SMA Newsletter

Submillimeter Array Newsletter | Number 13 | March 2012

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FROM THE DIRECTOR

Dear SMA Newsletter readers,

Interest in submillimeter astronomy continues to grow. This year we saw a record number of SMA science publications: 86 compared to a previous high of 68. Submitted proposals maintain the high demand of prior years. We expect interest in submillimeter astronomy to further increase as the new ALMA interferometer opens up new opportunities at this wavelength. With ALMA, the SMA is one of two observatories capable of high angular resolution imaging in the submillimeter, and we expect interest in the SMA to continue to increase.

To better meet the opportunities of the future, we continue to improve the capabilities of the SMA. Several months ago we embarked on an upgrade path that will enable even broader bandwidth observations, by an additional factor of two. Recent tests on receivers operating in both the 230 and 345 GHz band have shown good performance in the lab, and upgraded 230 GHz receivers have been installed in four SMA antennas. On sky spectral line test observations that demonstrate wide-band receiver performance have been performed on several antennas (see article, page 10). The current schedule calls for a single baseline demonstration in the coming months, with full implementation at 230 GHz at the end of 2012, and at 345 GHz by the summer of 2013.

This newsletter presents three recent scientific results obtained with the SMA. The first is from observations of gravitationally-lensed submillimeter galaxies at high redshift. The second is from a near earth astroid observation, and also highlights the SMA's ability to track such objects. The third elucidates the role of magnetic field structure in the formation of giant molecular clouds. On the technical side, a fourth article describes improvements to widen the intermediate frequency (IF) bandwidth to improve sensitivity and spectral line coverage.

Ray Blundell

DISSECTING A BRIGHT CLUSTER-LENSED SUBMILLIMETER GALAXY AT z=4.69

Eiichi Egami, Mark A. Gurwell, Giovanni G. Fazio

Gravitational lensing is a powerful astrophysical/cosmological probe, and is particularly valuable for studying dusty (i.e., infrared-luminous) galaxies at high redshift in the far-infrared and submillimeter. This is because the sensitivities of these long-wavelength observations (e.g., by *Herschel*) are often confusion-limited and cannot be improved by integrating longer. To penetrate through the confusion limit, gravitational lensing offers a powerful and yet cheap solution, amplifying the brightness of a faint source (or sources) behind an astronomical gravitational lens (e.g., a galaxy or a cluster of galaxies) often by a large factor (×20-30).

The process of gravitational lensing preserves surface brightness, and therefore this lensing-induced brightness amplification is caused by the areal stretching of a background source (e.g., a source gets ×10 brighter because its apparent size gets enlarged by ×10). When the mass distribution of a foreground lens is accurately known, the mass model can be used to reconstruct the intrinsic image shape of a lensed galaxy with a greatly improved spatial resolution. When the high spatial resolution offered by the SMA is combined with this gravitational lensing effect, the resultant map can achieve an unprecedented spatial resolution. SMA observations of gravitationally lensed submillimeter galaxies (SMGs) therefore provide a new frontier in the studies of high-redshift galaxies as a lens-augmented SMA could reveal the structures and properties of observed galaxies with a physical spatial resolution as small as ~100 pc. The power of this observing strategy (SMA + gravitational lensing) was spectacularly demonstrated by the SMA observations of a strongly lensed SMG at z=2.3 dubbed as the Eyelash galaxy (Swinbank *et al.* 2010; also reported in the SMA Newletter #10). This study resolved the galaxy into several lensed

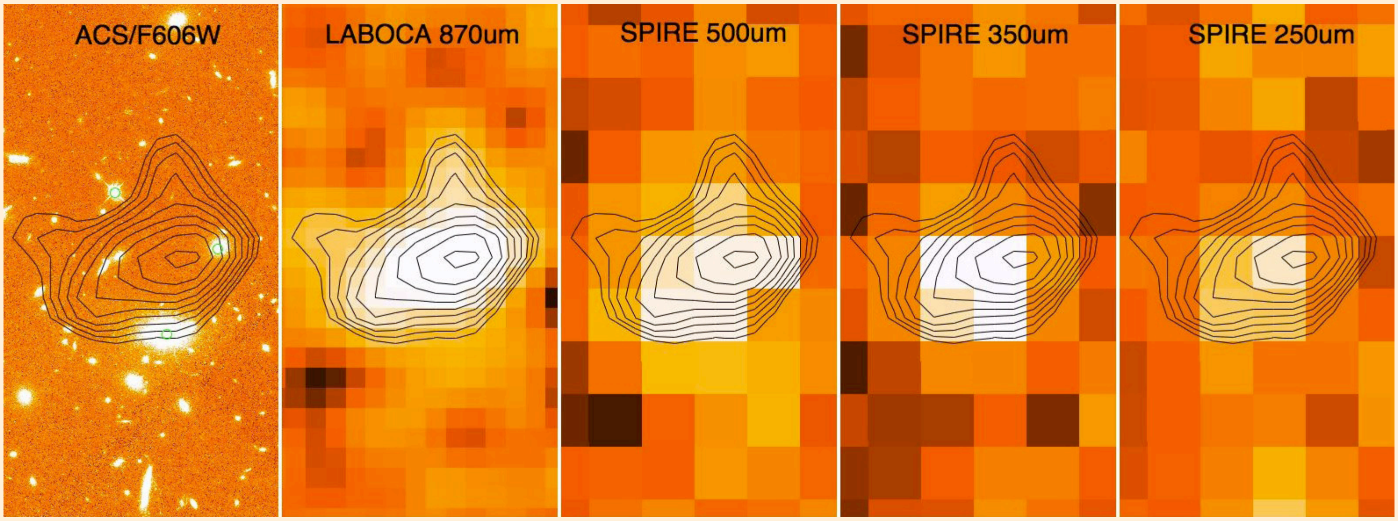


Figure 1: Multi-wavelength images of the z=4.69 galaxy discovered in the HLS-snapshot survey. (From left to right) HST/ACS F606W, APEX/LABOCA 870 μm, *Herschel*/SPIRE 500, 350, and 250 μm images of the source. The LABOCA contours are overlaid on all images. The source is extended even in the LABLOCA map with a smoothed resolution of ~20", and is invisible in the HST optical image. The bright optical source seen in the ACS image just south of the LABOCA contours is the brightest cluster galaxy, marking the center of the foreground cluster at z=0.32.

pairs of star-forming clumps with a physical scale of only ~90 pc, comparable to the sizes of giant molecular clouds in the Milky Way.

The main challenge for applying this strategy in practice is to find a significant number of gravitationally lensed galaxies at high redshift that are bright enough for the SMA to spatially resolve such details. The Eyelash galaxy mentioned above has flux densities of 325 and 106 mJy at 500 and 870 µm, respectively (Ivison *et al.* 2010), and such a bright SMG is extremely rare. To find similarly bright SMGs, we can think of the following two strategies: (i) conduct a wide-field submillimeter/millimeter survey with an areal coverage of many hundreds of square degrees, and (ii) conduct a more focused survey targeting already known powerful gravitational lenses (e.g., massive galaxy clusters). The first strategy is being employed by the *Herschel* (H-ATLAS) and South Pole Telescope (SPT) surveys. The H-ATLAS survey, for example, has shown that above 100 mJy at 500 µm, sources are expected to be either low-redshift galaxies or gravitationally lensed high-redshift galaxies, both of which contribute roughly equally in number to the combined surface density of ~1 per deg^2 (Negrello *et al.* 2010). This low surface density explains why a bright SMG like the Eyelash had not be discovered for a long time. However, with the great sensitivity and mapping speed of SPIRE on *Herschel*, the situation has dramatically changed. These rare extraordinary lensed objects are now discovered routinely by wide-field SPIRE surveys like H-ATLAS and HerMES, such as H-ATLAS ID141 at z=4.24 (Cox *et al.* 2011) and HerMES HLSW-01 at z=2.96 (Conley *et al.* 2011). Note that the majority of bright lensed sources discovered by these wide blank-field surveys are galaxy-lensed systems.

Our survey, the *Herschel* Lensing Survey (HLS) has adopted the second strategy, targeting the fields of massive galaxy clusters. Observing cluster-lensed sources (as opposed to galaxy-lensed ones) offers a few advantages. First, accurate cluster mass models are easier to construct because cluster-scale lenses, due to their larger mass (and correspondingly larger lensing caustic structure), produce multiple images of several background galaxies, which can then be used to construct detailed lens models. In contrast, galaxy-scale lens models are harder to constrain because the only information comes from the morphology (positions of images, orientations, and relative brightness) of the highly obscured background source being studied. Second, because of their large sizes, cluster lenses do not produce strong amplification gradients on kpc-scales, which is usually the case with galaxy lenses. This means that when a galaxy-sized background source is magnified by a galaxy lens, we may be seeing a highly amplified patch within the system rather than measuring galaxy-integrated properties (i.e., the differential magnification effect). When combined with a mix of physical processes occurring within galaxies, it is possible that this could result in strong selection effects. Finally, unlike galaxy-lensed SMGs, cluster-lensed ones do not usually have a bright foreground galaxy along the line of sight, which makes it possible to study their SEDs and morphologies at optical/near-infrared wavelengths.

In the first survey (HLS-deep; Egami *et al.* 2010), which was conducted as part of the *Herschel* Key Programs (Cycle 0), we obtained deep PACS (100/160 µm) and SPIRE (250/350/500 µm) images of 44 massive galaxy clusters. Although this data set has allowed us to study a large number of cluster-lensed SMGs systematically for the first time (e.g., see Rex *et al.* (2010) for the first analysis conducted with the Bullet Cluster), it has found only a small number of bright (>100 mJy) SPIRE sources in the whole sample. Realizing that a much larger sample of clusters is needed to find lensed galaxies as bright as the Eyelash, we started the second survey (HLS-snapshot) in the *Herschel* Cycle 1, imaging 279 X-ray-luminous (i.e., massive) galaxy clusters with SPIRE only. Here, we report the SMA observations of the first bright lensed SMG at high redshift (z=4.69) discovered in this HLS-snapshot survey.

Figure 1 shows the multi-wavelength images of this z=4.69 galaxy. It was first discovered as a bright SPIRE source with a peak flux density of 114 mJy at 500 µm near the center of a massive galaxy cluster at z=0.32. Such a bright SPIRE source is rare, and its proximity to the cluster center suggests that this source is likely to be gravitationally lensed by the foreground cluster. In the LABOCA image, the source is seen to be extended even with a spatial resolution of ~20", which suggests that this is either a highly-elongated or multiply-imaged lensed system. As for its redshift, the SPIRE spectral energy distribution peaking toward 500 µm (so-called 500 µm peakers/risers) is indicative of a high redshift (z>3-4), which is consistent with this source being invisible in the HST optical

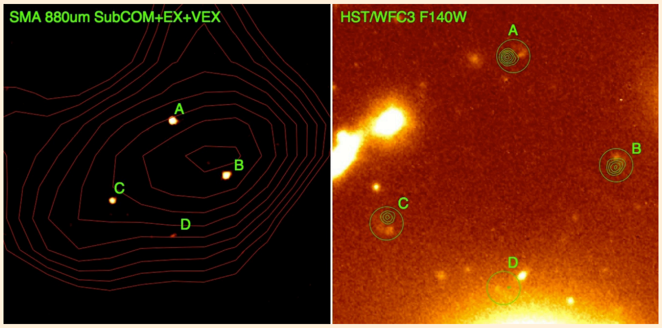


Figure 2: (Left) SMA resolves the bright SPIRE-LABOCA source into four separate components (A, B, C, and D). This SMA map was constructed by combining the 345 GHz data obtained in the Subcompact (SubCOM; 2 tracks), Extended (EX; 1 track), and Very Extended (VEX; 1 track) configurations. The effective wavelength of the map is 880 µm. The individual components are compact, but are barely resolved with the beam size of 0.79"x0.70". The LABOCA contours are overlaid; (Right) HST/WFC3 F140W (1.4 µm) image of the four components. The SMA contours are overlaid. Note that each SMA source has a likely counterpart in the near-infrared, but the SMA and near-infrared sources are not coincident spatially. In each component (i.e., lensed image), we are likely seeing two distinct components in the background source, one detected by the SMA and the other by the HST in the near-infrared. The lens model predicts the fifth image on the other side of the cluster, and this HST/WFC3 image also detects a source at the right position, confirming the validity of the lensing interpretation for all these components.

image. When a SPIRE source is this bright, it is often possible to measure its redshift through a blind CO search. For this source, we conducted wide-band millimeter spectroscopy with EMIR on the IRAM 30m telescope, and detected two emission lines, which correspond to the CO (4-3) and CO (5-4) lines at z=4.69.

To further investigate this source, we obtained SMA 34 GHz maps in the Subcompact (2 tracks), Extended (1 track), and Very Extended (1 track) configurations during July-September 2011. We also obtained the HST/WFC3 F140W (1.4 μm) image of this source through the on-going HST snapshot survey of massive galaxy clusters. Figure 2 shows the fully-combined final SMA map, and compares it with the HST/WFC3 image.

What is striking is that the SMA has resolved this bright SPIRE-LABOCA source into four separate components separated by 10-15". The total flux density of these four components at 880 μm is measured to be 45-57 mJy, which is roughly consistent with the LABOCA 870 μm flux density of 60 mJy. This indicates that these four components are responsible for the observed SPIRE-LABOCA flux densities. Each component is spatially compact, but is marginally resolved with a beam size of 0.79"x0.70".

What is even more intriguing is that each of these SMA sources has a likely counterpart in the HST near-infrared image, but that the SMA and HST sources are offset from each other. This is not due to a systematic offset with astrometry between the two data sets. For example, it is not possible to make the four source positions coincide by simply shifting/rotating one image with respect to the other. Instead, we think that the spatial offsets are real. In fact, the offset patterns seen in the four images are consistent with what we would expect from our lensing model if we assume that each lensed image consists of two distinct components in the background source, one detected by the SMA and the other by the HST. In other words, the SMA signal is coming from a component that is invisible even in the HST near-infrared image. The separation between the SMA and HST sources in the source plane is estimated to be 0.1" or 660 pc at z=4.69. We are currently in the process of refining the lensing model for this system and using that model to analyze the background source in detail (Egami *et al.* 2012, in preparation).

This is the first bright lensed SPIRE source discovered in the HLS-snapshot survey after a few tens of clusters have been imaged, and this survey will eventually observe 279 massive clusters. We are already seeing a number of similarly interesting sources in the data we have received since. In addition, we are extending this HLS-snapshot survey to another ~300 clusters in the Cycle 2 (i.e., the last cycle) of Herschel. The SMA will play a crucial role in the investigation of these extraordinary lensed sources as the example of this z=4.69 SMG clearly illustrates.

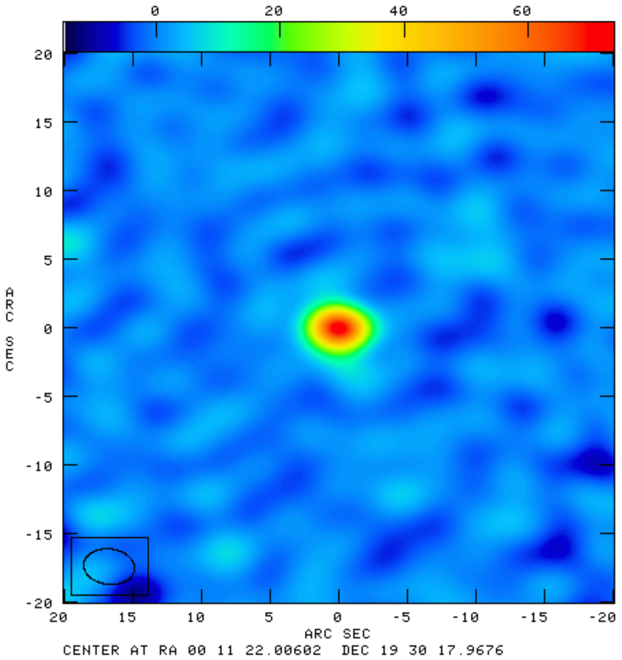
REFERENCES

- Conley, A., *et al.* 2011, *ApJ,* 732, L35
- Cox, P., *et al.* 2011, *ApJ*, 740, 63
- Egami, E., *et al.* 2010, *A&A,* 518, L12
- Ivison , R. J., *et al.* 2010, *A&A,* 518, L35
- Negrello, M., *et al.* 2010, *Science*, 330, 800
- Rex, M., *et al.* 2010, *A&A,* 518, L13
- Swinbank, M., *et al.* 2010, *Nature,* 464, 733

SMA OBSERVATIONS OF NEAR EARTH ASTEROID 2005YU55

Mark Gurwell, Ken Young, Glen Petitpas and the entire SMA Team

With an estimated diameter of around 400m, 2005YU55 is a recently discovered asteroid whose orbit crosses the Earth orbital plane, and is therefore labeled as a potentially hazardous object. On November 8, 2011 it underwent a near-Earth event, passing within the orbit of the Moon (0.85 lunar distance, just over 320,000 km). This close approach coupled with the object's relatively large size was a notably rare event, and many observatories attempted observations as the asteroid shot through the Earth-Moon system, including the Submillimeter Array (SMA).



At millimeter wavelengths radiation from the asteroid comes as thermal emission from the surface and near surface. Observations, even spatially unresolved, can thus inform our understanding of some basic parameters from the asteroid, including its mean diameter. By modeling the expected brightness temperature, a measure of the total flux density (which is proportional to the object's apparent area as well as the brightness temperature) can be used to accurately determine the geometric mean diameter of the body. Further, because the flux density measured is related to the square of the object's size, the fractional error on the determined radius is half the fractional error on the flux density. Thus, a flux density error of 10% (SNR 10) maps to an error on the mean radius of just 5%.

An asteroid passing this close to Earth is not an easy target to observe, especially for an interferometer. At its closest approach, 2005 YU55 was moving at nearly 7″ per second relative to sidereal motion, requiring rapid updating of antenna pointing as well as the phase center reference. Typically for solar system objects the SMA updates the object position relative to sidereal at the beginning of a scan, which lasts anywhere from 5 to 30 seconds. Clearly, that would be insufficient for such a fast moving object. On the day before closest approach, when it was decided to attempt detection of the asteroid, Ken Young created a special version of the array control software which allowed for a much faster updating of the source location, at a rate of 10 ms.

On the night of November 8 in Hawaii (UT 9 Nov 09:00 hr to 12:30 hr) the SMA observed the asteroid at a wavelength of 1.35 mm using the compact configuration. Over this period of time the asteroid was just a few hours past closest approach and receding from the earth; the apparent diameter fell over the observing period from 0.146" to 0.115" (assuming a 400 m diameter). Despite this small extent, for a mean surface brightness temperature of around 265K (estimated 294K mean physical temperature at depth coupled with a surface emissivity of ~0.9) we expected a mean flux density of around 125 mJy, well within the sensitivity of the SMA to detect over the course of a fraction of an hour.

The observing conditions were considered poor: The summit was fogged in (100% humidity for much of the first half of the night), clearing around UT 8hr enough to start observations. The 225 GHz opacity dropped from around 0.2 to 0.12 over the observing period. The atmospheric phase stability was very poor at the start (phase fluctuations on a 30-s timescale over 50 degrees rms) though improved through the observations.

During data calibration with the MIR tool set we noted that the amplitude and phase of the calibration quasars (3C454.3, J2148+069,2334+076 and 0121+118), particularly on longer baselines, had systematic decorrelation patterns that adversely affected the data quality, such that we had to exclude a significant fraction of the data (retaining 16 of the 21 initial baselines for at least portions of the 3.5 hour coverage). We suspect that the software changes that were quickly implemented in order to allow for the tracking of the fast-moving asteroid were only partly successful, and while allowing for rapid tracking also introduced some unwanted systemic effects. We thus required baseline-based gain calibration. Even so, on most baselines we could clearly see that the asteroid was detected on the few minute timescale, so were optimistic that the data would be usable. The SNR on the baselines was such that, after standard gain calibration, we performed a simple zeroth order self-calibration of the asteroid phase on each baseline to remove further systematic effects clearly evident in the data. Flux calibration was determined using Uranus and Callisto. After calibration, the remaining data provided a spatial resolution of 3.7”x2.6” for imaging performed within AIPS.

The resulting map determined from combining visibility data from both sidebands (4 GHz bandwidth each) is provided in Fig. 1. The map rms is 2.6 mJy/beam, consistent with the expected noise as estimated from within MIR. The peak (and integrated) flux density of the asteroid averaged over the observing window is 74 mJy. This is surprising, and interesting, as it is significantly lower than expected.

If we assume that the temperature model of the source is not the major source of error in our estimate, then the low flux density maps directly to a lower size for the asteroid than initially thought. We find that, assuming a mean brightness temperature of 265 K, a flux density of 74±7.8 (3-σ) mJy requires that the asteroid 2005YU55 has a geometric mean diameter of 310±17 meters, 22.5% smaller than initially thought (50% smaller by volume and mass). Note that this result also compares favorably with independent measurements of the size obtained with *Herschel* (Mueller *et al.* 2011; see also http://www.mpg.de/4652308/2005_YU55_rocks_in_space).

While obtaining the data was difficult, and the rapid deployment of specialized software to handle the tracking was partly inaccurate, these observations do show that power of the SMA to respond quickly to target-of-opportunity observations and for detection of even very small objects in the solar system. Thanks go to the entire SMA team for these successful results.

REFERENCE

- Mueller, T., Altieri, B. and Kidger, M. 2011. IAU Circular 9241

ANCHORING GALACTIC MAGNETIC FIELDS IN GIANT MOLECULAR CLOUDS: A BIRD'S-EYE VIEW

Hua-bai Li

The relationship between galaxy-wide magnetic fields (B-fields) and smaller scale molecular clouds is not well understood. Some models of cloud formation suggest that the large scale galactic field is largely irrelevant at the scale of individual clouds[1] (Fig. 1) because turbulence and rotation might randomize the magnetic field orientation within a cloud, severing its connection with larger scale structure. Others suggest that the larger galactic B-fields can be strong enough to influence or even control the formation of the clouds[2,3,4] (Fig. 1) ultimately affecting the rate and efficiency of star formation[5].

Radio telescopes such as the SMA can see the direction of the magnetic fields in galaxies and clouds by measuring the polarization of their radio emission. A comparison of the field direction within individual clouds with the direction of galactic-scale magnetic fields and spiral arms should determine which model is correct. If the direction of the magnetic field in clouds is unrelated to the galactic-scale structure then the internal dynamics of the clouds are also unrelated and therefore not controlled by galactic scale forces.

These observations are difficult in the Milky Way because, from our vantage point inside our own Galaxy, we cannot get a clear

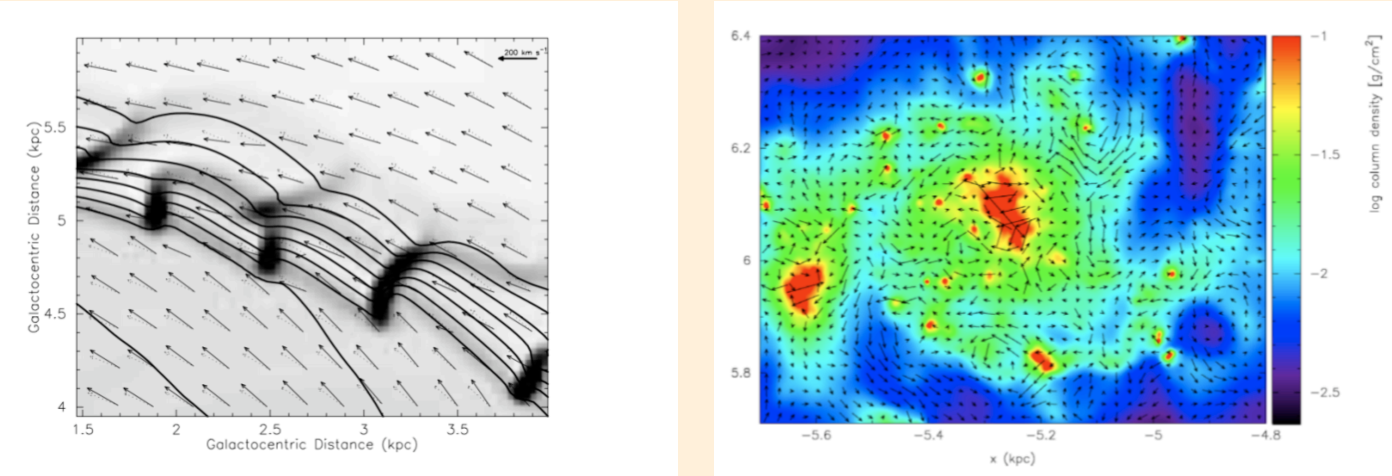


Fig. 1: Two competing scenarios of cloud formation. **Left:** A patch from a global galaxy simulation[2]. The solid vectors show the instantaneous gas velocity in the frame rotating with the spiral potential. The dotted vectors show the initial velocities (pure circular motion). The solid lines show B-field orientations. The gray scale stands for the relative surface density. *The B-fields of the spiral arm are only slightly twisted in the molecular cloud complexes* (dark elongated regions), and in turn the field tension is strong enough to hinder the cloud rotation. **Right:** A similar simulation[1] but the well developed cloud rotation has produced tidal tails extending from the GMC, and the *B-fields (vectors) follow the rotation and lost the "memory" of the galactic field direction.*

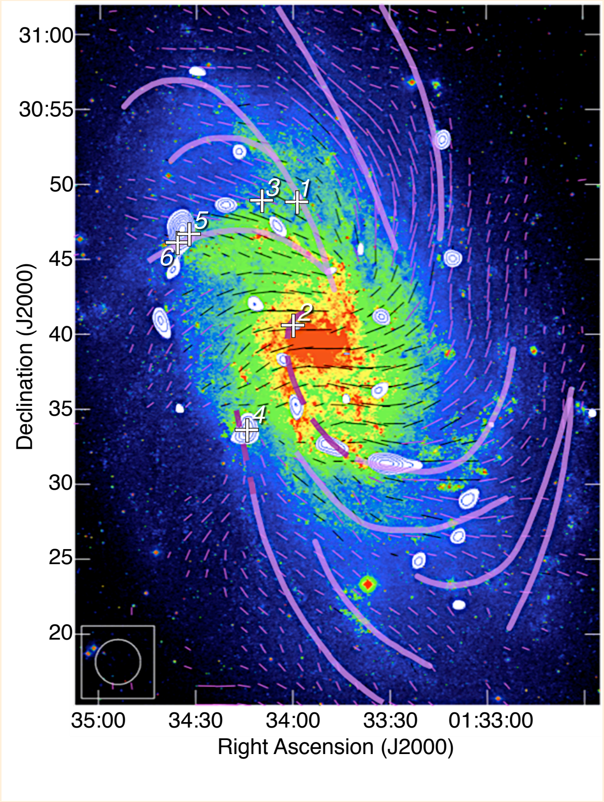


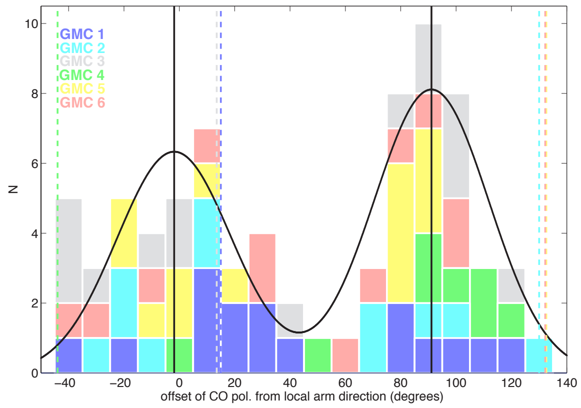
Fig 2: Locations of the 6 most massive GMCs ("+"s) and the optical spiral arms in M33. The background is an optical image of M33 (ref 13). The purple lines trace the optical arms adopted from reference 14 and 15. The vectors indicate the B-field directions from the diffuse warm media traced by synchrotron radiation[13]. Note that the directions of the spiral arms and the B-fields in warm media are not aligned. Whether the B-fields in the molecular clouds (cold media) will be aligned with the spiral arms has never be observed before.

view of the arms and the large scale structure. External galaxies are so far away that the radio emission from conventional magnetic field tracers such as the dust continuum is too faint for even state-of-the-art instruments[3]. Here we report a novel strategy to determine the significance of magnetic fields in extragalactic clouds by applying a simple statistical test to observations of CO emission lines polarized by the Goldreich-Kylafis effect[6].

Because CO emission is much brighter than the dust emission our current radio telescopes have enough sensitivity to measure the polarization. However, unlike the polarization in dust emission which is always perpendicular to the magnetic field, the polarization in the CO lines contains an ambiguity. It can be either perpendicular or parallel to the local magnetic field direction. Nonetheless, even with this ambiguity, the CO polarization can still be useful in a statistical sense. A random distribution of magnetic field directions in a cloud would indicate that the turbulence in the cloud is controlling the magnetic field. On the other hand, a single preferred orientation throughout the cloud, or two preferred orientations 90° apart, would indicate that the direction of the magnetic field within the cloud is maintained by the larger scale structure in the galaxy. This would indicate that the large scale magnetic field is a significant force in the internal dynamics of the cloud.

M33 is the nearest face-on galaxy with pronounced optical spiral arms. We used the sub-compact configuration of the Submillimeter Array (SMA[8]), which offers a linear spatial resolution of ~15 parsecs at 230 GHz (the frequency of the CO J=2-1 transition) at the distance of M33 (900 kpc). We picked the six most massive clouds (Fig. 2) from the BIMA M33 survey[9] because of their strong CO line emission. We measure the direction of the magnetic field at many points throughout the clouds and plot the differences between the orientation of the field and the nearby spiral arm in figure 3. The distribution shows two favored orientations appoximately 90° apart. The distribution can be fit by a double-Gaussian function with the two peaks at -1.9° ± 4.7° and 91.1° ± 3.7° and a standard deviation of 20.7° ± 2.6°. This indicates that *the mean field directions within molecular clouds in M33 are well-defined and highly correlated with the spiral arms,* consistent with the scenario that galactic B-fields can exert tension forces strong enough to resist cloud rotation[2] (Fig. 1).

Fig. 3: Distribution of the polarization-arm offsets. The offsets are from the difference between the orientations of CO polarization and local arms. Contributions from different GMCs are distinguished by the colors. The distribution can be fitted by a double-Gaussian function with a standard deviation of 20.7° ± 2.6° and peaks at -1.9° ± 4.7° and 91.1° ± 3.7°, suggesting that the cloud B-field directions are correlated with the arm directions. The directions of synchrotron polarization, which traces B-field from the low-density warm vicinities of each cloud, are also shown as the dashed lines. The fields in the less compressed warm media do not align with the spiral arms.



The magnitude of the dispersion of the field direction, ~20° , is also important. The non-randomness of the field implies that cloud turbulence is a random perturbation on the ordered magnetic field rather than fully developed turbulence which would completely randomize the field. In other words, *the cloud turbulence is sub-Alfvenic* based on the Chandrasekhar-Fermi criterion[10]. Whether molecular clouds are sub- or super-Alfvenic is another long-lasting debate[3, 11, 12] and is a critical assumption made in various theories of star formation. The Chandrasekhar-Fermi criterion also allows us to estimate the strength of the magnetic field in the molecular clouds in M33. We find filed strengths of 0.1 to 0.5 milliGauss, comparable to the estimated strengths in molecular clouds in our own Galaxy.

REFERENCES

- Dobbs, C. GMC formation by agglomeration and self gravity. *Mon. Not. R. Astron. Soc.* 391, 844-858 (2008)
- Shetty, R. & Ostriker, E. Global Modeling of Spur Formation in Spiral Galaxies. *Astrophys. J.* 647, 997-1017 (2006)
- Li, H.-b., Dowell, C., Goodman, A., Hildebrand, R. & Novak, G. Anchoring Magnetic Field in Turbulent Molecular Clouds. *Astrophys. J.* 704, 891-897 (2009)
- Li, H.-b., Blundell, R., Hedden, A., Kawamura, J., Paine, S. & Tong, E. Evidence for dynamically important magnetic fields in molecular clouds. *Mon. Not. R. Astron. Soc.* 411, 2067-2075 (2011)
- Price, D. & Bate, M. The effect of magnetic fields on star cluster formation. *Mon. Not. R. Astron. Soc.* 385, 1820-1834 (2008)
- Goldreich, P. & Kylafis, N. On mapping the magnetic field direction in molecular clouds by polarization measurements. *Astrophys. J.* 243, 75-78 (1981)
- Falceta-Goncalves, D., Lazarian, A. & Kowal, G. Studies of Regular and Random Magnetic Fields in the ISM: Statistics of Polarization Vectors and the Chandrasekhar-Fermi Technique. *Astrophys. J.* 679, 537-551 (2008)
- Ho, P., Moran, J. M. & Lo, K. Y. The Submillimeter Array. Astrophys. J. 616, 1-6 (2004). The Goldreich-Kylafis effect has been detected by the SMA before from a Galactic cloud (Beuther, H., Vlemmings. W., Rao, R. & van der Tak, F., *Astrophys. J.* 724, 113, 2010)
- Rosolowsky, E., Engargiola, G., Plambeck R. & Blitz L. Giant Molecular Clouds in M33. II. High-Resolution Observations. *Astrophys. J.* 599, 258-274 (2003)
- Chandrasekhar, S. & Fermi, E. Magnetic Fields in Spiral Arms. *Astrophys. J.* 118, 113-115 (1953)
- Li, H.-b., Griffin, G., Krejny, M., Novak, G., Loewenstein, R., Newcomb, M., Calisse, P. & Chuss, D. Results of SPARO 2003: Mapping Magnetic Fields in Giant Molecular Clouds. *Astrophys. J.* 648, 340-354 (2006)
- Padoan, P. Jimenez, R. Juvela, M. & Nordlund, Å. The Average Magnetic Field Strength in Molecular Clouds: New Evidence of Super-Alfvénic Turbulence. *Astrophys. J.* 604, 49-52 (2004)
- Tabatabaei, F., Krause, M., Fletcher, A. & Beck, R. High-resolution radio continuum survey of M 33. III. Magnetic fields. *Astron. Astrophys.* 490, 1005–1017 (2008).
- Sandage, A. & Humphreys, R. On the warped optical plane of M33. *Astrophys. J.* 236, 1-5 (1980)
- Rogstad, D., Wright, M. & Lockhart, I. Aperture synthesis of neutral hydrogen in the galaxy M33. *Astrophys. J.* 204, 703-716 (1976)

NEW WIDE-BAND IF OPTIONS FOR THE SMA 1.3 MM RECEIVER BAND

Edward Tong and Ken Young

As discussed in the August 2011 SMA newsletter, the SMA is engaged in the development of a new generation of receiver systems capable of delivering a much broader instantaneous frequency coverage. Here we report on a significant milestone towards this development. Two new broadband 1.3 mm receivers, with higher intermediate frequency output, were recently installed in antennas 1 and 5. These new receivers, which now form part of the instrumentation for regular science observations, have undergone on-sky interferometric tests with the IF extended to 12 GHz, doubling the IF range that can currently be used. Once all of the SMA antennas are equipped with this new receiver type, we will offer a new observing mode through which data can be collected using the current 4 – 6 GHz IF together with any 2 GHz – wide IF segment in the frequency range of 6 – 12 GHz, thus opening the door for more versatile observations of sets of spectral lines.

The heart of the new 1.3 mm receivers is a distributed SIS mixer fabricated at ASIAA. Shown in figure 1, the mixer chip carries three SIS junctions connected in series. These junctions are 1.6 µm in diameter and their critical current density is about 7 kA/cm^2. By distributing the junctions, we are able to reduce the total IF output capacitance, and thereby increase the IF bandwidth of the mixer.

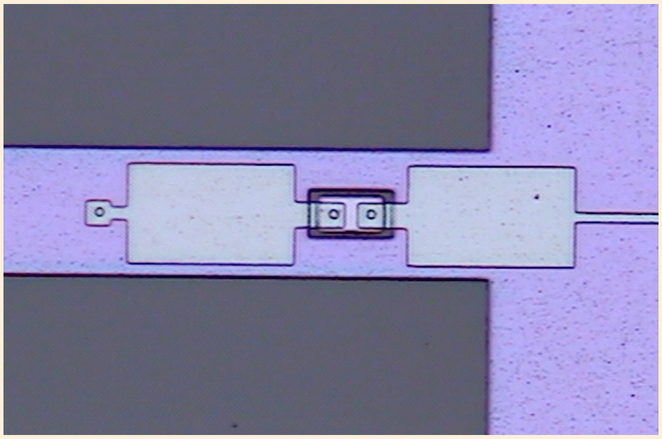


Figure 1: Photograph of the three junction series-connected, distributed SIS mixer for 1.3 mm operation (courtesy M. J. Wang, ASIAA).

The noise performance of one of the new receivers is plotted as a function of IF in figure 2. These data were obtained in the Receiver Lab in Cambridge using an SMA cryostat coupled to an exact copy of the entire optics train found in each of the SMA antennas. From the figure, we note that low receiver noise is measured over the IF range of 3 – 12 GHz. The increase in receiver noise temperature above 12 GHz is caused primarily by loss in the isolator and the noise performance of cryogenic amplifier following the mixer.

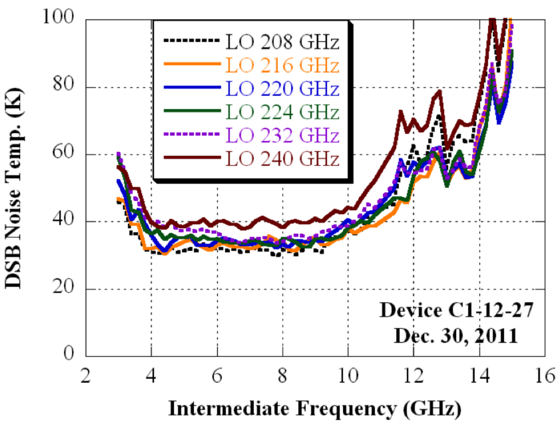


Figure 2: Lab measurements of receiver noise temperature plotted as a function of IF for the new wide-band 1.3 mm SIS receiver to be installed at the SMA during 2012.

Although the SMA signal processing capacity is still limited in bandwidth by its correlator, we have made changes to the analog signal processor in each antenna to enable access to the higher IF region offered by these receivers. In the present configuration, a single SMA receiver can be run in the 'Bandwidth Doubled' mode by mapping the 6 – 8 GHz part of the IF to a second standard

4 – 6 GHz band which the correlator and associated analog processors can handle. This is achieved using a 12 GHz intermediate Local Oscillator in each antenna to perform the frequency translation. In order to gain access to the 8 – 12 GHz IF of the new wideband receivers, we have made changes such that we can tune the intermediate LO to any frequency between 12 GHz and 18 GHz. In this way any 2 GHz wide interval between 6 GHz and 12 GHz (and potentially to 14 GHz with further improvements in receiver bandwidth) can be mapped into the standard 4 – 6 GHz band.

To validate this new configuration, we have performed on-sky test observations towards Orion BN/KL on the one baseline for which both antennas have the new wideband receivers. Referring to figure 3, the black spectra show the 4 – 6 GHz spectral region, which is always covered in either single- or dual-receiver mode. The red spectra show the additional coverage obtained in the 'Bandwidth Doubled' mode of operation, with the usual 12 GHz LO sent to the Bandwidth Doubler Assembly. A 14 GHz LO provides spectral coverage over the 8 – 10 GHz IF range, shown in green, and a 16 GHz LO provides coverage over the 10 – 12 GHz range, shown in blue. Because changing the LO to the Bandwidth Doubler Assembly allows the two halves of a sideband to span as much as 8 GHz, which is also the separation between the lowest USB frequency and the highest LSB frequency, one can now target any two spectral lines which are separated by less than 24 GHz, either by putting them both in one sideband, which offers coverage for up to 8 GHz separation, or by putting them in different sidebands for up to 24 GHz separation.

It is anticipated that by the fall of 2012, most of the SMA antennas will be equipped with the new 1.3 mm wide band receivers. At that point, the wide IF option described above will be available to observers. In addition, we recently began work to develop and build additional correlator hardware that will enable processing of the full 4 – 12 GHz IF, so that observers will have the option of observing 16 GHz of bandwidth in a single observation. We expect this upgrade to be available during the second half of 2013.

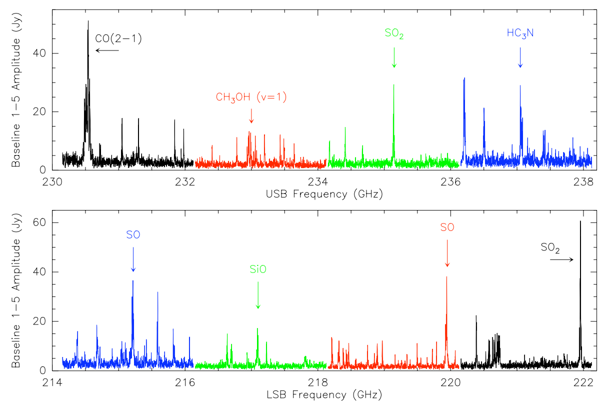


Figure 3: Upper- and lower- sideband spectra taken towards Orion BN/KL with a single LO setting using the wideband 1.3 mm receivers recently installed into SMA antennas 1 and 5. Note that the two sidebands are obtained simultaneously because of the DSB mode of operation of the SMA receivers.

PROPOSAL STATISTICS (16 NOV 2011 – 15 MAY 2012)

The SMA received a total of 102 proposals (SAO and ASIAA:95, UH: 7) requesting observing time in the 2011B semester. The proposals received by the joint SAO and ASIAA Time Allocation Committee are divided among science categories as follows:

Category	Proposals
low/intermediate mass star formation, cores	27
local galaxies, starbursts, AGN	20
high mass (OB) star formation, cores	11
protoplanetary, transition, debris disks	11
evolved stars, AGB, PPN	8
GRB, SN, high energy	6
submm/hi-z galaxies	6
galactic center	3
solar system	2
other	1

TRACK ALLOCATIONS BY WEATHER REQUIREMENT (ALL PARTNERS):

PWV(1)	SAO+ASIAA	UH(2)
< 4mm	13A + 41B	10
< 2.5mm	31A + 29B	3
< 1 mm	10A + 9B	8
Total	**54A + 79B**	**21**

(1) Precipitable water vapor required for the observations.
(2) UH does not list As and Bs.

TOP-RANKED SAO AND ASIAA PROPOSALS - 2011B SEMESTER

The following is the listing of all SAO and ASIAA proposals with at least partial A ranking with the names and affiliations of the principal investigators.

EVOLVED STARS, AGB, PPN

Benjamin Sargent, Space Telescope Science Institute
Gas Mass Loss Rates and Gas-to-Dust Ratios of Galactic Bulge Evolved Stars

Izaskun Jimenez-Serra, Harvard-Smithsonian Center for Astrophysics
Unveiling the Origin of the Radio Recombination Maser Emission toward the eta Carinae Massive Star

Laurence Sabin, Institute of Astronomy, Universidad Nacional Autonoma de Mexico
Magnetic Fields in Proto-Planetary nebulae

GALACTIC CENTER

Dan Marrone, University of Arizona
Disentangling the Polarization of Sagittarius A with SMA and CARMA*

Paul Ho, SAO/ASIAA
Kinematic Processes of the Extremely Turbulent ISM around the Supermassive Blackholes (duplicate of 2011B-A019)

Paul Ho, SAO/ASIAA
Kinematic Processes of the Extremely Turbulent ISM around the Supermassive Blackholes (duplicate of 2011B-S040)

GRB, SN, HIGH ENERGY

Bevin Zauderer, Harvard-Smithsonian Center for Astrophysics
Insights on Gamma-Ray Bursts and Transients from Combined mm/cm Observations

Laura Chomiuk, Harvard-Smithsonian Center for Astrophysics/ National Radio Astronomy Observatory
Exploring the Millimeter Behavior of Novae

Sergio Martin Ruiz, European Southern Observatory
Observing the peak emission of gamma-ray bursts afterglows in submillimeter frequencies

Yuji Urata, NCU/ASIAA
Constrain Emission Mechanism of GRB Afterglow with Broadband SED

HIGH MASS (OB) STAR FORMATION, CORES

Qizhou Zhang, Harvard-Smithsonian Center for Astrophysics
Filaments, Star Formation and Magnetic Fields

Raghvendra Sahai, Jet Propulsion Laboratory
Investigating the High-Velocity Outflows in, and Environment of, an Interstellar Bullet Engine

LOCAL GALAXIES, STARBURSTS, AGN

Eric Keto, Harvard-Smithsonian Center for Astrophysics
The building blocks of the starburst in M82

Ian McHardy, University of Southampton
*The Disk/Jet connection in LLAGN: The relationship between the mm and X-ray emission in M81**

Kazushi Sakamoto, ASIAA
Circumnuclear Gas in NGC 4418

Kazushi Sakamoto, ASIAA
Circumnuclear Gas in NGC 4418 (=2011B-S026)

Lisa H. Wei, Harvard-Smithsonian Center for Astrophysics
The Mass Spectrum of the ISM in Starbursts

Sheperd Doeleman, MIT Haystack Observatory
230 GHz VLBI Observations of SgrA and M87*

LOW/INTERMEDIATE MASS STAR FORMATION, CORES

Hsi-Wei Yen, ASIAA
Unveiling Rotational Profiles of Protostellar Envelopes from 100 to 5000 AU: How Disks Form?

Hua-bai Li, MPIA
Fragmentation and Ambipolar Diffusion in Filamentary Molecular Clouds II

Mark Thompson, University of Hertfordshire
A candidate isolated proto-brown dwarf discovered in the Herschel ATLAS

Michael Dunham, Yale University
Outflow and Disk Properties of a Candidate First Core

Ramprasad Rao, ASIAA
Magnetic Fields through Polarization Observations of the Serpens Main Core

PROTOPLANETARY, TRANSITION, DEBRIS DISKS

Catherine Espaillat, Harvard-Smithsonian Center for Astrophysics
Constraining Planet Formation in Dusty Disks Around Young Stars

Lauren Cleeves, University of Michigan
Searching for an Extrasolar Heliopause

Meredith Hughes, UC Berkeley
Molecular Gas in Debris Disks: HD 141569

Meredith Hughes, UC Berkeley
Resolving Structure in the Debris Disk around HD 61005

Robert Harris, Harvard-Smithsonian Center for Astrophysics
A Protoplanetary Disk Census in Taurus Multiple Star Systems

SOLAR SYSTEM

Arielle Moullet, NRAO
Investigating Iapetus' surface dichotomy at 1.3mm

Mark Gurwell, Harvard-Smithsonian Center for Astrophysics
Vertically Resolved Stratospheric Winds on Titan and Mapping of Nitrile Species

SUBMM/HI-z GALAXIES

Giovanni G. Fazio, Harvard-Smithsonian Center for Astrophysics
SMA Observations of an Exceptionally Bright Gravitationally-Lensed Submillimeter Galaxy at z~4.6

Shane Bussmann, Harvard-Smithsonian Center for Astrophysics
SMA Imaging of F880um ~ 60 mJy Strongly-lensed z >2 Galaxies Discovered By Herschel

ALL SAO PROPOSALS - 2011A SEMESTER

The following is the listing of all the SAO proposals observed in the 2011A semester (16 May 2011 – 15 November 2011)

Katherine Alatalo, UC - Berkeley
High Resolution Observations of the Molecular Outflow in NGC 1266: a Candidate for AGN Feedback

Sean Andrews, Harvard-Smithsonian Center for Astrophysics
Dust Emission from Disks in Very Wide Binary Systems

Tyler Bourke, Harvard-Smithsonian Center for Astrophysics
Disk Structure around Class I Protostars

Joanna Brown, Harvard-Smithsonian Center for Astrophysics
Is the 40 AU gas hole in transition disk Oph IRS 48 cleared of large dust grains?

Shane Bussmann, Harvard-Smithsonian Center for Astrophysics
Long Baseline SMA Imaging of Strongly-lensed Galaxies Discovered In Herschel Surveys

Philipp Carlhoff, Physikalisches Institut, Universität zu Köln
Molecular cloud structure and star formation in the W43 complex

Vivien Huei-Ru Chen, National Tsing Hua University
Delineating the Molecular Accretion Flow around the Forming O Star, NGC 7538 IRS 1

David Clements, Imperial College London
Detailed Imaging of Herschel Selected Candidate High z Galaxies

Pierre Cox, IRAM
Mapping the [CII] Emission in a gravitationally lensed z=4.24 SMG from the Herschel ATLAS

Salvador Curiel, Instituto de Astronomia, UNAM
Tracking down the High-velocity SiO and CO Emission in the High-mass YSO CepA/HW2

Claudia Cyganowski, Harvard-Smithsonian Center for Astrophysics
Resolving Complexity in Massive Protoclusters: Young HC HIIs in GLIMPSE EGOs?

Michael Dunham, Yale University
SMA Observations of a New Candidate FU Orionis Object

Catherine Espaillat, Harvard-Smithsonian Center for Astrophysics
Constraining Planet Formation in Dusty Disks Around Young Stars

Giovanni G. Fazio, Harvard-Smithsonian Center for Astrophysics
A Search for CII in an Exceptionally Bright Gravitationally-Lensed Submillimeter Galaxy at z = 5.243

Giovanni G. Fazio, Harvard-Smithsonian Center for Astrophysics
SMA Observations of a Newly Discovered Bright Cluster-Lensed Submillimeter Galaxy at z>3

Pau Frau, Institut de CiΦncies de l'Espai (IEEC-CSIC)
Revealing the magnetic field and rotation properties of the accretion disk around a massive protostar

Mark Gurwell, Harvard-Smithsonian Center for Astrophysics
M81 Flare Monitoring*

Robert Harris, Harvard-Smithsonian Center for Astrophysics
A Census of Protoplanetary Disks in Rho Oph Binaries: the Timescale for Tidal Stripping

Robert Harris, Harvard-Smithsonian Center for Astrophysics
Completing A Protoplanetary Disk Census in Taurus Multiple Star Systems

Paul Ho, SAO/ASIAA
KISS: Kinematic Processes of the Extremely Turblent ISM around the Supermassive Blackholes

Joseph Hora, Harvard-Smithsonian Center for Astrophysics
Investigating the Massive Star Formation in the DR21 filament

Tien Hao Hsieh, National Tsing Hua University
Director's track for 2011A-A010 and A014

Tien Hao Hsieh, National Tsing Hua University
Study the outflows and chemical properties of two proto brown dwarf candidates DCE064 and DCE065

Lijin Huang, ASIAA
SMA/345 GHz continuum emission study on the dark GRB 020819 host galaxy

Meredith Hughes, UC Berkeley
Resolving the Disk around a Newly-Discovered Isolated T Tauri Star

Daisuke Iono, National Astronomical Observatory of Japan
Reformation of Cold Molecular Disks in Merger Remnants

Izaskun Jimenez-Serra, Harvard-Smithsonian Center for Astrophysics
Radio Recombination Maser Lines toward NGC7538 IRS1?

Chin-Fei Lee, ASIAA
A Big Hollow Rotating Jet From a Low-Mass Protostar?

Hua-bai Li, MPIA
Fragmentation and Ambipolar Diffusion in Filamentary Molecular Clouds

Sheng-Yuan Liu, ASIAA
Characterizing The Early Stages of Massive Star Formation - A Case Study of IRDC G34.43+0.24

Sheng-Yuan Liu, ASIAA
The Disk-Outflow System in IRDC G351.78û0.54

Hau-Yu Baobab Lu, Harvard-Smithsonian Center for Astrophysics
Filamentary Spiral Structures in the Self-Gravitational Accretion Flow

Hau-Yu Baobab Lu, Harvard-Smithsonian Center for Astrophysics
Structures and Kinematics of the Hub-Filament System: The Intermediate Mass Case

Sarah Maddison, Swinburne University
Grain growth in protoplanetary disks

Rita Mann, Herzberg Institute of Astrophysics - National Research Council
A Submillimeter Array Survey of Protoplanetary Disks in the NGC 1333 Rich Cluster

Arielle Moullet, NRAO
Measuring the thermal lightcurve of asteroid (4) Vesta

Nadia Murillo, National Tsing Hua University
VLA1623: a triple system with a candidate First Core?

Nicole Nesvadba, Institut d'Astrophysique Spatiale Orsay
Live together, die together? The star-forming regions in two obscured quasars at z~3.5

Karin Oberg, Harvard-Smithsonian Center for Astrophysics
Resolving the N- and O-bearing complex organics in hot cores

Nagayoshi Ohashi, ASIAA
Determination of Properties of Disks around Young Brown Dwarfs

Aina Palau, Institut de Ciencies de l'Espai (CSIC-IEEC)
What is controlling the fragmentation process in intermediate-mass protoclusters? (copied from 2010B-S070)

David Paneque, SLAC/Kipac
Extensive multifrequency monitoring of the TeV blazars Mrk 421 and Mrk501

Berengere Parise, Max Planck Institut fuer Radioastronomie
Development of molecular complexity in a protosolar nebula: deuterated water, formaldehyde and methanol in IRAS16293-2422

Berengere Parise, Max Planck Institut fuer Radioastronomie
Probing cold gas in the line of sight of SgrB2(M) : a confirmation of the detection of H2D+

Nimesh Patel, Harvard-Smithsonian Center for Astrophysics
AY191: Hydrogen RRL observations of MonR2-IRS2

Nimesh Patel, Harvard-Smithsonian Center for Astrophysics
Propagating Star Formation: CO View of a Neutral Hydrogen Supershell in M101

Glen Petitpas, Harvard-Smithsonian Center for Astrophysics
A New Young Supernova in NGC 4490

Glen Petitpas, Harvard-Smithsonian Center for Astrophysics
Extreme Star Formation in the Eary Type Galaxy NGC 1222

Keping Qiu, Max-Planck-Institute for Radioastronomy
A Primary Wind in Massive Star Formation? Proper motion and excitation of molecular bullets in HH 80--81

Victor M. Rivilla, Centro de Astrobiologia. INTA-CSIC
Observational HC3N systematic trends and their connection to the formation processes of the most massive stars*

Katherine Rosenfeld, Harvard-Smithsonian Center for Astrophysics
Reconciling the Gas and Dust Distributions in the V4046 Sgr Protoplanetary Disk

Michael Rupen, NRAO
SMA Observations of outburst of the transient X-ray binary MAXI J1836-194

Kazushi Sakamoto, ASIAA
Vibrational Excitation in Galaxy Nuclei

Carmen Sanchez Contreras, Astrobiology Center (CAB) - CSIC/INTA
High-angular resolution CO mapping of the fast, massive outflow of the pre-planetary nebula IRAS 19374

Howard Smith, Harvard-Smithsonian Center for Astrophysics
From cold cores to hot cores (2): The early evolution of massive star formation, an SMA followup of Herschel FIR maps

Ren-Shiang Sung, National Tsing Hua University
CO Outflows of Very Low Luminosity Objects in Taurus

Arthur Cheng-Hung Tsai, National Tsing Hua University
Determining the Outflow Properties in the Luminous High-Mass Protostellar Object IRAS 23151+5912

Vivian U, Harvard-Smithsonian Center for Astrophysics
Mapping the Molecular Gas in the Nuclei of Luminous Infrared Galaxies

Ke Wang, Harvard-Smithsonian Center for Astrophysics
Evolution of Hub-Filament Structure in Star Formation Regions

Ke Wang, Harvard-Smithsonian Center for Astrophysics
Hierarchical Fragmentation in the Galactic 'Snake'

Wei-Hao Wang, ASIAA
Brightness of the SDSS QSO J1009+0713

Wei-Hao Wang, ASIAA
Brightness of the SDSS QSO J1619+3342

Lisa H. Wei, Harvard-Smithsonian Center for Astrophysics
Modeling the ISM of Local LIRGs

David Wilner, Harvard-Smithsonian Center for Astrophysics
Resolving Structure in the Debris Disk around AU Mic

Hsi-Wei Yen, ASIAA
Direct Measurements of Disk Sizes Around Protostars

Luis Zapata, CRyA-UNAM
Episodic Mass Ejection Event in a Young Star

Luis Zapata, CRyA-UNAM
What is powering the massive outflow in DR21?

Bevin Zauderer, Harvard-Smithsonian Center for Astrophysics
A search for mm-emission from new SN in M51

Bevin Zauderer, Harvard-Smithsonian Center for Astrophysics
Progenitors to Probes: New Insights on GRBs from Combined mm/cm Observations

Qizhou Zhang, Harvard-Smithsonian Center for Astrophysics
Filaments, Star Formation and Magnetic Fields

Jun-Hui Zhao, Harvard-Smithsonian Center for Astrophysics
Gas dynamics in the circumnuclear disk and measurements of the central potential in the Galaxy

RECENT PUBLICATIONS

Title: Molecular Outflows in the Substellar Domain: Millimeter Observations of Young Very Low Mass Objects in Taurus and ρ Ophiuchi
Authors: Phan-Bao, Ngoc; Lee, Chin-Fei; Ho, Paul T. P.; Tang, Ya-Wen
Publication: *The Astrophysical Journal,* Volume 735, Issue 1, article id. 14 (2011). (ApJ Homepage)
Publication Date: 07/2011
Abstract: http://arxiv.org/abs/1104.2831

Title: The Extremely High-Velocity Outflow from the Luminous Young Stellar Object G5.89-0.39
Authors: Su, Yu-Nung; Liu, Sheng-Yuan; Chen, Huei-Ru; Tang, Ya-Wen
Publication: *eprint arXiv:*1112.2041
Publication Date: 12/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1112.2041S

Title: Protostellar Outflow Heating in a Growing Massive Protocluster
Authors: Wang, Ke; Zhang, Qizhou; Wu, Yuefang; Li, Hua-bai; Zhang, Huawei
Publication: *eprint arXiv:*1112.1885
Publication Date: 12/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1112.1885W

Title: Surviving the hole I: Spatially resolved chemistry around Sgr A*
Authors: Martín, S.; Martín-Pintado, J.; Montero-Castaño, M.; Ho, P. T. P.; Blundell, R.
Publication: *eprint arXiv:*1112.0566
Publication Date: 12/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1112.0566M

Title: Interferometric CO(3-2) Observations toward the Central Region of NGC 1068
Authors: Tsai, Mengchun; Hwang, Chorng-Yuan; Matsushita, Satoki; Baker, Andrew J.; Espada, Daniel
Publication: *eprint arXiv:*1112.0108
Publication Date: 12/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1112.0108T

Title: Arcsecond resolution mapping of Sulfur Dioxide emission in the circumstellar envelope of VY Canis Majoris
Authors: Fu, Roger; Moullet, Arielle; Patel, Nimesh A.; Biersteker, John; DeRose, Kimberly L.; Young, Kenneth H.
Publication: *eprint arXiv:*1111.7004
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1111.7004F

Title: The TW Hya Disk at 870 microns: Comparison of CO and Dust Radial Structures
Authors: Andrews, Sean M.; Wilner, David J.; Hughes, A. M.; Qi, Chunhua; Rosenfeld, Katherine A.; Oberg, Karin I.; Birnstiel, T.; Espaillat, Catherine; Cieza, Lucas A.; Williams, Jonathan P.; Lin, Shin-Yi; Ho, Paul T. P.
Publication: *eprint arXiv*:1111.5037
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1111.5037A

Title: Initial conditions for star formation in clusters: physical and kinematical structure of the starless core Oph A-N6
Authors: Bourke, Tyler L.; Myers, Philip C.; Caselli, Paola; Di Francesco, James; Belloche, Arnaud; Plume, René; Wilner, David J.
Publication: *eprint arXiv*:1111.4424
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1111.4424B

Title: A Closer Look at the LkCa 15 Protoplanetary Disk
Authors: Andrews, Sean M.; Rosenfeld, Katherine A.; Wilner, David J.; Bremer, Michael
Publication: *The Astrophysical Journal Letters,* Volume 742, Issue 1, article id. L5 (2011). (ApJL Homepage)
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...742L...5A

Title: Properties and Keplerian Rotation of the Hot Core IRAS 20126+4104
Authors: Xu, Jin-Long; Wang, Jun-Jie; Ning, Chang-chun
Publication: *eprint arXiv*:1110.3115
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1110.3115X

Title: Unveiling the physical properties and kinematics of molecular gas in the Antennae Galaxies (NGC 4038/9) through high resolution CO (J = 3-2) observations
Authors: Ueda, Junko; Iono, Daisuke; Petitpas, Glen; Yun, Min S.; Ho, Paul T. P.; Kawabe, Ryohei; Mao, Rui-Qing; Martin, Sergio; Matsushita, Satoki; Peck, Alison B.; Tamura, Yoichi; Wang, Junzhi; Wang, Zhong; Wilson, Christine D.; Zhang, Qizhou
Publication: *eprint arXiv*:1110.2496
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1110.2496U

Title: The alignment of molecular cloud magnetic fields with the spiral arms in M33
Authors: Li, Hua-Bai; Henning, Thomas
Publication: *Nature,* Volume 479, Issue 7374, pp. 499-501 (2011). (Nature Homepage)
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011Natur.479..499L

Title: The Origin of OB Clusters: From 10 pc to 0.1 pc
Authors: Liu, Hauyu Baobab; Quintana-Lacaci, Guillermo; Wang, Ke; Ho, Paul T. P.; Li, Zhi-Yun; Zhang, Qizhou; Zhang, Zhiyu
Publication: *eprint arXiv*:1110.1318
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1110.1318L

Title: Hot Molecular Cores in Infrared Dark Clouds
Authors: Rathborne, J. M.; Garay, G.; Jackson, J. M.; Longmore, S.; Zhang, Q.; Simon, R.
Publication: 11/2011
Publication Date: *The Astrophysical Journal*, Volume 741, Issue 2, article id. 120 (2011). (ApJ Homepage)
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...741..120R

Title: Intermediate-mass Hot Cores at ~500 AU: Disks or Outflows?
Authors: Palau, Aina; Fuente, Asunción; Girart, Josep M.; Fontani, Francesco; Boissier, Jérémie; Piétu, Vincent; Sánchez-Monge, Álvaro; Busquet, Gemma; Estalella, Robert; Zapata, Luis A.; Zhang, Qizhou; Neri, Roberto; Ho, Paul T. P.; Alonso-Albi, Tomás; Audard, Marc
Publication: *The Astrophysical Journal Letters*, Volume 743, Issue 2, article id. L32 (2011). (ApJL Homepage)
Publication Date: 12/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...743L..32P

Title: Comparing star formation models with interferometric observations of the protostar NGC 1333 IRAS 4A. I. Magnetohydrodynamic collapse models
Authors: Frau, P.; Galli, D.; Girart, J. M.
Publication: *Astronomy & Astrophysics*, Volume 535, id.A44 (A&A Homepage)
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011A%26A...535A..44F

Title: Structure of the hot molecular core G10.47+0.03
Authors: Rolffs, R.; Schilke, P.; Zhang, Q.; Zapata, L.
Publication: *Astronomy & Astrophysics*, Volume 536, id.A33 (A&A Homepage)
Publication Date: 12/2011
Abstract: http://adsabs.harvard.edu/abs/2011A%26A...536A..33R

Title: Millimeter multiplicity in DR21(OH): outflows, molecular cores and envelopes
Authors: Zapata, Luis A.; Loinard, Laurent; Su, Y. -N.; Rodríguez, Luis F.; Menten, Karl M.; Patel, Nimesh; Galván-Madrid, Roberto
Publication: *eprint arXiv*:1109.3153
Publication Date: 09/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1109.3153Z

Title: Birth of a relativistic outflow in the unusual γ-ray transient Swift J164449.3+573451
Authors: Zauderer, B. A.; Berger, E.; Soderberg, A. M.; Loeb, A.; Narayan, R.; Frail, D. A.; Petitpas, G. R.; Brunthaler, A.; Chornock, R.; Carpenter, J. M.; Pooley, G. G.; Mooley, K.; Kulkarni, S. R.; Margutti, R.; Fox, D. B.; Nakar, E.; Patel, N. A.; Volgenau, N. H.; Culverhouse, T. L.; Bietenholz, M. F.; Rupen, M. P.; Max-Moerbeck, W.; Readhead, A. C. S.; Richards, J.; Shepherd, M.; Storm, S.; Hull, C. L. H.
Publication: *Nature*, Volume 476, Issue 7361, pp. 425-428 (2011). (Nature Homepage)
Publication Date: 08/2011
Abstract: http://adsabs.harvard.edu/abs/2011Natur.476..425Z

Title: Kinematics and Physical Conditions of the Innermost Envelope in B335
Authors: Yen, Hsi-Wei; Takakuwa, Shigehisa; Ohashi, Nagayoshi
Publication: *The Astrophysical Journal*, Volume 742, Issue 1, article id. 57 (2011). (ApJ Homepage)
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...742...57Y

Title: The Ionization Fraction in the DM Tau Protoplanetary Disk
Authors: Öberg, Karin I.; Qi, Chunhua; Wilner, David J.; Andrews, Sean M.
Publication: *The Astrophysical Journal*, Volume 743, Issue 2, article id. 152 (2011). (ApJ Homepage)
Publication Date: 12/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...743..152O

Title: Detection of an ultrabright submillimetre galaxy in the Subaru/XMM-Newton Deep Field using AzTEC/ASTE
Authors: Ikarashi, S.; Kohno, K.; Aguirre, J. E.; Aretxaga, I.; Arumugam, V.; Austermann, J. E.; Bock, J. J.; Bradford, C. M.; Cirasuolo, M.; Earle, L.; Ezawa, H.; Furusawa, H.; Furusawa, J.; Glenn, J.; Hatsukade, B.; Hughes, D. H.; Iono, D.; Ivison, R. J.; Johnson, S.; Kamenetzky, J.; Kawabe, R.; Lupu, R.; Maloney, P.; Matsuhara, H.; Mauskopf, P. D.; Motohara, K.; Murphy, E. J.; Nakajima, K.; Nakanishi, K.; Naylor, B. J.; Nguyen, H. T.; Perera, T. A.; Scott, K. S.; Shimasaku, K.; Takagi, T.; Takata, T.; Tamura, Y.; Tanaka, K.; Tsukagoshi, T.; Wilner, D. J.; Wilson, G. W.; Yun, M. S.; Zmuidzinas, J.
Publication: *Monthly Notices of the Royal Astronomical Society*, Volume 415, Issue 4, pp. 3081-3096. (MNRAS Homepage)
Publication Date: 08/2011
Abstract: http://adsabs.harvard.edu/abs/2011MNRAS.415.3081I

Title: The enigmatic core L1451-mm: a first hydrostatic core? or a hidden VeLLO?
Authors: Pineda, Jaime E.; Arce, Héctor G.; Schnee, Scott; Goodman, Alyssa A.; Bourke, Tyler; Foster, Jonathan B.; Robitaille, Thomas; Tanner, Joel; Kauffmann, Jens; Tafalla, Mario; Caselli, Paola; Anglada, Guillem
Publication: *eprint arXiv*:1109.1207
Publication Date: 09/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1109.1207P

Title: Arcsecond resolution images of the chemical structure of the low-mass protostar IRAS 16293-2422. An overview of a large molecular line survey from the Submillimeter Array
Authors: Jørgensen, J. K.; Bourke, T. L.; Nguyen Luong, Q.; Takakuwa, S.
Publication: *Astronomy & Astrophysics*, Volume 534, id.A100 (A&A Homepage)
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1109.0415J

Title: Millimeter Observations of the Transition Disk around HD 135344B (SAO 206462)
Authors: Lyo, A.-Ran; Ohashi, Nagayoshi; Qi, Chunhua; Wilner, David J.; Su, Yu-Nung
Publication: *The Astronomical Journal*, Volume 142, Issue 5, article id. 151 (2011). (AJ Homepage)
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011AJ....142..151L

Title: Disks and Outflows in the Massive Protobinary System W3(OH)TW
Authors: Zapata, Luis A.; Rodríguez-Garza, Carolina; Rodríguez, Luis F.; Girart, Josep M.; Chen, Huei-Ru
Publication: *The Astrophysical Journal Letters*, Volume 740, Issue 1, article id. L19 (2011). (ApJL Homepage)
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011arXiv1108.4899Z

Title: Detection of a Bipolar Molecular Outflow Driven by a Candidate First Hydrostatic Core
Authors: Dunham, Michael M.; Chen, Xuepeng; Arce, Héctor G.; Bourke, Tyler L.; Schnee, Scott; Enoch, Melissa L.
Publication: *The Astrophysical Journal*, Volume 742, Issue 1, article id. 1 (2011). (ApJ Homepage)
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...742....1D

Title: Outflow, Infall, and Protostars in the Star-forming Core W3-SE
Authors: Zhu, Lei; Zhao, Jun-Hui; Wright, M. C. H.
Publication: *The Astrophysical Journal*, Volume 740, Issue 2, article id. 114 (2011). (ApJ Homepage)
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...740..114Z

Title: Sagittarius B2 Main: A Cluster of Ultra-compact H II Regions and Massive Protostellar Cores
Authors: Zhao, Jun-Hui; Wright, M. C. H.
Publication: *The Astrophysical Journal*, Volume 742, Issue 1, article id. 50 (2011). (ApJ Homepage)
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...742...50Z

Title: H2CS in Outflows of the Massive Star-forming Core DR21(OH)
Authors: Minh, Y. C.; Liu, S.-Y.; Chen, H.-R.; Su, Y.-N.
Publication: *The Astrophysical Journal Letters*, Volume 737, Issue 1, article id. L25 (2011). (ApJL Homepage)
Publication Date: 08/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...737L..25M

Title: Central free-free dominated 880-μm emission in II Zw 40
Authors: Hirashita, Hiroyuki
Publication: *Monthly Notices of the Royal Astronomical Society*, Volume 418, Issue 2, pp. 828-837. (MNRAS Homepage)
Publication Date: 12/2011
Abstract: http://adsabs.harvard.edu/abs/2011MNRAS.418..828H

Title: Resolving the CO Snow Line in the Disk around HD 163296
Authors: Qi, Chunhua; D'Alessio, Paola; Öberg, Karin I.; Wilner, David J.; Hughes, A. Meredith; Andrews, Sean M.; Ayala, Sandra
Publication: *The Astrophysical Journal*, Volume 740, Issue 2, article id. 84 (2011). (ApJ Homepage)
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...740...84Q

Title: A Rotating Molecular Disk Toward IRAS 18162-2048, the Exciting Source of HH 80-81
Authors: Fernández-López, M.; Girart, J. M.; Curiel, S.; Gómez, Y.; Ho, P. T. P.; Patel, N.
Publication: *The Astronomical Journal*, Volume 142, Issue 4, article id. 97 (2011). (AJ Homepage)
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011AJ....142...97F

Title: Resolved Submillimeter Observations of the HR 8799 and HD 107146 Debris Disks
Authors: Hughes, A. Meredith; Wilner, David J.; Andrews, Sean M.; Williams, Jonathan P.; Su, Kate Y. L.; Murray-Clay, Ruth A.; Qi, Chunhua
Publication: *The Astrophysical Journal*, Volume 740, Issue 1, article id. 38 (2011). (ApJ Homepage)
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...740...38H

Title: Identification of γ-ray emission from 3C 345 and NRAO 512
Authors: Schinzel, F. K.; Sokolovsky, K. V.; D'Ammando, F.; Burnett, T. H.; Max-Moerbeck, W.; Cheung, C. C.; Fegan, S. J.; Casandjian, J. M.; Reyes, L. C.; Villata, M.; Raiteri, C. M.; Agudo, I.; Bravo Calle, O. J. A.; Carosati, D.; Casas, R.; Gómez, J. L.; Gurwell, M. A.; Hsiao, H. Y.; Jorstad, S. G.; Kimeridze, G.; Konstantinova, T. S.; Kopatskaya, E. N.; Koptelova, E.; Kurtanidze, O. M.; Kurtanidze, S. O.; Larionov, V. M.; Larionova, E. G.; Larionova, L. V.; Marscher, A. P.; Morozova, D. A.; Nikolashvili, M. G.; Roca-Sogorb, M.; Ros, J. A.; Sigua, L. A.; Spiridonova, O.; Troitsky, I. S.; Vlasyuk, V. V.; Lobanov, A. P.; Zensus, J. A.
Publication: *Astronomy & Astrophysics*, Volume 532, id.A150 (A&A Homepage)
Publication Date: 08/2011
Abstract: http://adsabs.harvard.edu/abs/2011A%26A...532A.150S

Title: Gas and Dust in a Submillimeter Galaxy at z = 4.24 from the *Herschel* Atlas
Authors: Cox, P.; Krips, M.; Neri, R.; Omont, A.; Güsten, R.; Menten, K. M.; Wyrowski, F.; Weiß, A.; Beelen, A.; Gurwell, M. A.; Dannerbauer, H.; Ivison, R. J.; Negrello, M.; Aretxaga, I.; Hughes, D. H.; Auld, R.; Baes, M.; Blundell, R.; Buttiglione, S.; Cava, A.; Cooray, A.; Dariush, A.; Dunne, L.; Dye, S.; Eales, S. A.; Frayer, D.; Fritz, J.; Gavazzi, R.; Hopwood, R.; Ibar, E.; Jarvis, M.; Maddox, S.; Michałowski, M.; Pascale, E.; Pohlen, M.; Rigby, E.; Smith, D. J. B.; Swinbank, A. M.; Temi, P.; Valtchanov, I.; van der Werf, P.; de Zotti, G.
Publication: *The Astrophysical Journal*, Volume 740, Issue 2, article id. 63 (2011). (ApJ Homepage)
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...740...63C

Title: Dissecting a hot molecular core: the case of G31.41+0.31
Authors: Cesaroni, R.; Beltrán, M. T.; Zhang, Q.; Beuther, H.; Fallscheer, C.
Publication: *Astronomy & Astrophysics*, Volume 533, id.A73 (A&A Homepage)
Publication Date: 09/2011
Abstract: http://adsabs.harvard.edu/abs/2011A%26A...533A..73C

Title: The long-lasting activity of 3C 454.3. GASP-WEBT and satellite observations in 2008-2010
Authors: Raiteri, C. M.; Villata, M.; Aller, M. F.; Gurwell, M. A.; Kurtanidze, O. M.; Lähteenmäki, A.; Larionov, V. M.; Romano, P.; Vercellone, S.; Agudo, I.; Aller, H. D.; Arkharov, A. A.; Bach, U.; Benítez, E.; Berdyugin, A.; Blinov, D. A.; Borisova, E. V.; Böttcher, M.; Bravo Calle, O. J. A.; Buemi, C. S.; Calcidese, P.; Carosati, D.; Casas, R.; Chen, W.-P.; Efimova, N. V.; Gómez, J. L.; Gusbar, C.; Hawkins, K.; Heidt, J.; Hiriart, D.; Hsiao, H. Y.; Jordan, B.; Jorstad, S. G.; Joshi, M.; Kimeridze, G. N.; Koptelova, E.; Konstantinova, T. S.; Kopatskaya, E. N.; Kurtanidze, S. O.; Larionova, E. G.; Larionova, L. V.; Leto, P.; Li, Y.; Ligustri, R.; Lindfors, E.; Lister, M.; Marscher, A. P.; Molina, S. N.; Morozova, D. A.; Nieppola, E.; Nikolashvili, M. G.; Nilsson, K.; Palma, N.; Pasanen, M.; Reinthal, R.; Roberts, V.; Ros, J. A.; Roustazadeh, P.; Sadun, A. C.; Sakamoto, T.; Schwartz, R. D.; Sigua, L. A.; Sillanpää, A.; Takalo, L. O.; Tammi, J.; Taylor, B.; Tornikoski, M.; Trigilio, C.; Troitsky, I. S.; Umana, G.; Volvach, A.; Yuldasheva, T. A.
Publication: *Astronomy & Astrophysics*, Volume 534, id.A87 (A&A Homepage)
Publication Date: 10/2011
Abstract: http://adsabs.harvard.edu/abs/2011A%26A...534A..87R

Title: Spectral energy distribution variation in BL Lacs and flat spectrum radio quasars
Authors: Rani, Bindu; Gupta, Alok C.; Bachev, R.; Strigachev, A.; Semkov, E.; D'Ammando, F.; Wiita, P. J.; Gurwell, M. A.; Ovcharov, E.; Mihov, B.; Boeva, S.; Peneva, S.
Publication: *Monthly Notices of the Royal Astronomical Society*, Volume 417, Issue 3, pp. 1881-1890. (MNRAS Homepage)
Publication Date: 11/2011
Abstract: http://adsabs.harvard.edu/abs/2011MNRAS.417.1881R

Title: Molecular outflows and hot molecular cores in G24.78+0.08 at sub-arcsecond angular resolution
Authors: Beltrán, M. T.; Cesaroni, R.; Zhang, Q.; Galván-Madrid, R.; Beuther, H.; Fallscheer, C.; Neri, R.; Codella, C.
Publication: *Astronomy & Astrophysics*, Volume 532, id.A91 (A&A Homepage)
Publication Date: 08/2011
Abstract: http://adsabs.harvard.edu/abs/2011A%26A...532A..91B

Title: The Brightest Gamma-Ray Flaring Blazar in the Sky: AGILE and Multi-wavelength Observations of 3C 454.3 During 2010 November
Authors: Vercellone, S.; Striani, E.; Vittorini, V.; Donnarumma, I.; Pacciani, L.; Pucella, G.; Tavani, M.; Raiteri, C. M.; Villata, M.; Romano, P.; Fiocchi, M.; Bazzano, A.; Bianchin, V.; Ferrigno, C.; Maraschi, L.; Pian, E.; Türler, M.; Ubertini, P.; Bulgarelli, A.; Chen, A. W.; Giuliani, A.; Longo, F.; Barbiellini, G.; Cardillo, M.; Cattaneo, P. W.; Del Monte, E.; Evangelista, Y.; Feroci, M.; Ferrari, A.; Fuschino, F.; Gianotti, F.; Giusti, M.; Lazzarotto, F.; Pellizzoni, A.; Piano, G.; Pilia, M.; Rapisarda, M.; Rappoldi, A.; Sabatini, S.; Soffitta, P.; Trifoglio, M.; Trois, A.; Giommi, P.; Lucarelli, F.; Pittori, C.; Santolamazza, P.; Verrecchia, F.; Agudo, I.; Aller, H. D.; Aller, M. F.; Arkharov, A. A.; Bach, U.; Berdyugin, A.; Borman, G. A.; Chigladze, R.; Efimov, Yu. S.; Efimova, N. V.; Gómez, J. L.; Gurwell, M. A.; McHardy, I. M.; Joshi, M.; Kimeridze, G. N.; Krajci, T.; Kurtanidze, O. M.; Kurtanidze, S. O.; Larionov, V. M.; Lindfors, E.; Molina, S. N.; Morozova, D. A.; Nazarov, S. V.; Nikolashvili, M. G.; Nilsson, K.; Pasanen, M.; Reinthal, R.; Ros, J. A.; Sadun, A. C.; Sakamoto, T.; Sallum, S.; Sergeev, S. G.; Schwartz, R. D.; Sigua, L. A.; Sillanpää, A.; Sokolovsky, K. V.; Strelnitski, V.; Takalo, L.; Taylor, B.; Walker, G.
Publication: *The Astrophysical Journal Letters*, Volume 736, Issue 2, article id. L38 (2011). (ApJL Homepage)
Publication Date: 08/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJ...736L..38V

Title: Blazar 3C 454.3 in Outburst and Quiescence during 2005-2007: Two Variable Synchrotron Emission Peaks
Authors: Ogle, Patrick M.; Wehrle, Ann E.; Balonek, Thomas; Gurwell, Mark A.
Publication: *The Astrophysical Journal Supplement*, Volume 195, Issue 2, article id. 19 (2011). (ApJS Homepage)
Publication Date: 08/2011
Abstract: http://adsabs.harvard.edu/abs/2011ApJS..195...19O

Title: The (sub-)millimeter SED of protoplanetary disks in the outskirts of the Orion nebula cluster
Authors: Ricci, L.; Mann, R. K.; Testi, L.; Williams, J. P.; Isella, A.; Robberto, M.; Natta, A.; Brooks, K. J.
Publication: *Astronomy and Astrophysics*, Volume 525, id.A81 (A&A Homepage)
Publication Date: 01/2011
Abstract: http://adsabs.harvard.edu/abs/2011A%26A...525A..81R

Title: Infall, outflow, and rotation in the G19.61-0.23 hot molecular core
Authors: Furuya, R. S.; Cesaroni, R.; Shinnaga, H.
Publication: *Astronomy and Astrophysics*, Volume 525, id.A72 (A&A Homepage)
Publication Date: 01/2011
Abstract: http://adsabs.harvard.edu/abs/2011A%26A...525A..72F

The Submillimeter Array (SMA) is a pioneering radio-interferometer dedicaed to a broad range of astronomical studies including finding protostellar disks and outflows; evolved stars; the Galactic Center and AGN; normal and luminous galaxies; and the solar system. Located on Mauna Kea, Hawaii, the SMA is a collaboration between the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy and Astrophysics.

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