investigate the first core objects as well as the outflow at this stage. In this proposal, we will carry out ALMA observations toward a dense core that contains the youngest protostar in Taurus, MC27 or L1521F in the lines of HCO+(3-2) and HCN(3-2) with multiple pointings, and in the lines of H13CO+(3-2), CS(5-4), and SiO(6-5) with a single pointing. The CSO observation in HCO+(3-2) showed that compact outflow wing is clearly seen only at the center pointing, and we found that this is due to the existence of high-density compact outflow originated from the central source. The proposed observation will be able to investigate the physical properties of the “very young” outflow, giving us invaluable information to solve how the initial angular momentum is distributed during the phase observationally.

2011.0.00612.S

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Title

An Off-Nuclear Starburst in the Luminous IR Galaxy IIZw96

Abstract

The infrared luminous merger IIZw96 contains an extremely compact off-nuclear starburst that is the source of more than 80% of the total infrared luminosity. Uncovered by the Great Observatories All-sky LIRG Survey (GOALS) using Spitzer mid-IR imaging and spectroscopy, IIZw96 is a rare example of a galaxy caught in the early merger stage of driving its vast reservoirs of molecular gas inward toward what will become the merger remnant. This unique system is reminiscent of the more famous merging galaxy NGC4038/9 (the Antennae) but is an order of magnitude more luminous at log(LIR/Lsun) = 11.94. We propose to map the off-nuclear starburst on spatial scales of 0.25"-3.0" over the entire starburst region. Given the small spatial extent and the need for extremely high sensitivity and spatial resolution, we request extended and compact array observations in Band 9 to trace the molecular gas via CO J=6-5, HCO+ J=8-7 and HCN J=8-7, and to measure the 450um dust continuum all on scales of 200-300 pc. The resulting high spatial resolution maps will allow comparisons between the distribution of the bulk of the cold molecular gas (via CO J=6-5) and dust (at 450um), the location of higher density gas clumps (from HCO+ J=8-7 and HCN J=8-7), and the distribution of the stellar populations traced by the near-infrared emission. The velocity structure will reveal possible infall or outflows of gas as well as pinpoint the dynamical center and how it relates to the density and temperature of the gas. Together the morphology and kinematics of the dense (cold) molecular gas that dominates the gas mass and fuels the star-formation will reveal the precise nature of the starburst and ultimate fate of the system.

2011.0.00628.S

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Title

Disks and complex organics in the inner regions of low-mass protostars

Abstract

One of the key questions that ALMA will address is how circumstellar disks form around low-mass protostars and how their physics and chemistry evolve until the planet-forming stages. We here propose to observe a range of transitions from isotopologues of common molecular species (H13CO+, C34S) and of complex organic molecules tracing the inner few hundred AU of two embedded low-mass protostars. These observations will address two coupled questions about low-mass star formation prompted by recent ground-based submillimeter interferometric observations: what is the origin of complex organic molecules around low-mass protostars and when are rotationally supported disks formed around such sources? This is made possible with the angular resolution and sensitivity offered by ALMA in its extended array in cycle 0. A key facet of these observations will be the spatial resolution and the sensitivity to reveal emission from complex molecules and relate those to the density distribution and kinematical profile revealed in H13CO+ and C34S on few hundred AU scales.

2011.0.00629.S

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Title

CN excitation in T-Tauri disks: a challenge to protoplanetary disks models

Abstract

Gas and dust disks are ubiquitous around Pre-Main-Sequence stars of masses below 3 solar masses. Understanding their density and temperature structures is one of the major issues to study the formation of planetary systems.
Theoretical studies of proto-planetary disks structure lead to a model with three layers, i.e. a photo-dissociation region illuminated by the stellar UV, a warm molecular layer and a cold gas-phase molecule depleted mid-plane. This picture is however not yet constrained by current observations. Nevertheless, existing observations of CO, CN , HCN and CCH suggest very low excitation temperature (< 10 K), and challenge the current disk model.
Here we propose to take advantage of the ALMA Early Science to observe the CN J=3-2 and HCN J=4-3 lines (one setup in Band 7) in one ``cold'' disk surrounding the TTauri star DM Tau and in the ``warm'' disk surrounding the Herbig Ae star MWC 480. Combining these observations with our CN J=2-1 and HCN J=1-0 data taken with the PdBI will allow us to better constraint the excitation condition, and check if the apparent low excitation temperatures is due to sub-thermal excitation.

2011.0.00635.S

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Brown, Joanna	NA	United States	Harvard-Smithsonian Center for Astrophysics
Pontoppidan, Klaus	NA	United States	Space Telescope Science Institute
Bruderer, Simon	EU	Germany	Max-Planck-Institute for Extraterrestrial Physics
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Title

Do dust holes in transitional disks still contain cold gas?

Abstract

Transitional disks with large inner dust cavities are thought to be the best laboratories for studying disk evolution during the planet-forming stage. Little is known about the gas inside dust cavities, yet this gas significantly affects planet formation through gas-grain dynamics and planetary migration. We propose here pioneering ALMA Band 9 observations of CO 6-5, C17O 6-5 and the millimeter continuum to provide the first deep searches for molecular gas inside a dust hole. The Herbig Ae star IRS48 in Ophiuchus is one of the very few disks known to have a large enough hole to be imaged during ALMA Cycle 0. This disk is unusual in that it shows very strong PAH emission inside the hole, yet the mid-IR continuum and CO infrared lines show a ring with 30-40 AU radius. The huge leap in sensitivity provided by ALMA at high frequencies allows a large range of gas masses inside the hole to be tested, down to a fraction of a Neptune mass. This, in turn, allows the origin of the hole in this disk to be determined: substellar or planetary mass companions versus photoevaporation versus grain growth.

2011.0.00645.S

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COI			
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Gallagher III, John	NA	United States	Wisconsin at Madison, University of
Roussel, Helene	EU	France	Astrophysical Institute Paris

Title

Winds of change? - probing the nuclear activity and outflow of the FIR-excess galaxy NGC1377

Abstract

ALMA offers a unique opportunity to probe the nature of FIR-excess galaxies where the IR emission is powered by dust-embedded starbursts and/or AGN activity. The molecular outflow and dusty core of the extreme FIR-excess, synchrotron deficient galaxy NGC1377 presents an opportunity to study this important phenomenon. We propose extended array CO 1-0 observations to image the molecular outflow to determine its age and address the nature of the dust enshrouded nuclear activity: an extremely young (1~Myr) starburst or a super-Eddington accreting black hole.
We furthermore propose CO 6-5 and 690 micron continuum observations also in extended to study the buried central source on scales of 20 pc. We expect intense, 50-80 K emission from the very nuclear region probing the dynamics of the inner disk, the enclosed mass and the gas heating/energy budget. The continuum will constrain the IR surface luminosity and dust mass. This proposed study will allow us to uniquely probe the very earliest phases of nuclear activity - the onset of black hole accretion or the pre-synchrotron beginnings of a starburst.

2011.0.00647.S

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COI			
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Yvart, Walter	EU	France	Paris Observatory

Title

The origin of molecular jets: new clues from CO and SiO in HH212

Abstract

We propose to use ALMA in its extended configuration to investigate the SiO bipolar microjet driven by the low-mass protostar HH212. We wish to constrain its origin by observing CO(6-5) at 691.5 GHz at the unprecedented angular resolution of 90 AU. We propose to observe also CO(3-2) and SiO(8-7), on a 220 AU scale, with a sensitivity at least one order of magnitude higher than that of previous SMA data.

In this way, we will be able to constrain for the first time the CO opacity, the SiO abundance, the jet density and mass-flux rate on a 220 AU scale. These parameters will hold crucial clues to the jet launch region. Observations will be confronted with updated predictions for SiO in C-shocks and dust-free wind models, to elucidate the SiO formation process.

2011.0.00648.S

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COI			
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Iwamuro, Fumihide	EA	Japan	Kyoto University
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Title

Molecular gas/dust and gas metallicity in star-forming galaxies at z~1.4

Abstract

We propose CO(5-4) and dust thermal continuum emission from star-forming galaxies at z~1.4. The sample contains 20 star-forming galaxies extracted originally from our stellar mass limit sample. From usual spectral energy distribution analysis, stellar masses and star-formation rates (SFRs) of these galaxies are obtained. Subsequent near infrared spectroscopy enabled us to derive gas metallicity from Halpha and [NII] emission lines, and extinction corrected Halpha luminosity for the targets. With this unique sample, we will investigate whether the molecular gas mass and the dust mass as well as CO-to-H2 conversion factor at the redshift show some trend against gas metallicity rather than stellar mass, SFR, etc. Since there is a possibility that CO luminosity at a given molecular gas depend on the gas metallicity and dust mass is also expected to be dependent on metallicity, studies of star-forming galaxies covering a certain range of metallicity, stellar mass, and SFR is inevitable to push further high-z CO/dust observations in general. Furthermore, since gas inflow/outflow also affects gas metallicity evolution, we will be able to constrain a process of galaxy evolution from the metallicity and the gas mass fraction. The results obtained in this proposal are expected to give us a good compass to navigate future high-z observations with ALMA. Thus the program would be suitable to be conducted in cycle 0 phase.

2011.0.00652.S

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Title

Deciphering black hole feedback: molecular outflow in an obscured quasar

Abstract

We propose to search for outflowing molecular gas in the obscured quasar SDSS J1356+1026. This nearby (z=0.123) luminous quasar
is blowing a 10kpc-scale bubble of ionized gas, and provides strong evidence that black holes can inject energy into their
large-scale environments without the help of star formation or radio jets. The bulk of the outflow may well be in the molecular
phase, and we will search for it with CO(1-0) and CO(3-2) observations with ALMA. We will probe the majority of the outflowing
mass and reveal the physical conditions of the outflow. SDSS J1356+1026 provides the key to understanding the prevalence of
black hole energy injection in the growth and evolution of galaxies.

2011.0.00656.S

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COI

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Yamamoto, Satoshi	EA	Japan	The University of Tokyo

Title

Deuterium Fractionation in the IRDC clump G34.43+00.24 MM3

Abstract

We propose to observe the HN13C, DNC, N2H+, and N2D+ J=3-2 lines toward the infrared dark cloud(IRDC) clump, G34.43+99.24MM3, to examine our idea of extracting the initial condition of high-mass star formation from the deuterium fractionation ratios observed in the star-forming clump. From our previous single-dish observation (HPBW~18”), the DNC/HNC ratio of high-mass sources is found to be systematically lower than that of the low-mass sources. Taking the time dependence of the deuterium fractionation into account, the low DNC/HNC ratio does not reflect the current temperature, but it may suggest that the cold starless phase is shorter than that of the low-mass cores, or that the initial temperature is higher. However, we need to evaluate the DNC/HNC ratio at a higher angular resolution with ALMA for a fair comparison with the ratio in low-mass cores under the similar physical size scale, considering that high-mass sources are more distant than low-mass sources. For this purpose, we select G34.43+00.24MM3, which has the lowest DNC/HNC ratio in the sample of our previous single-dish observation. By higher angular resolution (3”) observations with ALMA, we will investigate the deuterium fractionation ratio in the innermost part of the clump, which is directly related to the star formation. If we confirm the low DNC/HNC ratio in the innermost part of the clump, we can state that the initial conditions are different between low-mass and high-mass star formations. Furthermore, we wish to investigate how the star formation activities affect the deuterium fractionations, by comparing the distribution of DNC/HNC ratio with those of the N2D+/N2H+ ratio and the shocked gas tracers, like SiO and CH3OH.

2011.0.00724.S

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Title

The origin of transitional disks: grain growth or dynamical clearing by planets?

Abstract

Most young, low mass stars are surrounded by optically thick accretion disks. A small fraction of these stars show a remarkable depletion of dust in the inner disk regions. These so-called ``transition disks'' are thought to represent a brief, but extremely important, evolutionary phase between young, optically thick protoplanetary disks and old, optically thin debris disks.

A number of mechanisms have been proposed to deplete the inner regions of transition disks, including grain growth, photo-evaporation by the central star, and dynamical clearing by a recently formed planet. Observationally, distinguishing between these mechanisms has been difficult up to now. In this proposal, we request time with ALMA to image a subset of transition disks with large inner holes, large disk masses, and high accretion rates, that likely originate by either grain growth or dynamical clearing by a planetary object.

ALMA's exquisite sensitivity and high angular resolution, already available in Early Science, can resolve the inner disk and detect trace amounts of dust in the depleted regions. Analysis of the visibility data will reveal if the inner edge of the disk is sharply truncated (favoring dynamical sculpting by a planet), or if the inner edge varies smoothly with radius (favoring accelerated grain growth in the inner disk).

2011.0.00727.S

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Title

Mapping the nitrile chemistry and dynamics of Titan's thermosphere

Abstract

The Cassini space mission has shown that Titan's atmosphere is a complex system
involving strong interactions between chemistry and dynamics.
Titan's stratosphere and lower mesosphere (150-500 km) is currently explored in details by Cassini/CIRS.
At the top of the atmosphere, the thermosphere (900-1200 km) is currently explored by Cassini/INMS,
but with a scarce sampling in latitude, altitude and local time.
In between, Titan's mesosphere/lower thermosphere region from 500 to 1000 km remains largely
unexplored by Cassini.
The main goals of this proposal are (i) to map the HNC(4--3) and HCN(4--3) lines in the upper atmosphere
(500-1000 km),
in order to constrain the chemistry, temperature and dynamics in this poorly known region.
(ii) to take benefits of the large bandwidth of ALMA to simultaneously
map other nitriles (HC3N and CH3CN) and search for an as-yet undiscovered nitrile (DCN).

2011.0.00733.S

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casassus, simon	CL	Chile	Chile, University of
Jordan, Andres	CL	Chile	Catolica of Chile, Pontifica University

Title

Towards a global understanding of circumstellar disk evolution

Abstract

In recent years it has been established that the evolution of circumstellar disks is fundamentally driven by the following processes: viscous accretion, grain growth, planet formation, and photoevaporation. Despite this progress, we are still far from developing a comprehensive disk evolution theory and additional observational constraints are highly required. Transition disk objects are crucial in this context as they show clear signs of disk evolution: inner opacity holes. We have performed a detailed follow-up project of Spitzer-selected transition disk systems with the aim to distinguish between different types of transition disks (Cieza et al. 2010, Romero et al. 2011). Here we propose to observe 26 transition disks characterized by Romero et al. (2011) with ALMA's unprecedented sensitivity to address fundamental issues related to grain growth, planet formation, and photoveporation in circumstellar disks. In a complementary proposal we request identical ALMA observations for 26 Ophiuchus targets (PI: Cieza). Characterizing a large and homogenous sample of transition disks from star forming regions of different ages is key as disk evolution very probably does not follow a unique path.

2011.0.00735.S

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Title

Molecular Gasdynamics in the Central Elliptical Galaxy of the NGC 5044 Cool-Core Group

Abstract

The central elliptical galaxies of cool-core groups and clusters rank among the most molecular-gas-rich galaxies in the Local Universe. Such groups/clusters exhibit a strong central peak in their X-ray emission, indicating intensive cooling of the X-ray gas in the group/cluster core. In the absence of sufficient reheating by radio jets from their central galaxies, the gas in the group/cluster core should cool below X-ray temperatures and flow inwards (an X-ray cooing flow), thus depositing atomic and molecular gas in the central galaxy. In the only such galaxy so far mapped in CO, the central galaxy of the Perseus cluster, the molecular gas is distributed in radially-infalling filaments indicative of an X-ray cooling flow. Such molecular structures have not previously been observed in any other galaxy, and call to attention an important galactic-scale phenomenon yet to be fully elucidated. Here, we propose to image the molecular gas in the central elliptical galaxy of a cool-core group, NGC 5044. Unlike the Perseus cluster where the X-ray gas is reheated by a powerful AGN outburst from its central galaxy, in the NGC 5044 group gas reheating occurs through the cumulative effects of many weak AGN outbursts from its central galaxy as is more characteristic of cool-core groups/clusters. Our goals are to determine where the molecular gas in NGC 5044 is being deposited or dragged outwards, and through comparisons with the central galaxy of the Perseus cluster gain insights not possible from studies of one system or environment alone.

2011.0.00742.S

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Nikola, Thomas	NA	United States	Cornell University
Brisbin, Drew	NA	United States	Cornell University
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Falgarone, Edith	EU	France	Paris Observatory

Title

ALMA Imaging of the Star Formation Process at the Historic Peak

Abstract

We propose an ALMA ES "mini-survey" of z~2 sources to image the 158 μm [CII] line in four objects from three representative sources from our ZEUS/CSO survey. Through ZEUS/CSO spectroscopy we have detected the [CII] line from 22 star forming and AGN dominated galaxies in the z~1-2 redshift interval. The redshift range 1-3 is important since half the star formation through cosmic time occurred in this epoch. The [CII] line is a critical tracer of star formation, and we use this line together with the FIR continuum and CO lines to constrain the intensity and physical size of star formation regions. We find that star formation dominated sources host kpc-scale star formation regions with surface intensities similar to that of local starburst galaxies. This suggests a more quiescent mode of star formation in this epoch than the extremely intense and temporally punctuated starbursts powering similarly luminous local ULIRGs. We also find relatively weak [CII] emission in AGN dominated systems and evidence for [CII] line emission from the AGN-associated XDR in at least one system. Our ALMA ES source list samples a variety of environments capable of emitting strong [CII] line radiation that includes the blazar/AGN (PKS0215), an AGN host at the center of a proto-cluster of SMGs (RX0941) and one of the star forming SMGs within the cluster, and a transitioning starburst/QSO (SDSSJ1000). By constraining the origins and spatial distribution of the [CII] line we will trace star formation modes and efficiency. The proposed work is unique since it leverages the prior ZEUS/CSO detections of redshift 2 sources and, at ES the (Band 9) redshift 2 epoch is the only time within the historic peak of star formation in which the [CII] line can be observed.

2011.0.00747.S

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Title

Mapping the [NII] 122 micron line in high-z galaxies.

Abstract

We propose to greatly improve our study of the high-z galaxies SMMJ02399-0136 and H1413-117 (the Cloverleaf QSO) at z=2.81 and z=2.56 respectively, by adding high spatial resolution observations of the redshifted [NII] 122 μm line that only ALMA can provide. We have previously detected this line in these two sources using our instrument ZEUS on the CSO. Both sources reside at the epoch of peak star formation in the Universe and have been extensively studied at other wavelengths. Taking advantage of the resolving power and sensitivity of ALMA ES, we will identify the sources of the [NII] (star formation or AGN), characterize the starburst within each source, and probe the star formation rate/molecular mass relationship.

2011.0.00750.S

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Title

The largest circumstellar disk - Birth of a high-mass star through accretion?

Abstract

In 2004 we discovered a 24.000 AU symmetric dark silhouette with a stellar source in its center and a bipolar outflow perpendicular to the triangular absorption pattern in a region of high-mass star formation. CO data from PdBI indicate that the object is rotating. Optical and infrared spectroscopy of the central object yielded a wealth of emission lines with shapes typical for accreting YSOs. Since then there is the debate whether this is the first case where the formation of a high-mass star via disk accretion is directly observed in analogy to the scenario for low-mass stars. Unfortunately there are two missing links to solve this puzzle: the kinematics and the mass of the putative disk. We propose to solve the puzzle by studying some characteristic lines and the continuum of the disk. The observations will unambiguously provide the rotation curve of the disk-like silhouette and its mass. The ALMA data will answer the long-standing questions whether the disk mass is gravitationally bound to the central object and whether it is sufficiently large to create a high-mass star. This largest circumstellar disk is a must for Cycle 0 of the largest interferometer!

2011.0.00754.S

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Ozaki, Shinobu	EA	Japan	National Astronomical Observatory of Japan
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Title

The Sombrero galaxy with a very massive black hole at extreme sub-Eddington rate

Abstract

The Sombrero galaxy is quite unique in the nearest super massive black hole and an extreme sub-Eddington and jet-suppressed accretion system. We propose point source photometry toward the Sombrero galaxy at multi-frequency to obtain continuum spectra to understanding of accretion and outflow phenomena in about 10 Schwarzschild radius or less. This is another way to access the vicinity of the event horizon, as well as a future submm VLBI.

Observations quasi-simulteneously at multi~frequency are essential to this study. Hence, we cannot accept to utilize data of line-free channels taken for other individual projects aiming observations of molecular lines, etc.

Why we request to cycle-0? The target source was detected and little contaminations. The better sensitivities and spatial resolutions of cycle-1 or later are no longer necessary to this target. PI and several co-Is are expert for mm interferometry observations and data reductions, and then can contribute the evaluations of ALMA calibrations via this multi-band photometric study.

2011.0.00767.S

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Title

The [CII] Line Study of a Star-forming Galaxy in the Epoch of Cosmic Reionization

Abstract

Detecting galaxies from the local to the highest redshift Universe, including the epoch of cosmic reionization at z > 6, and characterizing their star formation activity and physical properties are obviously a key issue to understand the formation and evolution of galaxies as well as disentangle the relationship between the diverse populations of galaxies. While star formation and dynamics of low-z galaxies have been well studied using the CO lines as a tracer, those of high-z galaxies have not due to its faintness.

Meanwhile, the ionized carbon 158 micron [CII] line can be a powerful alternative to detect high-z galaxies, because it is the strongest cooling line of ISM in galaxies and observable at submm/mm when redshifted to z > 6. The ALMA can detect high-z [CII] line only in a few hours and resolve galaxies in this line emission on a few kpc scales, enabling to probe obscured star formation and constrain the sizes, the dynamical masses and ISM in early star-forming galaxies at the epoch of reionization for the first time.

Here, we propose the ALMA [CII] line observation of a star-forming galaxy at z > 6. We particularly propose to target a z = 6.96 galaxy IOK-1, because it is one of the spectroscopically confirmed highest-class redshift objects in the epoch of reionization and we have a lot of information about this galaxy that can be compared with the ALMA observation. Using IOK-1 as a probe, we will (1) reveal the relation between high-z and local star-forming galaxies, (2) estimate obscured SFR at z~7, (3) investigate the morphology, dynamics and physical properties of a z~7 galaxy, (4) to constrain the physical states of ISM in a z~7 galaxy.

2011.0.00768.S

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Perez-Torres, Miguel Ángel	EU	Spain	Astrophysical Institute of Andalucia
Colina, Luis	EU	Spain	Centro de astrobiología (INTA-CSIC)
Alberdi, Antxon	EU	Spain	Astrophysical Institute of Andalucia
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Title

Star formation rates enhanced by dynamical effects: the extreme starburst in NGC1614

Abstract

The star formation efficiency of the dense molecular gas in the LIRG NGC1614 is one of the highest ever measured. This may be related to its unusually short dynamical timescale. We propose Band 7 observations with the ALMA extended array to image the line emission of the dense gas tracers CO(3-2) and HCO+(4-3) in this extreme starburst. The acquired data will be combined with a multiwavelentgh data-set that includes HCN(1-0), HCO+(1-0), HNC(1-0), H-alpha and Pa-alpha images. We will assess the extent to which a high fraction of dense molecular gas and/or an unsettled dynamics enhance the star formation efficiency of (U)LIRG.

2011.0.00772.S

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Ishizuki, Sumio	EA	Japan	National Astronomical Observatory of Japan
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Title

Giant Molecular Cloud Survey Toward bar and arm of the nearby Galaxy M83

Abstract

Molecular-rich galaxies with prominent galactic structures are the most suitable targets for the investigation of the evolution of giant molecular clouds (GMCs, size < 50pc) which lead massive star formation. However, due to the limited mapping ability of the existing telescopes, observations toward such molecular-rich galactic disks were mostly limited with coarse resolutions (over 200pc), up to recent.

Our recent pilot studies made with GMC-scale resolutions have revealed an evolutionary sequence of GMCs and suggested one of the necessary conditions for GMCs to initiate massive star formation is virialization of the natal GMCs on global scale, despite star formation is a sub-pc scale phenomena.

However, previous studies were made with small survey area. To robustly verify the previous findings and make further constraints, we propose wide-field observations of the nearby barred galaxy M83 in CO(1--0) with a significantly larger mapping area compared to the previous studies. Proximity of the galaxy, presence of prominent galactic structures, and accessibility from the ALMA site make this galaxy most suitable for our purpose.

Combining ALMA data with existing single-dish data, we will recover the total CO flux. Suggested observations will enable us to identify hundreds of GMCs from the combined data. Identified GMCs will be compared with the existing multiwavelength datasets to find associated HII regions and star clusters, and to robustly state their evolutionary stage. By comparing the properties of identified clouds which reside in variety of evolutionary stages and galactic environments, conditions required for onset of massive star formation will be strictly verified and further constrained.

2011.0.00777.S

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Jorgensen, Jes	EU	Denmark	Copenhagen, University of
van Dishoeck, Ewine	EU	Netherlands	Leiden University

Title

Imaging the Peculiar Carbon-Chain Chemistry of IRAS 15398-3359 in Lupus

Abstract

IRAS15398-3359 in the Lupus molecular cloud is a Class 0 protostar showing peculiar carbon chemistry. In this source, we have found that various carbon-chain molecules and their related molecules such as CCH, c-C3H2, and C4H are extremely abundant. Since these molecules are generally deficient in star forming regions, a similar source is very rare. Only exception known so far is L1527 in Taurus. In these two sources, carbon-chain molecules would be regenerated by evaporation of CH4 from grain mantles followed by subsequent gas-phase reactions(Warm Carbon-Chain Chemistry: WCCC). We have observed carbon-chain molecules in L1527 with PdBI, and have found that their abundances are indeed enhanced in the CH4 evaporation region(20-30 K: 1000-2500 AU) around the protostar. Furthermore, the abundances decreases in the central 300-600 AU region, suggesting that they are partly destroyed and/or depleted in the innermost part. In order to establish the concept of the WCCC, it is indispensable to investigate the distributions of carbon-chain molecules in another WCCC source, IRAS15398-3359, at high resolution. Then, we here propose to observe CCH and other carbon-chain related species toward this source. Similarity and difference between the two WCCC sources provide us with important information on the origin and the mechanism of the WCCC. Now the WCCC is recognized as one of the extreme chemical nature of low-mass protostellar cores. The other extreme case is hot corino, characterized by rich existence of saturated complex organic molecules such as HCOOCH3 and C2H5CN. Since the chemical composition of protostellar cores can be regarded as the initial condition for chemical evolution to protoplanetary disks, a thorough understanding of the WCCC through this observation is of fundamental importance in astrochemistry and related fields.

2011.0.00779.S

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Title

Characterizing Io's atmospheric composition and circulation

Abstract

Jupiter's moon Io is the most volcanically active body in the solar system and has a very thin and spatially variable atmosphere, mainly composed of SO2.
The goal of this proposal is to adress several aspects of the atmosphere that are not well characterized : the nature and abundance of the minor species, the replenishment sources for SO and SO2, and the atmospheric circulation (wind). To bring unprecedented constraints on these questions, we propose to observe a rich portion of band 7 with the extended configuration and a fine spectral resolution.
The excellent available sensitivity will allow to search for expected yet undetected volcanic species such as KCl, S2O, SiO and CO, for which the abundance measurement will put strong constraints on the volcanic regimes.
Simultaneously, the strong lines of main species SO2 and SO will be mapped with an improved spatial resolution, with the objective to relate their spatial distribution to their possible respective replenishment mechanisms.
Finally, we will measure Doppler-shifts on the strongest line to retrieve the best observation of the

atmospheric wind-field. Io's atmosphere circulation has only been observed once so far, and the proposed ALMA observations are expected to provide a radical improvement on the wind measurement.

2011.0.00780.S

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Title

The origin of molecular gas in the oldest gaseous debris disk system HD 21997

Abstract

Nearly all young stars harbor circumstellar disks, which initially serve as reservoir for mass accretion, and later may become the birthplace of planetary systems. These disks thought to evolve from gas-dominated primordial disks to debris dust disks on the timescale of less than 10 million years. In debris disks, only a very small amount of gas is expected, and indeed, only a few debris disks with a detectable gas component are known. In our preparatory APEX survey, we discovered that the 30 million-year-old HD 21997 exhibits molecular gas detectable at millimeter wavelengths. This is the oldest known gaseous debris disk, making it the best candidate for containing CO gas of secondary origin, produced by sublimation of planetesimals, photodesorption from dust grains, or vaporization of colliding dust particles. Here we propose to obtain the first spatially resolved interferometric continuum (at 870 micrometer) and line (at the J=2-1 and J=3-2 transitions of CO) observations with ALMA. Our goal is to understand the nature and formation process of the gas in this uniquely old gas-rich debris disk. In particular, we will (1) determine the structure and inclination of the dust disk; (2) measure the spatial distribution of the CO gas, test whether gas and dust are co-located, and compute the gas-to-dust ratio; and (3) map the excitation temperature and gas density throughout the disk. A primordial origin for the gas would pose a serious question to the current paradigm, because the age of the system significantly exceeds both model predictions for disk clearing and the ages of the oldest T Tauri-like or transitional disks in the literature. If a secondary origin is confirmed, the proposed observations will open the way to study the evolution of secondary gas in debris disks.

2011.0.00808.S

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Title

Probing the vertical structure of Saturn's storm with ALMA

Abstract

Saturn's usually slowly evolutive seasonal cycle has been disrupted in December 2010 between 20°N and 50°N by the outbreak of an unexpected huge storm system. First Cassini/CIRS and ground-based observations have shown that temperatures, winds and chemistry have been rapidly affected by the storm in the stratosphere. For instance, a temperature increase of 50K over 60° in longitude has been measured by Cassini/CIRS in May 2011.
We propose to take advantage of this rare opportunity to use ALMA's imaging capability during Cycle 0 in band 6 to probe the vertical structure of this unique storm and derive constraints on its formation processes.
We will map the CO (2-1) emission to measure the temperature between 0.1 and 10 mbar in the stratosphere and to check for any disturbance in the CO vertical profile. Such disturbance would be due to the injection of massive amounts of tropospheric CO into the stratosphere by the storm.
In addition, we propose to try to detect H2S for the first time in the storm, as this species could as well have been transported from the deep troposphere to the stratosphere by the storm. Its observation would provide us with an indirect probe of Saturn's internal sulfur abundance and of the composition of the planetesimals that formed the planet's core.

2011.0.00820.S

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Title

A 170 GHz-wide Complete Spectral Scan of an IR-pumped, Luminous Infrared Galaxy

Abstract

A wide-band, high-quality, unbiased census of mm/submm lines has now become possible with the advent of ALMA.
Here, we propose an ALMA cycle 0, 170 GHz-wide complete spectral scan of the luminous infrared Galaxy NGC4418.
For a compact galaxy nucleus such as the one in NGC4418, the line confusion limit can be achieved within a short integration time in cycle 0. NGC4418 is a benchmark object for LIRGs and one of the best targets known to demonstrate the capabilities of ALMA cycle 0. A rich scientific return is guaranteed and will help to understand the molecular emissions from dusty galaxies through cosmic time.
With the proposed spectral scan we can identify and quantify excitation mechanisms (collisional, radiative, new maser lines), determine abundances, find new absorption and emission lines, and

compare to other Galactic and extragalactic objects. Gas motions through line wings, P-Cygni profiles, or line emission channel maps can be probed in great detail. The narrow (170 km/s) spectral lines allow for a revealing picture of the nuclear chemistry and excitation of NGC 4418 since lines and species can be separated. The first extragalactic submm vibrational lines of HCN and HC3N were detected in NGC4418 and this shows great promise for a rich IR-pumped spectrum and a large variation of species, a research area that warrants further exploration if we are to understand the most dust-enshrouded phases of galaxy evolution.

2011.0.00851.S

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Title

The Origin of the Destroyed Minor Planet at G29-38: a Main Belt or Kuiper Belt Analog?

Abstract

G29-38 is the prototype and brightest example of a white dwarf orbited by rocky debris from a tidally-destroyed minor planet. Because this warm debris orbits within 1 solar radius, the parent body must have originated in a more distant region populated by a substantial number and mass of remnant planetary bodies. We propose ALMA observations to identify the orbital region from which the parent body originated, by detecting and spatially-resolving cold dust from within this remnant planetesimal belt. The primary science goal is to distinguish between a Main Belt and Kuiper Belt analog. The proposed observations should yield the first image of planetary debris around a white dwarf, and provide insight into the fate of planetary systems at A- and F-type stars.

The bulk chemical composition of the destroyed parent body can be determined via spectroscopy of the metal-polluted stellar atmosphere, and the ALMA observations will identify the formation region associated with this chemistry. With these data we will possess a nearly complete picture of a rocky (and perhaps icy) minor planet around another star; both where it formed and its bulk composition. Only white dwarfs offer this opportunity and ALMA observations of G29-38 represent an ideal way to highlight this scientific potential.

2011.0.00863.S

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Title

Tracing the Dust Destruction Zone in Protoplanetary Disks via SiO Rotational Line Emission

Abstract

Protoplanetary disks are vital objects in star formation. They drive the accretion of matter from the parent cloud material onto the new star whilst dissipating angular momentum away from the system. They are also the sites of planet formation, containing the material, gas and dust, which may form a planetary system encompassing the new star.

Disks are active environments and thus are chemically and physically complex. They are heavily irradiated by their parent star and are permeated by shocks as material impinges upon the star and upon the disk itself. Approximately 1 % of the mass of the disk is in dust grains which themselves consist of around 50 % silicate material. Dust grains are destroyed in disks via shock and collisions and grain sublimation can occur in the inner hot regions (T > 1500 K). Dust destruction releases a significant amount of silicon into the gas-phase which is efficiently converted to SiO, hence, SiO is good tracer of the dust destruction zone in protoplanetary disks.

We propose to observe SiO rotational line emission in a selection of nearby, warm protoplanetary disks in order to investigate the extent to which shocks and other dust destruction mechanisms influence the gas-phase composition and evolution of the disk. This proposal utilizes the superior sensitivity of ALMA Early Science capabilities to detect SiO in a protoplanetary disk for the first time.

2011.0.00876.S

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Title

The Antennae: A Luminous Stellar Nursery

Abstract

We propose to use ALMA in the extended configuration at Band 7 to simultaneously survey the 850 micron dust continuum, CO(3-2), and the dense gas tracers HCN(4-3), HCO+(4-3), and CS(7-6) in the interaction region (IAR) of the Antennae Galaxies with 0.5" (50 pc) resolution. The Antennae are the nearest prototypical major merger, and may soon evolve into an ultraluminous infrared galaxy. Hence, they offer our best chance to study the anatomy of a young, merger-induced starburst in detail. We will use these observations to identify the cores and clouds that will form the next generation of clusters. Analyzing these in conjunction with our extensive existing panchromatic data, we will build a complete picture of cluster formation from the cloud stage through cluster formation and dissolution. We will measure CO and sub-mm luminosity functions, correlate the sub-mm populations with young clusters, and search for the eminent sites of cluster formation. Because we focus on bright point sources this is a natural application for ALMA in Early Science. Our mosaic extends to the northern IAR which contains many optically dark filaments, not previously studied interferometrically in CO(3-2). In the southern IAR region we will combine our continuum and CO(3-2) data with the to-be-distributed ALMA Science Verification data for greater sensitivity (and shorter uv-spacings). Our interferometric HCN(4-3), HCO+(4-3), and CS(7-6) data will be completely unique. The wide scientific and public interest in the Antennae, and the synergy with our

team's HST and EVLA work, promise to make this a high impact, high visibility result.

2011.0.00887.S

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Title

Monitoring fast variations of event-horizon scale gas in Sgr A* with frequency switching

Abstract

Sgr A* in the Galactic Center is by now the best constrained supermassive black hole candidate. Its radio spectrum peaks at submm-waves and its size as measured with VLBI experiments shrinks with increasing frequency, exhibiting a clear size-frequency relation. The Millimeter-wave emission comes from less than four Schwarzschild radii and will allow imaging of the event horizon with mmVLBI in the future. The orbital time scale in Sgr A* is 24 minutes for a Schwarzschild black hole and the source frequently flares at radio, infrared, and X-ray wavelengths on timescales of hours. VLA monitoring has shown that there is a time lag of 20 minutes between flares at lambda 7mm and lambda 13mm, consistent with an outflow model. It is predicted that a lag-frequency relation should exist extending up to the mm-regime, but so far reliable multi-frequency mm-wave monitoring is not available. Here we want to use ALMA in a frequency switching mode to establish the variability properties of Sgr A* at different frequencies on orbital time scales of the black hole. Submm emission is ideal for this, since it is optically thick emission, probing actual bulk plasma motions and densities. X-ray and IR flares are in contrast completely optically thin and hence much more sensitive to particle heating. Hence Alma monitoring may become a powerful tool for understanding Sgr A* and black holes in general. The observation should, for example, establish the lag-frequency relation, which together with the existing size-frequency relation would provide a quantitative tool to constrain flow speed and acceleration of gas within a few Schwarzschild radii of the event horizon. Finally, the integrated data set will provide the best-ever multi-frequency map of the gas streamers (Sgr A West) in the Galactic Center.

2011.0.00902.S

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Title

VLA1623B: a First Core candidate?

Abstract

First Cores (FC) are the transient phase between prestellar cores and Class 0 protostars. They are characterized by low luminosities, short lifetimes and capable of driving slow collimated outflows. Not surprisingly they are difficult to detect. FC are key in understanding the earliest stage of protostellar formation. Our recent studies using SMA data towards VLA1623 suggest that VLA1623B is a FC candidate. We propose to confirm that VLA1623B is a FC candidate by detecting the early astrochemical molecule DCO+ and N2D+. ALMA is the only instrument that can resolve the two components and has enough sensitivity to detect the emission with reasonably short timescale (~ 1hr).

2011.0.00921.S

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Title

Physical conditions for planet formation: the case of T Cha

Abstract

T Cha is a young star surrounded by a transitional disk. High angular observations obtained with VLT/NACO allowed us to detect an extremely red substellar companion located within the gap of the disc. We propose to use the unique capabilities of ALMA in its Cycle 0 to derive physical properties of the disk, study its morphology, and provide key constrains to understand the physics that govern the early stages of planetary formation. The proposed observations will provide information to characterize the binary system and provide important clues about its formation mechanism.

2011.0.00957.S

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Title

The ALMA-SPT Redshift Survey

Abstract

Recent ground and space-based multiwavength (sub)millimeter surveys covering hundreds of square degrees have discovered a large number of strongly lensed, ultra-bright submm galaxies (SMGs). The largest of these, by nearly an order of magnitude at present, is the South Pole Telescope (SPT) survey, which covers 1300 square degrees. The unparalleled SPT sky area makes it the survey most adept at locating the 'brightest of the brightest' of this new population. Its 1.4mm detection wavelength ensures a uniform source selection function across z=1-8. Both aspects make SPT the ideal survey to uncover substantial numbers of the elusive z>4 SMG population.

We are carrying out a major multi-wavelength (optical to mm) observating campaign aimed at characterizing the SPT sources in terms dust/gas content, star-formation rates and stellar masses. The most urgently missing information are the redshifts. With the advent of ALMA, even in the early science configuration, unbiased redshift searches for these bright high-z sources are possible in a revolutionary small amount time (3-4 redshifts per hour even in moderate observing conditions). We propose to observe the 26 brightest SMGs selected from the SPT survey. Our proposed observations are designed to obtain unambiguous and unbiased redshifts out to z=6, and as such will sample the high redshift tail of SMGs for the first time.

2011.0.00958.S

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Title

Imaging the Brightest Starbursts in the Universe

Abstract

We propose detailed ALMA imaging of an exciting new population of rare, ultra-bright, high redshift, strongly-lensed dusty star forming galaxies (DSFGs). The sources were discovered in a 2500-square-degree mm-wave survey conducted with the 10 meter South Pole Telescope (SPT). The large survey area and flux-limited mm-wave selection has allowed the SPT to find the rarest (roughly one per twenty square degrees) and highest-redshift DSFGs. The SPT team is now in the midst of a systematic and coordinated follow-up program to characterize and fully exploit the scientific potential of these sources. With its exquisite angular resolution and sensitivity, ALMA is crucial to the success of this follow-up program. ALMA observations will allow us to construct accurate lens models which will enable us to make robust estimates of the source magnification and, hence, the intrinsic properties of the lensed DSFGs, thus opening a new window on star and galaxy formation in the high-redshift universe. ALMA observations of these lensed systems will enable unique and powerful investigations of what would otherwise be inaccessibly faint high-redshift members of the population responsible for the cosmic infrared background. The ALMA observations will also complement approved HST observations of a subset of the sample, allowing side-by-side comparisons of HST and ALMA images with matching resolution. These images, in addition to their use in groundbreaking science, will demonstrate the power of ALMA to the public. The resulting data set will also have high legacy value to the community.

As the sources are extremely bright (345 GHz fluxes span 40 to 200 mJy), our proposal requests a total of only 2.6 hours to image 47 sources in Band 7.

2011.0.00961.S

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Title

A Close-up Look at Comet Elenin

Abstract

The start of ALMA Early Science coincides with the appearance of comet C/2010 X1 (Elenin), a rare example of a bright near-Earth non-periodic comet, discovered far enough from the closest approach that we can plan observations outside of ToO time. Taking advantage of this remarkable opportunity, we wish to pursue three fundamental issues of cometary science: (i) compositional structure of the nucleus, (ii) 3D kinematics of cometary jets, and (iii) physical conditions in the coma. Non of these problems has been investigated in detail yet all are of key importance. The first one provides excellent diagnostics of the formation process of comets. The second one offers perhaps the best insight into the rotational dynamics of comet nuclei, which has direct implications for the lifetime and internal structure of comets. This would work best if combined with a longer spectral time series, even if single-pixel, which our team has already secured at JCMT. The last problem has been investigated mainly in theory and the various model predictions wait for clear observational verification. Interesting on their own, physical conditions in the coma are also essential to correctly interpret various kinds of cometary observations. All these science goals can be addressed with a modest 2-h session and only two receiver tunings, owing to the already remarkable capabilities of ALMA and availability of a great target. Our immediate goal is to obtain spatially- and velocity-resolved snapshots of HCN J(4-3), HCN J(3-2), and CO J(3-2), as well as line-averaged snapshot of CH3OH. While providing valuable scientific information, our project will at the same time pave the way to regular observations of comets with ALMA in the subsequent cycles.