SMA Newsletter

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FROM THE DIRECTOR

Dear SMA Newsletter readers,

An important strength of the SMA is its ability to support enhancements and major upgrades to instrumentation on a fairly short time scale. Here I report on recent developments in this vein.

The receiver group has nearly completed installation of a second set of receivers that will enable full dual polarization capability at 230 GHz. We expect the full complement of 230 GHz receivers to be operational in the coming months. Along with full dual polarization capability at 345 GHz and the recent commissioning of the second tranche of the SWARM correlator, which is now running at 10/11 full speed, this will significantly enhance the polarimetry capabilities of the SMA.

Furthermore, since the new receivers have instantaneous bandwidths in excess of 12 GHz, we are looking forward to a significant increase in sensitivity for all observations as the third and fourth slices of SWARM are completed and commissioned later this year. The ageing ASIC correlator will be decommissioned once the third slice of SWARM is complete. While the old correlator has enabled observations to be made at high spectral resolution across small sections of the IF, moving towards full SWARM operation will provide the user with high resolution capability across much wider bandwidths, and without the complexity of a somewhat complicated and cumbersome correlator set-up.

Senior SAO and ASIAA staff recently presented a draft proposal to the SMA Governing Board to further develop detailed plans that will significantly enhance the SMA instrumentation over the next five years. In the interest of the SMA maintaining its status as a world-class facility, SAO Director Charles Alcock and ASIAA Director You-Hua Chu directed the SMA team to fully develop the proposal to include a detailed cost- and resource-loaded schedule for presentation and endorsement at the next Governing Board Meeting, to be held in Taipei next fall. In response, I have allocated significant additional funds to enable an immediate start on proposal development and the design and prototyping of critical-path components. More information on the Governing Board Meeting can be found at: **https://www.cfa.harvard.edu/sma/meetings/.**

Ray Blundell

EXTREME FLARING ACTIVITY DURING THE JUNE 2015 OUTBURST OF THE BLACK HOLE X-RAY BINARY V404 CYGNI

A.J. Tetarenko, G.R Sivakoff (University of Alberta), J.C.A. Miller-Jones (Curtin-ICRAR), M.Gurwell & G. Petitpas (CfA), on behalf of a larger X-ray binary collaboration

Black hole X-ray binaries (BHXBs) — the stellar-mass cousins of Active Galactic Nuclei (AGN) — provide ideal laboratories to probe the ubiquitous phenomena of accretion and jet ejection, especially as their rapid evolutionary timescales (typically days to months) allow us to study this process in real time. In particular, data in the mm/sub-mm regime (e.g., [1,2,3]) uniquely probe emission originating close to the black hole, at the base of the relativistic jet in the BHXB. Spectral and variability measurements of this jet emission provide information on the timescales of physical processes occurring in the jet, and constrain the physical conditions in the jet. Although several transient BHXBs may undergo an outburst period every year, only rare (once per decade) outbursts probe the process of accretion and the physics of accretion-fed outflows near (or above) the Eddington limit, the theoretical limit where radiation pressure and gravity balance (assuming a steady-state condition and spherical symmetry), which is essential in understanding jet launching and acceleration mechanisms.

After 26 years of quiescence, the BHXB V404 Cygni entered into one of these rare outburst states on June 15 this year. The source began exhibiting bright multi-wavelength flaring activity immediately following the initial detection of the outburst in X-rays (e.g., [4-11]), and swiftly became the most luminous BHXB outburst seen in the past decade. The chance to study this rare outburst state in V404 Cygni, which is one of the closet known BHXBs (2.39±0.14 kpc from geometric parallax [12]) and has well-determined system parameters [13,14], presented us with a unique opportunity to study jet and accretion physics in unprecedented detail. Thus, we immediately triggered our BHXB monitoring program with the SMA, detecting V404 Cygni for the first time at mm/sub-mm frequencies [15,16,17].

Our first two epochs of SMA observations, which were taken within days of the initial detection of the outburst, show dramatic variability on timescales of minutes (within one epoch) to days (between epochs). On June 16 we measured flux densities at 230 GHz of > 100mJy; the brightest typical BHXB outbursts show flux densities of ~ 5–40 mJy. The following night the flux density dropped to ~ 20 mJy, but varied on the order of 80% within this ~

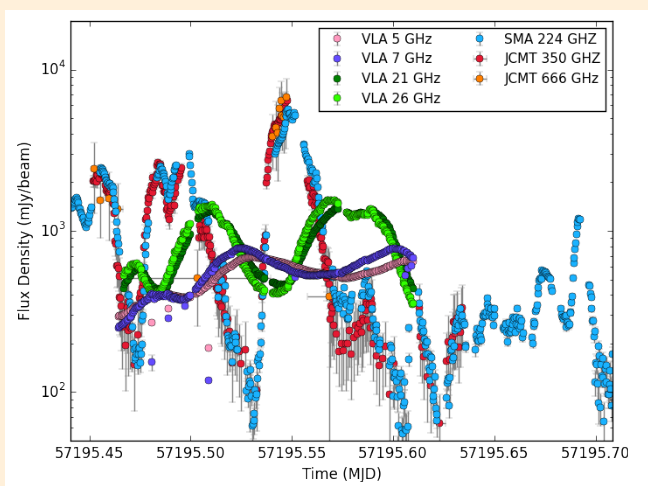

Figure 1: Simultaneous radio and mm/sub-mm light curves of the BHXB V404 Cygni during its June 2015 outburst [16]. The light curves sample the brightest flares at these wavelengths over the entire outburst. Both the VLA and SMA measurements have 30 second time bins. Due to the lower JCMT SCUBA-2 sensitivity during these measurements, an adaptive binning technique is used to ensure at least a 3σ detection in each JCMT SCUBA-2 time bin. The mm/sub-mm regime samples a much more extreme view of the flaring jet than the cm regime. Please note that these are preliminary results only and thus only statistical errors on the fluxes are considered.

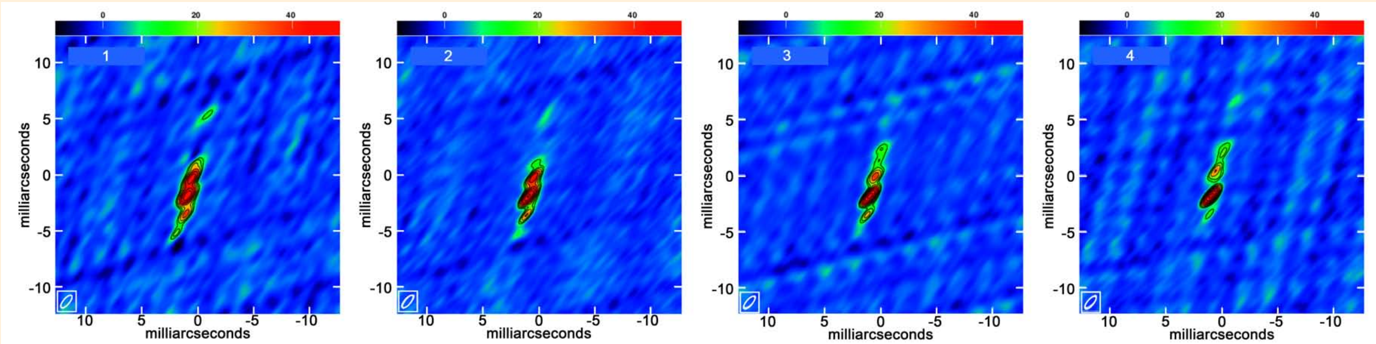

Figure 2: A sample of our VLBA imaging of V404 Cygni during its June 2015 outburst. These data occurred simultaneously with the light curves presented in Figure 1. With the milli-arcsec resolution of the VLBA we are able to directly resolve multiple jet ejection events, and compare these events to the flaring measured by the SMA. Time increases in five minute intervals from Panel 1 to Panel 4. Please note these images contain preliminary results only.

8 hour observation. Combined with quasi- simultaneous VLA radio and JCMT sub-mm observations, the spectral energy distribution (SED) at this time is consistent with optically thin discrete plasma ejections, with higher frequencies having smaller flux densities. Millimetre/sub-millimetre detections of such optically thin discrete ejecta are only possible in the brightest BHXB outbursts. In fact, our program typically targets the steady compact jet state, where flux density is constant or rising with frequency.

While the flux density and extreme variability we saw on June 16 and 17 were extraordinary by themselves, the most striking jet behaviour we observed occurred on the night of June 22, where we coordinated simultaneous radio/mm/sub-mm observations with the VLA, VLBA, SMA, and JCMT. In these data we observed multiple flares reaching Jy levels, which coincided with several plasma ejection events (see Figure 1 & 2). In particular, during the SMA track on June 22, the largest flare rose from ~ 75 mJy up to ~ 6.0 Jy on a timescale of ~ 25 min. This is the largest mm/sub-mm flux ever observed from a BHXB, far surpassing even the brightest ejections in famed micro-quasar, GRS 1915+105 [18]. For synchrotron emitting plasma (see [19] for details), assuming equipartition (although ignoring Doppler (de-) boosting corrections), we estimate that the minimum energy required to produce this SMA flare is $\sim 9 \times 10^{40}$ erg, corresponding to a mean power into the ejection event of $\sim 6 \times 10^{37}$ $ergs^{-1}$, and an equipartition magnetic field strength of 2.5 G.

In these unique simultaneous data sets, the lower frequency emission appears to be a smoothed, delayed version of the high frequency emission, with the flares showing longer rise times at lower frequencies, both a clear signature of optical depth effects playing a major role in the jet. Interestingly, this behaviour is in contrast to bright quasi-periodic oscillation events that have been observed to coincide with jet ejections in GRS 1915+105 (the only other Galactic BHXB to show this multi- wavelength flaring activity), whose amplitudes, rise, and decay times were similar from radio to IR (e.g., [20]). Without our SMA data, interpretation of the synchrotron jet based on radio observations alone would imply a dramatically different view than what the complete data set suggests (Tetarenko et al, 2015, in prep). Through fitting ejection models to our data we have calculated time delays between radio and sub-mm frequencies for the first time in a BHXB. By combining these time delays, variability timescales, and morphology measurements from VLBA data, we plan to place constraints on jet speed and geometry, as well as map out how the jet size scale and structure change with frequency.

Our work has already made it clear that that mm/sub-mm observations of ejection events provide a new perspective on BHXB jets that can not be achieved with radio frequency observations alone. Detailed analysis is ongoing and promises to provide new insights into the underlying physics that drives jet behaviour at this high accretion rate, not only in BHXBs but across the black hole mass and power scale.

The SMA has been a model instrument for transient followup and we extend our sincere thanks to all of the SMA staff who helped us obtain these extraordinary observations, which were instrumental in making this observing campaign a success.

REFERENCE

- [1] Russell, T. D., et al. 2014, MNRAS, 439, 1390;
- [2] van de Horst, A., et al. 2013, MNRAS, 436, 2625;
- [3] Tetarenko, A. J., et al. 2015, ApJ, 805, 30;
- [4] Barthelmy, S.D. et al. 2015, GCN, 17929;
- [5] Gazeas, K. et al. 2015, GCN, 17931;
- [6] Oates, S.R., 2015, GCN, 17933;
- [7] Negoro, H. et al. 2015, ATel, 7646;
- [8] Kuulkers, E. et al. 2015, ATel, 7647;
- [9] Mazaeva, E. et al. 2015, GCN, 17940;
- [10] Gazeas, K. et al. 2015, ATel, 7650;
- [11] Mooley, K. et al. 2015, ATel, 7658;
- [12] Miller-Jones, J.C.A. et al. 2009, ApJ, 706, L230;

- [13] Khargharia, J. et al. 2010, ApJ, 716, 1105;
- [14] Shahbaz, T. et al. 1994, MNRAS, 271, L10;
- [15] Tetarenko, A. et al. 2015, ATel, 7661;
- [16] Tetarenko, A. et al. 2015, ATel, 7708;
- [17] Tetarenko, A. et al. 2015, ATel, 7740;
- [18] Fender & Pooley 2000, MNRAS, 318, L1;
- [19] Fender, R.P. 2006, in Compact Stellar X-ray Sources, Cambridge Astrophysics Series, No.39, 381;
- [20] Mirabel et al 1998, A&A, 330, L9.

A SPIRAL AND BIPOLAR OUTFLOW IN CIT 6: UNWINDING THE MYSTERIES OF A CARBON STAR

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Preplanetary nebulae (pPNe) often consist of outer rings (or arcs) and inner bipolar (or multipolar) structures. The coexistence of such geometrically distinct structures is commonly interpreted as the evidence of the shape transition from spherically-symmetric circumstellar envelopes (CSEs) of asymptotic giant branch (AGB) stars to highly-asymmetric PNe. A binary scenario naturally leads to spiral-shell patterns as imprints of the orbital motions of the AGB star and its companion on the CSEs of the mass-losing systems [1,2,3,4]. The gravitational attraction of gas toward the companion in this picture further facilitates the creation of a circumstellar or circumbinary disk, facilitating the opening of the polar directions for the new vigorous ejection in the PN phase [5,6].

The typical dynamical timescales of the observed ring-like patterns are 100-1000 years, corresponding to the orbital periods of *wide* binary systems with the binary separation of a few tens to hundreds AU. At such a large separation, the perturbation caused by the companion is insufficient to form a circumstellar disk and bipolar outflow. This is inconsistent with the observational results of pPNe.

The group of astronomers led by Dr. Hyosun Kim from Academia Sinica Institute of Astronomy and Astrophysics (ASIAA) in Taiwan used the Submillimeter Array (SMA) to observe the circumstellar envelope of an embedded AGB star, named CIT 6, which has structure that hints at the eccentric orbital motion of a binary system [7]. The new findings by Kim et al. suggest a possibility of that a companion in a highly eccentric orbit and passing through the wind acceleration zone gravitationally focuses the wind material into the form of a circumbinary disk. This provides an environment for the formation of a non-spherical outflow from the system.

The high-resolution map of CO molecular line emission combines data from all possible (subcompact, compact, extended, and very extended) array configurations of the SMA as well as data from the 10-m Submillimeter Telescope of Arizona Radio Observatory

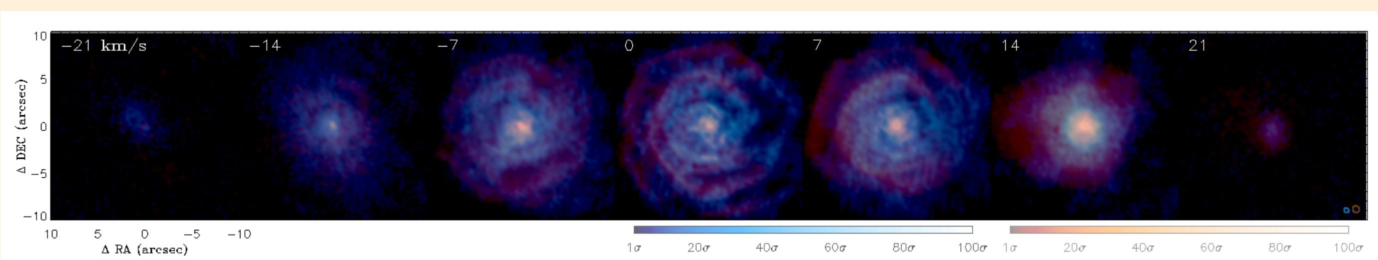
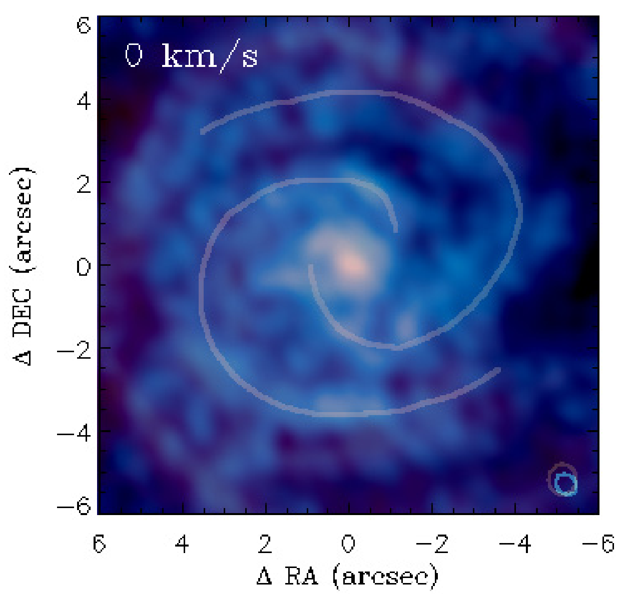


Figure 1: CO J=2-1 emission in CIT 6. The SMA CO J=2-1 channel maps, in blue, are shown atop the VLA HC_3N J=4-3 in red. Each panel displays the channel image averaged over 7 km s^{-1} and is labeled by the channel center velocity with respect to the systemic velocity, V_{LSR}=-2 km s^{-1}. Color bars are scaled by σ=10 mJy $beam^{-1}$ for CO and σ=0.3 mJy $beam^{-1}$ for HC_3N. The CO and HC_3N beam sizes are ~ 0.5 arc second and ~ 0.6 arc second, respectively, as denoted at the bottom right corner.



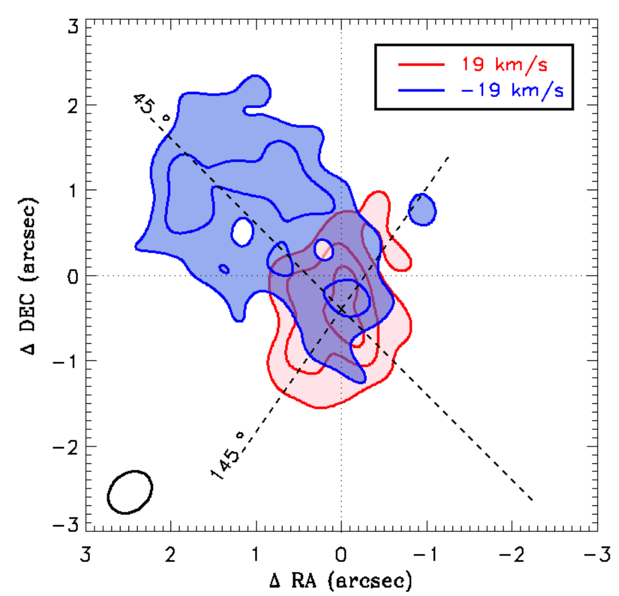


Figure 2 (left): Double spiral feature of CIT 6 at the systemic velocity. Same as the middle panel of Figure 1, but for the central 6 arc second region. **Figure 3 (right): Asymmetric outflow in the innermost region of CIT 6.** CO J=2-1 emission averaged over 3 km s^{-1} width for the channel velocities of -19 km s^{-1} (blue) and 19 km s^{-1} (red). Dashed lines represent the suggested multipolar directions of the observed asymmetric outflow features. The contour levels 8σ, 12σ, and 16σ. The AGB star is located at the coordinate center. The beam is denoted at the bottom left.

to provide excellent image fidelity in spatial scales from ½ to 25 arc seconds. The spiral-shell pattern seen in CO (blue in Figure 1) smoothly connects to the the arc-shaped pattern seen in the HC_3N line emission (red in Figure 1) that was observed earlier with the Very Large Array (VLA) [8]. This connection confirms the early speculation in a parameter space analysis and modeled by a hydrodynamic simulation [9] that the HC_3N segments are an incomplete form of the spiral-shell pattern.

A double spiral feature seen in the inner part of the CO map at the systemic velocity (Figure 2; see also middle panel of Figure 1) and the lack of inter-arm emission seen in CO on the right side (in e.g., the middle panel of Figure 1) hint that the binary orbit has a large eccentricity (Kim et al.). In an eccentric orbit, the speed of orbital motion varies with the location of the star along the orbit, altering the inter-arm gas density particularly in the direction toward the periastron. The absence of inter-arm CO emission on one side closely resembles a wide binary model with a highly eccentric orbit [10]. A double spiral feature is seen in a slow wind model at the locus of the companion [11]. Because of the different pattern propagation speeds, the inner double-spirals are expected to merge within a couple of windings. In CIT 6 this merging occurs at around 4 arc second, leaving the one-armed spiral pattern in the outer part of Figure 1 (middle panel) as traced by both the HC_3N and CO emissions.

The CO emission at velocities slightly higher than the propagation speed of the spiral-shell pattern reveals a highly asymmetric distribution (Figure 3). A multipolar shape is seen in the non-spherical CO outflow, while a bipolar shape was reported in the near-infrared as due to scattered light by CSE dust [12]. The correlation between the gas and dust in the CSE will be examined in a future study.

REFERENCES

- [1] Soker, N. 1994, MNRAS, 270, 774
- [2] Mastrodemos, N., & Morris, M. 1999, ApJ, 523, 357
- [3] Kim, H., & Taam, R. E. 2012a, ApJ, 744, 136
- [4] Kim, H., & Taam, R. E. 2012b, ApJ, 759, 59
- [5] Balick, B., & Frank, A. 2002, ARA&A, 40, 439
- [6] Sahai, R., Morris, M., et al. 2007, AJ, 134, 2200
- [7] Kim, H., Liu, S.-Y., et al. 2015, ApJ, 814, 61
- [8] Claussen, M. J., Sjouwerman, L. O., et al. 2011, ApJL, 739, L5
- [9] Kim, H., Hsieh, I-T., et al. 2013, ApJ, 776, 86
- [10] He, J. H. 2007, A&A, 467, 1081
- [11] Mohamed, S., & Podsiadlowski, P. 2012, Baltic Astronomy, 21, 88
- [12] Schmidt, G. D., Hines, D. C., & Swift, S. 2002, ApJ, 576, 429

PLANCK'S DUST GEMS WITH THE SMA – MAPPING INDIVIDUAL STAR FORMING REGIONS IN THE BRIGHTEST, GRAVITATIONALLY LENSED HIGH-REDSHIFT GALAXIES

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The brightest, most strongly gravitationally lensed sub-mm galaxies in the sky are veritable gems for studying intense star formation in the early Universe. In the most fortuitous cases massive individual galaxies and galaxy groups or clusters at intermediate redshifts boost the line and continuum fluxes by an order of magnitude or more, which enables us to study the resolved properties of individual star-forming regions on scales well below 100 pc. At these scales the gas stability is no longer dominated by rotational support (Toomre 1964, Escala & Larson 2010) and local processes like powerful winds driven by star formation, AGN activity, turbulence, and cosmic ray heating likely prevail (e.g., Swinbank et al. 2011, Lehnert et al. 2013, Papadopoulos et al. 2010). However, there are many things that we do not know about high-z star-forming galaxies. These gems may allow us to answer several questions including "What processes govern high-z star formation on these small scales, and over what timescales?" and "Does the Schmidt-Kennicutt law hold, and is there a genuine *high-z star-formation law?*" (e.g., Daddi et al. 2010, Genzel et al. 2010)

Addressing these questions is particularly interesting in the case of the most massive, most vigorously star-forming galaxies selected for their bright far-infrared and sub-mm continuum emission from dust heated by star formation (and potentially active galactic nuclei). With star formation rates orders of magnitude higher than in the Milky Way (up to 1000 $M_s\ yr^{-1}$) these galaxies have no peer in the local Universe. Although sub-mm surveys of high-redshift galaxies have taken advantage of more moderate levels of magnification by gravitational lenses for almost two decades (e.g., Smail et al. 1997), only in the last few years have Herschel Space Observatory and the South Pole Telescope have mapped large enough areas on the sky to allow the discovery of bright, strongly lensed galaxies at high redshift with FIR fluxes ~100-300 mJy (e.g., Negrello et al. 2010, Vieira et al. 2013, Bussmann et al. 2013). But even these wide-field surveys did not have enough sky coverage to identify the brightest gravitational lenses on the sky in a systematic way. Such galaxies are extremely rare, with number densities below 10^{-2} deg^{-2} (Negrello et al. 2010, Planck Collaboration 2015a).

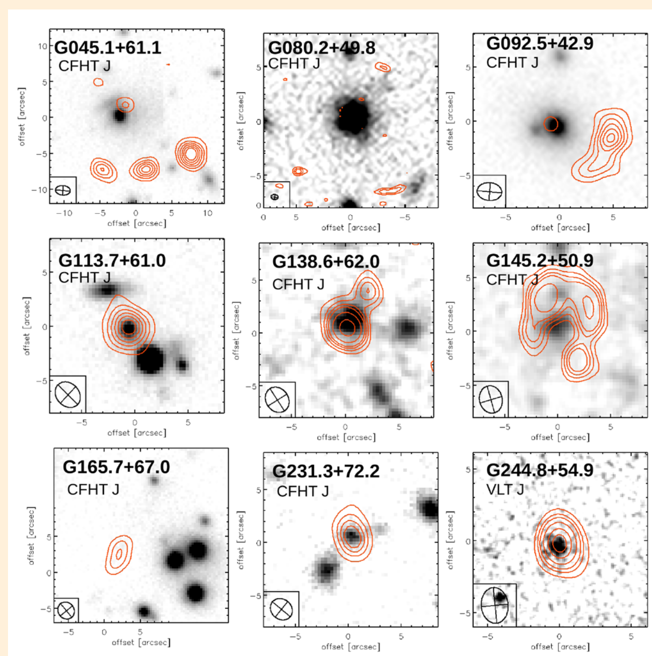

Figure 1: SMA 850 μm maps (red contours) taken in the compact configuration of 9 of our galaxies overlaid on the near-infrared J-band maps of their foreground structures taken at the CFHT. The SMA beam is shown in the lower left corner.

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We have used the Planck sub-millimeter all-sky survey to search for the brightest high-redshift galaxy candidates on the ~50% of sky that is not dominated by galactic foregrounds. Planck has mapped the sky at six frequencies between 100 and 857 GHz with a 5' beam and down to a 90% completeness limit of about 600 mJy at the highest frequencies. We used the S_{857}/S_{545} and S_{217}/S_{w} colors to identify high-redshift galaxy candidates (Planck Collaboration 2015a). Their redshifted far-infrared peak and Rayleigh-Jeans tail of the dust continuum heated by star formation is expected to fall into this frequency range for redshifts z~2-6. About 240 galaxies selected from the Planck candidate list were subsequently followed-up with Herschel/SPIRE imaging at 250, 350, and 500 µm (Planck Collaboration, 2015). We considered the 11 isolated point sources in the ~20c SPIRE beam at 250 µm with fluxes S_{350} ≥ 300 mJy and up to 1034 mJy at 350 µm as strong gravitational lensing candidates – Planck's Dusty Gravitationally Enhanced sub-Millimeter Sources (GEMS). All are in little explored regions of the sky. We therefore started a broad follow-up observing program including SMA 850 µm mapping in several configurations, IRAM and ALMA single-dish and interferometry CO measurements, optical imaging and spectroscopy with HST, CFHT, VLT, and Gemini which will allow us to characterize their gas, dust, stellar, and star-formation properties while further constraining their lensing configurations.

Figure 1 shows the SMA 850 µm maps taken in the compact configuration for nine of our galaxies overlaid on the near-infrared J-band CFHT images of their foreground structures. Dust morphologies range from bright, compact sources in the 2″ beam of our SMA observations to multiple sources, and extended arcs with lengths of up to 17″ (Canameras et al. 2015). The morphologies seen in these maps have been central for demonstrating that these are indeed strongly gravitationally lensed galaxies. All sources are associated with bright foreground objects, either massive individual galaxies at intermediate redshifts or clusters of multiple galaxies. All have spectroscopic redshifts z=2.2-3.6 obtained in a blind redshift search at the IRAM 30-m telescope. Their infrared-to millimeter spectral energy distributions (SEDs) show infrared luminosities of up to $2\times10^{14}\ M^{-1}\ L_{\odot}$ (with the gravitational magnification factor M) strongly dominated by star formation. The faint fluxes seen in the Herschel/SPIRE 250 µm images as well as in the WISE and IRAS all-sky surveys constrain the possible AGN contribution to powering the dust emission to at most 10%. Their integrated emission shows that all GEMS fall above the 'main sequence' of high-redshift galaxies having 'ordinary' star formation, and into the regime of particularly vigorously star-forming 'starburst' galaxies. About half of the GEMS galaxies follow the far-infrared/radio correlation for low-redshift galaxies while a few have brighter radio emission, possibly due to weak nuclear radio activity or particularly young starburst ages. Detailed on-going lens modeling with LENSTOOL and other algorithms imply magnification factors of up to 20. That all GEMS are gravitationally magnified with average magnification factors 10 and greater is also suggested by several empirical measures including their FIR luminosities, which are too bright for their dust temperatures and redshift when compared to high-z galaxies in the field (Figure 2).

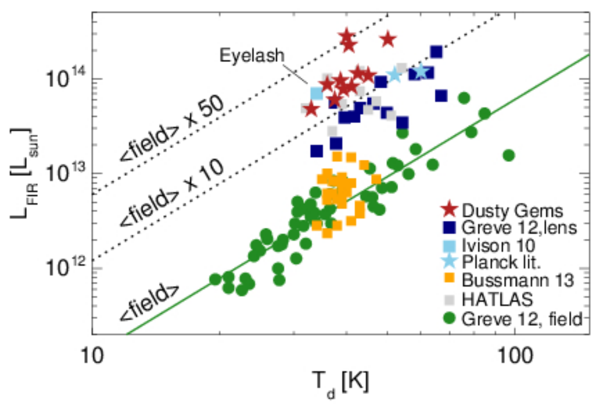


Figure 2: Infrared luminosity compared to dust temperature for this sample compared to previous studies. GEMS sources fall above the 'main sequence' of high-redshift galaxies with 'ordinary' star formation, and into the regime of particularly vigorously star-forming 'starburst' galaxies.

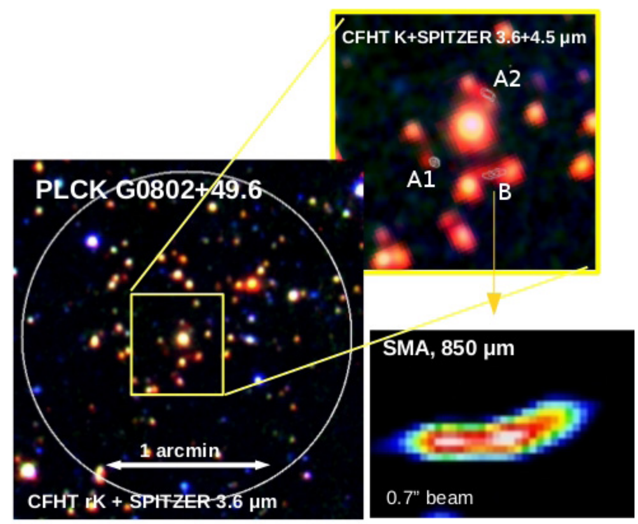


Figure 3: High resolution SMA (EXT) 850 µm map of PLCK G080.2+49.8.. We resolve this source into two interacting galaxies at a common redshift of z=2.6, which are magnified by a group or small galaxy cluster at z~0.7. The upper right panels shows the SMA contours in white overlaid on the composite CFHT+Spitzer image. The lower right panel is a closeup of the SMA data only.

We are currently complementing our initial COM observations of all targets through EXT and VEX mapping to analyze their spatially resolved properties. Figure 3 shows the EXT 850 µm map of PLCK G080.2+49.8 (the "Malachite") observed at 0.7″ resolution. The SMA observations show that this galaxy is actually comprised of two interacting galaxies at a common redshift of z=2.6 which are magnified by a group or small galaxy cluster at z~0.7. The two images of component A (the SMA point sources in the upper right panel of Figure 3) have moderate magnification factors M=3-4 and are intrinsically very luminous with a star-formation rate of about 600 $M_{\odot}$ yr^{-1}. Line profiles from IRAM show two broad line components with a relative velocity offset of 400 km s^{-1} suggesting these are two overlapping components of a merger of two massive star-forming galaxies. The extended arc B (lower right panel of Figure 3) consists of two images straddling the critical line of the lensing potential and folded back onto itself, and exhibits much more moderate star formation intensities of only few 10s of solar masses per year, with more narrow line widths below FWHM~150 km s^{-1}. The lensing model suggests it is about 10-20 kpc away from the merger (albeit at the same redshift) and is therefore likely a separate galaxy, but part of the same system. In Figure 4 we show an example of our VEX data for the brightest GEMS, PLCK G244.8+54.9 (a.k.a. "the Ruby") at z=3.0. This is a small partial Einstein ring with a diameter of 1.5" around a single distant galaxy with a mass of few times 10^{11} $M_{\odot}$. Most of the dust emission in this galaxy comes from a small knot in the southern part of the ring, which is at most marginally resolved in the 0.3″ beam of our data and has an intrinsic size of about 130 pc in the source plane. This suggests a very high star-formation intensity in this knot of about 20000 $M_{\odot}$ yr^{-1} kpc^{-2}. We are currently awaiting detailed ALMA CO mapping of this source to confirm that this is indeed a single knot forming stars at the maximally allowed intensity implied by the Eddington limit. Using these ALMA observations we will be able to further study the mechanisms that limit the star formation in one of the extreme star-forming objects in the Universe.

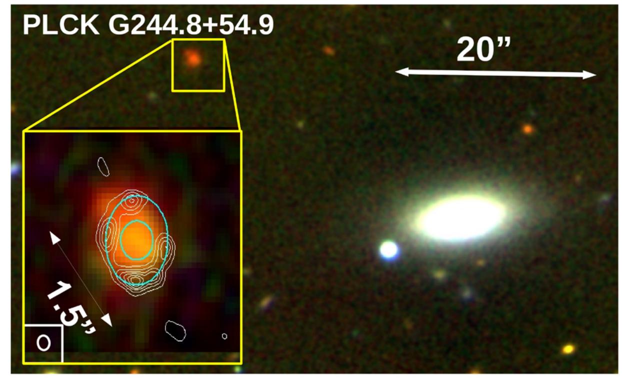


Figure 4: Very high resolution (0.3”) SMA observations (VEX) of PLCK G244.8+54.9 (the Ruby) at z=3.0. This is a small partial Einstein ring with a diameter of 1.5” around a single distant galaxy with a mass of few times 10^{11} $M_{\odot}$. The blue lines are the inner and outer critical lines of the lens potential. The SMA beam is shown in the lower left.

REFERENCES

- Bussmann et al. (2013), ApJ 779, 25
- Canameras et al. (2015) A&A 581, 105
- Daddi et al. (2010) ApJ 714, L118
- Escala & Larson (2008) ApJ 685, L31
- Genzel et al. (2010) MNRAS 407, 2091
- Lehnert et al. (2013), A&A 555,72
- Negrello et al. (2010), Science, 330, 800
- Papadopoulos et al. (2010) ApJ 720, 226
- Planck Collaboration (2015a) A&A submitted, astro-ph / 1508.04171
- Planck Collaboration (2015b) A&A 582, 30
- Smail et al. (1997), ApJS 110, 213
- Swinbank et al. (2011) ApJ 472, 11
- Toomre (1964) ApJ 139, 1217
- Vieira et al. (2013), Nature, 495, 344

WIDEBAND UPGRADE TO IF SIGNAL PROCESSING SYSTEM

ASIAA-SMA IF/LO TEAM

An upgrade to the SMA's IF signal processing system is nearly complete. The improvements are a subset of hardware changes made to the SMA to increase the available IF bandwidth from 4 - 8 GHz to 4 - 12 GHz. The changes to the IF system coincide with bandwidth improvements made to the SMA receiver assemblies as well as the addition of the SWARM correlator which has dramatically increased the signal processing capability of the digital back end.

The hardware changes included upgrades to the bandwidth doubling assemblies (BDAs), antenna IF enclosures and first downconverter assemblies as well as the addition of 4 new block downconverter drawers, new wideband continuum detectors, LO and ADC clock generator drawers and a new noise generator drawer. The upgrades required hardware modifications to 44 IF assemblies and the addition of 14 new hardware assemblies. Control and monitoring software for the 4 new block downconverter drawers has been developed and integrated into the array control software.

Each antenna has two IF assemblies that were originally designed to process an IF band of 4 - 6 GHz. Bandwidth doubling assemblies were installed in 2009 that were designed to take advantage of the rarely used high frequency receiver IF path. In bandwidth doubling mode the IF signal from a single receiver is split. One output is passed to a down converting mixer using an LO generated from the antenna YIG assembly normally used as a Gunn oscillator locking reference for the high frequency receiver. This down conversion maps the 6 - 8 GHz portion of IF from the receiver into the 4 - 6 GHz band which is then transmitted back to the first downconverters through the high frequency receiver IF path. The second output is transmitted directly through the low frequency receiver IF path with no additional down conversion. This technique allowed the SMA to process 4 - 8 GHz taking advantage of the full complement of first and second downconverters and the legacy ASIC correlator hardware.

Additional digital signal processing capacity provided by the installation of SWARM correlator hardware, allowed the SMA to increase the available IF bandwidth from 4 - 8 GHz to 4 - 12 GHz. The 4 - 8 GHz portion of the band is processed by the legacy correlator, as before, using the bandwidth doubling assemblies. The extended 8 - 12 GHz band is processed by the SWARM correlator.

Passing 4 - 12 GHz through the bandwidth doubling assemblies and the IF enclosures was accomplished by replacing the 4 - 6 GHz bandwidth limiting components with wideband parts. With the exception of the fiber optic transmitters, located in the antenna IF enclosures, and the fiber optic receivers, located in the first downconverters, all IF components have been upgraded with wideband components with a specified bandwidth of 2 to 18 GHz.

Processing the portion of the IF band above 8 GHz with SWARM hardware required the addition of new block downconverters. These assemblies down convert the 8 - 12 GHz IF band to baseband. The installation of the 8 - 12 GHz BDC drawers was completed in the fall of 2014. The new 8 - 12 GHz BDC drawers can process either the full 8 - 12 GHz from a single receiver or the 8 - 10 GHz band from 2 receivers. To transmit the wideband IF to these block downconverters additional components have been added to the existing first downconverters which, in addition to passing the IF signal to the legacy down converting hardware, pass the signal to the new BDC assemblies.

The addition of a second quadrant of SWARM hardware brought the DBE closer to the goal of processing the entire 4 - 12 GHz IF band with SWARM. Preprocessing the IF for the new digital hardware required addition of block downconverter drawers that could convert the 4 – 8 GHz band to baseband. Two sets of drawers which map the 4 - 8 GHz band of the IF into two 2 GHz wide baseband blocks were designed and have been installed at the summit. They can process all 16 of the antenna receiver IFs and pass 32 baseband blocks to the SWARM DBE.

A new LO generator and distribution drawer was designed to provide the down converting LOs for the 8 – 12 GHz block downconverter drawer. We have added an ADC clock generation-distribution assembly which provides the clock signals for the analog to digital converters in the ROACH2 assemblies used in SWARM.

Wideband continuum detector assemblies designed to measure the IF power across the 4 to 12 GHz band have been installed in antennas 1 and 8. Spectral power data from these detectors is currently being written to reflective memory. The reflective memory variables report the power in 10 spectral channels across the 4 - 12 GHz IF band. For now only the low frequency IF channels for antennas 1 and 8 are writing valid data. The spectral power data can be retrieved from the engineering data plotter using the rm variables:

RM_CONT_SPEC_CHAN1_V10_F
for the low frequency IF channel

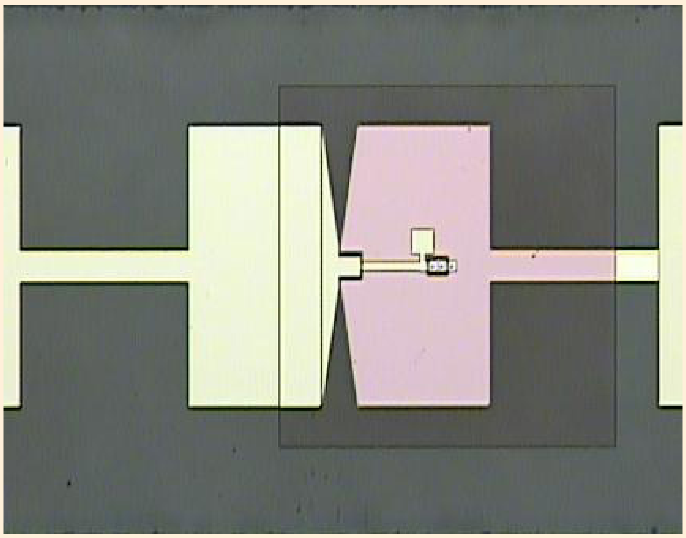
RM_CONT_SPEC_CHAN2_V10_F
for the high frequency channel.

An upgrade to the noise distribution system is in process with the purpose of providing a wideband correlated noise signal for use in calibration of the analog to digital converters used in the SWARM correlator. A common 2 – 18 GHz noise signal is transmitted to all 16 first downconverters. The noise is then injected into the 32 IF inputs of the new block downconverter drawers. These drawers down convert the noise to baseband which is passed to the analog to digital converters in the ROACH2 assemblies. When complete, this system will enable remote calibration and characterization of the ADCs used by the SWARM correlator.

In order to expand beyond the 12 GHz maximum IF frequency limit the signal processing system will require an upgrade to the fiber optic system. The existing Emcore transmitter/receiver sets are specified to 10 GHz but are transmitting the full IF band producing about 2 dB of roll off from 10 – 12 GHz. We are investigating replacement fiber optic transceivers which are currently available with maximum operating frequencies as high as 40 GHz.

NEW 240 GHZ RECEIVER FOR THE SMA

C-Y. Edward Tong, Paul Grimes and Patrick S. Leiker



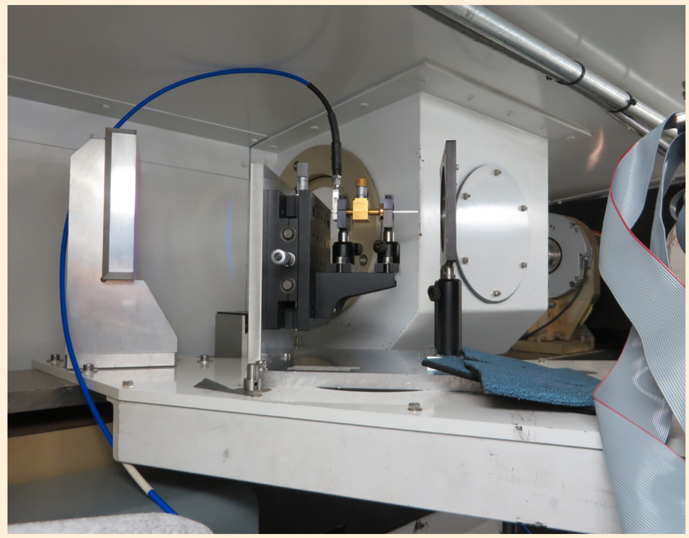


Figure 1 (left): Superconductor-Insulator-Superconductor (SIS) mixer chip used in the 240 GHz receiver. **Figure 2 (right):** Compact scanner used to perform in-situ co-alignment of the new 240 GHz receiver with the existing 200 GHz receiver.

Over the past few years, the Submillimeter Array (SMA) has offered 3 receiver bands for observation: the 200 GHz receiver covers 200 – 245 GHz; the 300 GHz receiver covers 260 – 350 GHz; and the 400 GHz receiver covers 330 – 420 GHz. While the SIS mixers at the heart of these receivers can be operated over much wider bandwidth, the above listed useful bandwidth is limited by the common overlap in tuning ranges among the various Gunn oscillator based local oscillators driving the individual receivers in each antenna of the SMA.

Starting in 2016, a new 240 GHz receiver band (SMA-240) will be introduced. This new 240 GHz receiver is driven by a YIG-based Local Oscillator (LO) which is continuously tunable between 210 and 270 GHz. The design of the LO module has been described in the January 2015 edition of the *SMA Newsletter*, **"Development of YIG-Based Local Oscillator Module for the SMA."** The new receiver is part of the wideband upgrade effort of the SMA. It offers an IF covering 4 – 12 GHz. As a result, the SMA-240 receiver can be tuned to receive any sky frequency covering 198 – 282 GHz.

The Superconductor-Insulator-Superconductor (SIS) mixer at the heart of this new receiver is a scaled version of other SMA receivers, and the mixer employs 3 SIS junctions connected in series. The mixer chips were fabricated at ASIAA. A photo of the mixer chip is shown in Fig. 1. The laboratory performance of this new receiver is comparable to that of the SMA-200 receiver already in operation. Including all the SMA receiver optics, typical receiver noise temperatures of 40 – 50 K are achieved across the whole receiver bandwidth.

As of the end of December, 6 out of 8 SMA antennas have been equipped with the new receiver. A commissioning phase is currently in progress. One key mission of the SMA-240 receiver is to operate in conjunction with the SMA-200 receiver to provide dual polarization observations. It is therefore important that the beams from the two receivers are co-aligned. The initial align-

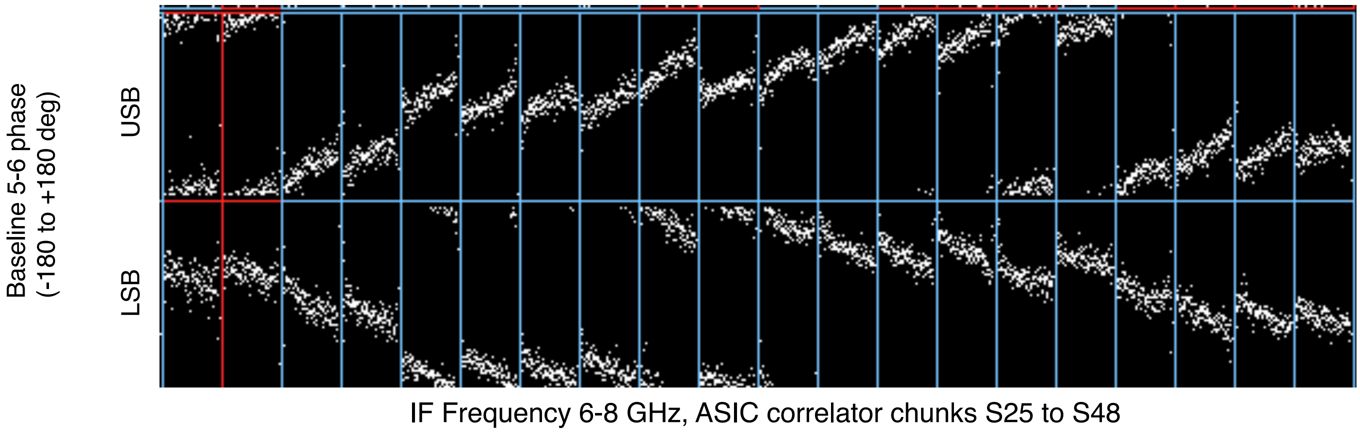


Figure 3: First-light fringes of the 240 GHz receiver. The fringes were recorded on the antenna 5 - 6 baseline while observing Venus at an LO frequency of 225.53 GHz.

ment is being performed with a compact scanner built around a multiplied noise source to perform in situ amplitude beam mapping of the two receivers at the first focal plane of the SMA optics train. A photo of the scanner is shown in Fig. 2.

On Dec. 11, we conducted a simple first light fringe test of the new receiver, with a pair of receivers installed in antennas 5 and 6. The LO frequency used was 225.53 GHz, and the antennas were sent to point at Venus. Fig. 3 shows the strong fringes obtained by the ASIC correlator on the 5-6 baseline.

We expect that the remaining 2 antennas will be fitted with the new receiver by March 2016, and the SMA-240 receiver band will be available for routine scientific observation in semester 2016-A.

CALL FOR SMA SCIENCE OBSERVING PROPOSALS

The joint CfA-ASIAA SMA Time Allocation Committee (TAC) solicits proposals for observations for the period May 16, 2016 - Nov 15, 2016 (2016A semester). The deadline for submitting proposals is Feb 4, 2016.

The SMA Observer Center website:

http://sma1.sma.hawaii.edu

is expected to open for proposal submission on Jan. 15 2016.

SIMON RADFORD JOINS SMA AS DIRECTOR OF HAWAII OPERATIONS

Simon Radford will join the SMA in January as Director of Hawaii Operations in Hilo. Most recently, he was a Member of the Professional Staff at the California Institute of Technology, where he has been Technical Manager of the Caltech Submillimeter Observatory on Maunakea since 2010. At Caltech he also managed deployment and operations for QUIET on the Chajnantor plateau and conducted site evaluation for CCAT on Cerro Chajnantor.

Previously, he was a staff astronomer at the National Radio Astronomy Observatory in Tucson, Arizona, where he managed site development for the Atacama Large Millimeter Array and conducted site exploration and evaluation on the Chajnantor plateau and elsewhere, and an astronomer at the Insitute de Radioastronomie Millimetrique in Grenoble, France, where he participated in the commissioning of the interferometer and observed distant galaxies with the 30 m telescope on Pico Veleta.

He received his B. S. in Engineering Physics from Cornell University and his M. S. and Ph. D. in Astronomy at the University of Washington. His research has included observations of the cosmic background radiation, spectroscopy of molecular gas in starburst galaxies, characterization of atmospheric conditions at submillimeter observing sites, and development of telescopes and instrumentation.

PROPOSAL STATISTICS 2015B (16 NOV 2015 - 15 MAY 2016)

The SMA received a total of 82 proposals (SAO 65) requesting observing time in the 2015B 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	24
local galaxies, starbursts, AGN	17
high mass (OB) star formation, cores	12
submm/hi-z galaxies	9
evolved stars, AGB, PPN	7
GRB, SN, high energy	4
protoplanetary, transition, debris disks	4
other	2
solar system	2
galactic center	1

TRACK ALLOCATIONS BY WEATHER REQUIREMENT (ALL PARTNERS):

PWV[1]	SAO	ASIAA
< 4.0mm	9A + 13B	10A + 7B
< 2.5mm	24A + 28B	0A + 4B
< 1.0mm	1A + 0B	0A + 2B
Total	**34A + 41B**	**10A + 13B**

(1) Precipitable water vapor required for the observations.

TOP-RANKED SAO AND ASIAA PROPOSALS – 2015B SEMESTER

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

EVOLVED STARS, AGB, PPN

Josep Miquel Girart, Harvard-Smithsonian Center for Astrophysics & Institut de Ciències de l'Espai (CSIC-IEEC)
Magnetic field in the expanding envelope of a Supernova precursor

Nimesh Patel, CfA, SMA
Chemical Evolution from AGB to PPN: A Spectral-line Survey of CRL 618 (copied from 2013B-S010)

GALACTIC CENTER

Dan Marrone, University of Arizona
Tracking Accretion onto Sagittarius A with SMA Polarimetry*

GRB, SN, HIGH ENERGY

Alexandra Tetarenko, University of Alberta
Constraining the Jet Properties of Transient X-ray Binaries

Atish Kamble, Harvard-Smithsonian Center for Astrophysics
The Unprecedented Metamorphosis of Supernova 2014C: from a Hydrogen-stripped to a Strongly Interacting Supernova (copied from 2015A-S028)

Yuji Urata, NCU/ASIAA
Search for Bright submm afterglows Associated with Gamma-Ray Bursts

HIGH MASS (OB) STAR FORMATION, CORES

Josep Miquel Girart, Harvard-Smithsonian Center for Astrophysics & Institut de Ciències de l'Espai (CSIC-IEEC)
Connecting magnetic fields from cores to disks

Xing Lu, Harvard-Smithsonian CfA
High-mass Star Formation in Dense Cores Embedded in Filaments

LOCAL GALAXIES, STARBURSTS, AGN

Geoffrey Bower, ASIAA
Variability Timescale of Low Luminosity AGN

Niklas Falstad, Chalmers University of Technology
Zw 049.057 - a greenhouse IR galaxy?

Sheperd Doeleman, SAO
Polarimetric VLBI with the Event Horizon Telescope

LOW/INTERMEDIATE MASS STAR FORMATION, CORES

John Tobin, Leiden Observatory
Confirming a Rotationally-Supported Disk Around the Class 0 protostar BHR7

L. Ilsedore Cleeves, Smithsonian Astrophysical Observatory
Confirming Structure in the TW Hya Protoplanetary Disk

Shigehisa Takakuwa, ASIAA
SMA Study of the Envelope Gas Motions surrounding the Planet-Forming Disk in HL Tau

OTHER

Marina Kounkel, University of Michigan
Search for thermal component of non-thermally radio emitting disk

PROTOPLANETARY, TRANSITION, DEBRIS DISKS

Charlie Qi, CfA
A search for the CO snow line in the HL Tau disk

Luca Matrà, Institute of Astronomy, University of Cambridge
Probing the exocometary HCN/CO ice composition around beta Pictoris

Luca Ricci, CfA
An SMA survey of protoplanetary disks in Serpens

SOLAR SYSTEM

Mark Gurwell, Harvard-Smithsonian Center for Astrophysics
Full Polarization Thermal Mapping of Ganymede and Callisto

SUBMM/HI-Z GALAXIES

Scott Chapman, Dalhousie University
Locating the bright submillimeter galaxy population with SMA in SCUBA-2 CLS fields

ALL SAO PROPOSALS - 2015A SEMESTER

The following is the listing of all SAO proposals observed in the 2015A semester (16 May 2015 – 15 Nov 2015)

Scott Chapman, Dalhousie University
Locating the bright submillimeter galaxy population with SMA in northern SCUBA-2 CLS fields

Vivien Huei-Ru Chen, National Tsing Hua University
Are Dense Clumps in M17 SWex Nurturing O Stars?

Timea Csengeri, Max-Planck-Institut fuer Radioastronomie
Peering into the dark: revealing the youngest massive protostars and their mass assembly process

Nanase Harada, ASIAA
Tracing Timescales of Starburst using Molecules

Naomi Hirano, ASIAA
ASIAA Summer Students' Project 2015

Li-Yen Hsu, Institute for Astronomy, University of Hawaii
Characterizing faint submm galaxies with cluster lensing

Carmen Juarez, Institut de CiËncies de l'Espai CSIC-IEEC
Assessing the role of magnetic fields in a filament with super-Jeans fragmention

Atish Kamble, CfA
The Unprecedented Metamorphosis of Supernova 2014C: from a Hydrogen-stripped to a Strongly Interacting Supernova

Joel Kastner, Center for Imaging Science, Rochester Institute of Technology
Imaging Molecular Emission Rings in Nearby Protoplanetary Disks

Lars Kristensen, CfA
Hot water with the SMA: a unique view of disks and winds in embedded low-mass protostars

Sheng-Yuan Liu, ASIAA
Shock Interaction between Supernova Remnant and Molecular Clouds - A Unique Case Study of W51 B/C

Wen-Ping Lo, ASIAA
Mass Accretion Rate onto the SMBH of Cyg A with mm/submm polarimetry

Xing Lu, CfA
Deeply Embedded Protostars in the Central Molecular Zone

Michael McCollough, Smithsonian Astrophysical Observatory
Cygnus X-3's Little Friend: Confirming the nature of the most distant observed Bok Globule (copied from 2014A-S050)

Nimesh Patel, CfA, SMA
Triggered Star Formation in the Bright Rimmed Globule IC1396A

Charlie Qi, CfA
A search for the CO snow line in the HL Tau disk

Keping Qiu, School of Astronomy and Space Science, Nanjing University
Survey of Cygnus-X star forming complex

Luca Ricci, CfA
A Census of Circumstellar Disks in Ophiuchus

Ian Stephens, Boston University
Mapping Line Polarization in L1157

Shaye Storm, University of Maryland
Kinematic Signatures of Filament Formation: In Search of Gradients

Kate Su, University of Arizona; ASIAA
Searching for Cold Dust around Extreme Debris Disks -- Sites for Active Terrestrial Planet Building/Destruction

John Tobin, Leiden Observatory
Characterizing the Chemical Impact of Episodic Accretion

Jonathan Williams, Institute for Astronomy, University of Hawaii
A deep search for leftover material from rapid planet formation

Jonathan Williams, Institute for Astronomy, University of Hawaii
Imaging debris disk structure with the SMA

Hsi-Wei Yen, ASIAA
From Large-Scale Gas Motions to Star Formation in Individual Dense Cores in L1455

Hsi-Wei Yen, ASIAA
Testing Magnetic Braking in the Class 0 Protostar B335

Qizhou Zhang, CfA
Role of Magnetic Fields in the Early Phase of Massive Star Formation

RECENT PUBLICATIONS

Title: Peculiar Near-nucleus Outgassing of Comet 17P/Holmes during its 2007 Outburst
Authors: Qi, Chunhua; Hogerheijde, Michiel R.; Jewitt, David; Gurwell, Mark A.; Wilner, David J.
Publication: *The Astrophysical Journal, Volume 799, Issue 1, article id. 110, 11 pp. (2015). (ApJ Homepage)*
Publication Date: 01/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...799..110Q

Title: Witness of gas infall and outflow in the young starburst dwarf galaxy NGC 5253
Authors: Miura, Rie E.; Espada, Daniel; Sugai, Hajime; Nakanishi, Kouichiro; Hirota, Akihiko
Publication: *Publications of the Astronomical Society of Japan, Volume 67, Issue 1, id.L16 pp. (OUP Homepage)*
Publication Date: 02/2015
Abstract: http://adsabs.harvard.edu/abs/2015PASJ...67L...1

Title: Discovery of SiCSi in IRC+10216: A Missing Link between Gas and Dust Carriers of Si&ndashC Bonds
Authors: Cernicharo, J.; McCarthy, M. C.; Gottlieb, C. A.; Agúndez, M.; Velilla Prieto, L.; Baraban, J. H.; Changala, P. B.; Guélin, M.; Kahane, C.; Martin-Drumel, M. A.; Patel, N. A.; Reilly, N. J.; Stanton, J. F.; Quintana-Lacaci, G.; Thorwirth, S.; Young, K. H.
Publication: *The Astrophysical Journal Letters, Volume 806, Issue 1, article id. L3, 6 pp. (2015). (ApJL Homepage)*
Publication Date: 06/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...806L...3C

Title: A SCUBA-2 850-micron Survey of Circumstellar Disks in the the λ Orionis Cluster
Authors: Ansdell, Megan; Williams, Jonathan P.; Cieza, Lucas A.
Publication: *The Astrophysical Journal, Volume 806, Issue 2, article id. 221, 9 pp. (2015). (ApJ Homepage)*
Publication Date: 06/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...806..221A

Title: Planck's Dusty GEMS: Gravitationally lensed high-redshift galaxies discovered with the Planck survey
Authors: Canameras, R.; Nesvadba, N. P. H.; Guery, D.; McKenzie, T.; Koenig, S.; Petitpas, G.; Dole, H.; Frye, B.; Flores-Cacho, I.; Montier, L.; Negrello, M.; Beelen, A.; Boone, F.; Dicken, D.; Lagache, G.; Le Floch, E.; Altieri, B.; Bethermin, M.; Chary, R.; De Zotti, G.; Giard, M.; Kneissl, R.; Krips, M.; Malhotra, S.; Martinache, C.; Omont, A.; Pointecouteau, E.; Puget, J.-L.; Scott, D.; Soucail, G.; Valtchanov, I.; Welikala, N.; Yan, L.
Publication: *eprint arXiv:1506.01962*
Publication Date: 06/2015
Abstract: http://adsabs.harvard.edu/abs/2015arXiv150601962C

Title: HNC in Protoplanetary Disks
Authors: Graninger, Dawn; Öberg, Karin I.; Qi, Chunhua; Kastner, Joel
Publication: *The Astrophysical Journal Letters, Volume 807, Issue 1, article id. L15, 5 pp. (2015). (ApJL Homepage)*
Publication Date: 07/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...807L..15G

Title: The Transitional Disk around IRAS 04125+2902
Authors: Espaillat, C.; Andrews, S.; Powell, D.; Feldman, D.; Qi, C.; Wilner, D.; D'Alessio, P.
Publication: *The Astrophysical Journal, Volume 807, Issue 2, article id. 156, 8 pp. (2015). (ApJ Homepage)*
Publication Date: 07/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...807..156E

Title: Signatures of Young Star Formation Activity within Two Parsecs of Sgr A*
Authors: Yusef-Zadeh, F.; Wardle, M.; Sewilo, M.; Roberts, D. A.; Smith, I.; Arendt, R.; Cotton, W.; Lacy, J.; Martin, S.; Pound, M. W.; Rickert, M.; Royster, M.
Publication: *The Astrophysical Journal, Volume 808, Issue 1, article id. 97, 18 pp. (2015). (ApJ Homepage)*
Publication Date: 07/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...808...97Y

Title: 230 GHz VLBI Observations of M87: Event-horizon-scale Structure during an Enhanced Very-high-energy to γ-Rays State in 2012
Authors: Akiyama, Kazunori; Lu, Ru-Sen; Fish, Vincent L.; Doeleman, Sheperd S.; Broderick, Avery E.; Dexter, Jason; Hada, Kazuhiro; Kino, Motoki; Nagai, Hiroshi; Honma, Mareki; Johnson, Michael D.; Algaba, Juan C.; Asada, Keiichi; Brinkerink, Christiaan; Blundell, Ray; Bower, Geoffrey C.; Cappallo, Roger; Crew, Geoffrey B.; Dexter, Matt; Dzib, Sergio A.; Freund, Robert; Friberg, Per; Gurwell, Mark; Ho, Paul T. P.; Inoue, Makoto; Krichbaum, Thomas P.; Loinard, Laurent; MacMahon, David; Marrone, Daniel P.; Moran, James M.; Nakamura, Masanori; Nagar, Neil M.; Ortiz-Leon, Gisela; Plambeck, Richard; Pradel, Nicolas; Primiani, Rurik A.; Rogers, Alan E. E.; Roy, Alan L.; SooHoo, Jason; Tavares, Jonathan-Le√≥n; Tilanus, Remo P. J.; Titus, Michael; Wagner, Jan; Weintroub, Jonathan; Yamaguchi, Paul; Young, Ken H.; Zensus, Anton; Ziurys, Lucy M.
Publication: *The Astrophysical Journal, Volume 807, Issue 2, article id. 150, 11 pp. (2015). (ApJ Homepage)*
Publication Date: 07/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...807..150A

Title: Multiwavelength behaviour of the blazar OJ 248 from radio to γ-rays
Authors: Carnerero, M. I.; Raiteri, C. M.; Villata, M.; Acosta-Pulido, J. A.; D'Ammando, F.; Smith, P. S.; Larionov, V. M.; Agudo, I.; Arévalo, M. J.; Arkharov, A. A.; Bach, U.; Bachev, R.; Benítez, E.; Blinov, D. A.; Bozhilov, V.; Buemi, C. S.; Bueno Bueno, A.; Carosati, D.; Casadio, C.; Chen, W. P.; Damljanovic, G.; Paola, A. Di; Efimova, N. V.; Ehgamberdiev, Sh. A.; Giroletti, M.; Gómez, J. L.; González-Morales, P. A.; Grinon-Marin, A. B.; Grishina, T. S.; Gurwell, M. A.; Hiriart, D.; Hsiao, H. Y.; Ibryamov, S.; Jorstad, S. G.; Joshi, M.; Kopatskaya, E. N.; Kurtanidze, O. M.; Kurtanidze, S. O.; Lähteenmäki, A.; Larionova, E. G.; Larionova, L. V.; Lázaro, C.; Leto, P.; Lin, C. S.; Lin, H. C.; Manilla-Robles, A. I.; Marscher, A. P.; McHardy, I. M.; Metodieva, Y.; Mirzaqulov, D. O.; Mokrushina, A. A.; Molina, S. N.; Morozova, D. A.; Nikolashvili, M. G.; Orienti, M.; Ovcharov, E.; Panwar, N.; Pastor Yabar, A.; Puerto Giménez, I.; Ramakrishnan, V.; Richter, G. M.; Rossini, M.; Sigua, L. A.; Strigachev, A.; Taylor, B.; Tornikoski, M.; Trigilio, C.; Troitskaya, Yu. V.; Troitsky, I. S.; Umana, G.; Valcheva, A.; Velasco, S.; Vince, O.; Wehrle, A. E.; Wiesemeyer, H.
Publication: *Monthly Notices of the Royal Astronomical Society, Volume 450, Issue 3, p.2677-2691 (MNRAS Homepage)*
Publication Date: 07/2015
Abstract: http://adsabs.harvard.edu/abs/2015MNRAS.450.2677C

Title: Detection of N2D+ in a Protoplanetary Disk
Authors: Huang, Jane; Öberg, Karin I.
Publication: *The Astrophysical Journal Letters, Volume 809, Issue 2, article id. L26, 5 pp. (2015). (ApJL Homepage)*
Publication Date: 08/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...809L..26H

Title: The Epsilon Eridani System Resolved by Millimeter Interferometry
Authors: MacGregor, Meredith A.; Wilner, David J.; Andrews, Sean M.; Lestrade, Jean-François; Maddison, Sarah
Publication: *The Astrophysical Journal, Volume 809, Issue 1, article id. 47, 11 pp. (2015). (ApJ Homepage)*
Publication Date: 08/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...809...47M

Title: The Distribution of Deuterated Formaldehyde within Orion-KL
Authors: Favre, Cécile; Bergin, Edwin A.; Neill, Justin L.; Crockett, Nathan R.; Zhang, Qizhou; Lis, Dariusz C.
Publication: *The Astrophysical Journal, Volume 808, Issue 2, article id. 155, 9 pp. (2015). (ApJ Homepage)*
Publication Date: 08/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...808..155F

Title: SMA Observations of C2H in High-mass Star-forming Regions
Authors: Jiang, Xue-Jian; Liu, Hauyu Baobab; Zhang, Qizhou; Wang, Junzhi; Zhang, Zhi-Yu; Li, Juan; Gao, Yu; Gu, Qiusheng
Publication: *The Astrophysical Journal, Volume 808, Issue 2, article id. 114, 9 pp. (2015). (ApJ Homepage)*
Publication Date: 08/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...808..114J

Title: Extremely Bright Submillimeter Galaxies beyond the Lupus-I Star-forming Region
Authors: Tamura, Y.; Kawabe, R.; Shimajiri, Y.; Tsukagoshi, T.; Nakajima, Y.; Oasa, Y.; Wilner, D. J.; Chandler, C. J.; Saigo, K.; Tomida, K.; Yun, M. S.; Taniguchi, A.; Kohno, K.; Hatsukade, B.; Aretxaga, I.; Austermann, J. E.; Dickman, R.; Ezawa, H.; Goss, W. M.; Hayashi, M.; Hughes, D. H.; Hiramatsu, M.; Inutsuka, S.; Ogasawara, R.; Ohashi, N.; Oshima, T.; Scott, K. S.; Wilson, G. W.
Publication: *The Astrophysical Journal, Volume 808, Issue 2, article id. 121, 14 pp. (2015). (ApJ Homepage)*
Publication Date: 08/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...808..121T

Title: Early Science with the Large Millimeter Telescope: observations of dust continuum and CO emission lines of cluster-lensed submillimetre galaxies at z=2.0-4.7
Authors: Zavala, J. A.; Yun, M. S.; Aretxaga, I.; Hughes, D. H.; Wilson, G. W.; Geach, J. E.; Egami, E.; Gurwell, M. A.; Wilner, D. J.; Smail, Ian; Blain, A. W.; Chapman, S. C.; Coppin, K. E. K.; Dessauges-Zavadsky, M.; Edge, A. C.; Montaña, A.; Nakajima, K.; Rawle, T. D.; Sánchez-Argüelles, D.; Swinbank, A. M.; Webb, T. M. A.; Zeballos, M.
Publication: *Monthly Notices of the Royal Astronomical Society, Volume 452, Issue 2, p.1140-1151 (MNRAS Homepage)*
Publication Date: 09/2015
Abstract: http://adsabs.harvard.edu/abs/2015MNRAS.452.1140Z

Title: Extremely Energetic Outflow and Decelerated Expansion in W49N
Authors: Liu, Tie; Kim, Kee-Tae; Wu, Yuefang; Li, Di; Lee, Chang-Won; De Pree, Christopher G.; Qin, Sheng-Li; Wang, Ke; Tatematsu, Ken'ichi; Zhang, Qizhou; Mardones, Diego; Liu, Sheng-Yuan; Cho, Se-Hyung
Publication: *The Astrophysical Journal, Volume 810, Issue 2, article id. 147, 9 pp. (2015). (ApJ Homepage)*
Publication Date: 09/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...810..147L

Title: The Deuterium Fraction in Massive Starless Cores and Dynamical Implications
Authors: Kong, Shuo; Tan, Jonathan C.; Caselli, Paola; Fontani, Francesco; Pillai, Thushara; Butler, Michael J.; Shimajiri, Yoshito; Nakamura, Fumitaka; Sakai, Takeshi
Publication: *eprint arXiv:1509.08684*
Publication Date: 09/2015
Abstract: http://adsabs.harvard.edu/abs/2015arXiv150908684K

Title: A Black Hole Mass-Variability Timescale Correlation at Submillimeter Wavelengths
Authors: Bower, Geoffrey C.; Dexter, Jason; Markoff, Sera; Gurwell, Mark A.; Rao, Ramprasad; McHardy, Ian
Publication: *The Astrophysical Journal Letters, Volume 811, Issue 1, article id. L6, 5 pp. (2015). (ApJL Homepage)*
Publication Date: 09/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...811L...6B

Title: A millimetre-wave redshift search for the unlensed HyLIRG, HS1700.850.1
Authors: Chapman, S. C.; Bertoldi, F.; Smail, Ian; Steidel, C. C.; Blain, A. W.; Geach, J. E.; Gurwell, M.; Ivison, R. J.; Petitpas, G. R.; Reddy, N.
Publication: *Monthly Notices of the Royal Astronomical Society, Volume 453, Issue 1, p.951-959 (MNRAS Homepage)*
Publication Date: 10/2015
Abstract: http://adsabs.harvard.edu/abs/2015MNRAS.453..951C

Title: Resolved Millimeter-Wavelength Observations of Debris Disks around Solar-Type Stars
Authors: Steele, Amy; Hughes, A. Meredith; Carpenter, John; Ricarte, Angelo; Andrews, Sean M.; Wilner, David J.; Chiang, Eugene
Publication: *eprint arXiv:1510.08890*
Publication Date: 10/2015
Abstract: http://adsabs.harvard.edu/abs/2015arXiv151008890S

Title: Young "Dipper" Stars in Upper Sco and and Oph Observed by K2
Authors: Ansdell, M.; Gaidos, E.; Rappaport, S. A.; Jacobs, T. L.; LaCourse, D. M.; Jek, K. J.; Mann, A. W.; Wyatt, M. C.; Kennedy, G.; Williams, J. P.; Boyajian, T. S.
Publication: *eprint arXiv:1510.08853*
Publication Date: 10/2015
Abstract: http://adsabs.harvard.edu/abs/2015arXiv151008853A

Title: Grain Growth in the Circumstellar Disks of the Young Stars CY Tau and DoAr 25
Authors: Perez, Laura M.; Chandler, Claire J.; Isella, Andrea; Carpenter, John M.; Andrews, Sean M.; Calvet, Nuria; Corder, Stuartt A.; Deller, Adam T.; Dullemond, Cornelis P.; Greaves, Jane S.; Harris, Robert J.; Henning, Thomas; Kwon, Woojin; Lazio, Joseph; Linz, Hendrik; Mundy, Lee G.; Ricci, Luca; Sargent, Anneila I.; Storm, Shaye; Tazzari, Marco; Testi, Leonardo; Wilner, David J.
Publication: *The Astrophysical Journal, Volume 813, Issue 1, article id. 41, 17 pp. (2015). (ApJ Homepage)*
Publication Date: 11/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...813...41P

Title: High-resolution CO Observation of the Carbon Star CIT 6 Revealing the Spiral Structure and a Nascent Bipolar Outflow
Authors: Kim, Hyosun; Liu, Sheng-Yuan; Hirano, Naomi; Zhao-Geisler, Ronny; Trejo, Alfonso; Yen, Hsi-Wei; Taam, Ronald E.; Kemper, Francisca; Kim, Jongsoo; Byun, Do-Young; Liu, Tie
Publication: *The Astrophysical Journal, Volume 814, Issue 1, article id. 61, 15 pp. (2015). (ApJ Homepage)*
Publication Date: 11/2015
Abstract: http://adsabs.harvard.edu/abs/2015arXiv151003916K

Title: A Multi-wavelength Polarimetric Study of the Blazar CTA 102 during a Gamma-Ray Flare in 2012
Authors: Casadio, Carolina; Gómez, Jośe L.; Jorstad, Svetlana G.; Marscher, Alan P.; Larionov, Valeri M.; Smith, Paul S.; Gurwell, Mark A.; Lähteenmäki, Anne; Agudo, Iván; Molina, Sol N.; Bala, Vishal; Joshi, Manasvita; Taylor, Brian; Williamson, Karen E.; Arkharov, Arkady A.; Blinov, Dmitry A.; Borman, George A.; Di Paola, Andrea; Grishina, Tatiana S.; Hagen-Thorn, Vladimir A.; Itoh, Ryosuke; Kopatskaya, Evgenia N.; Larionova, Elena G.; Larionova, Liudmila V.; Morozova, Daria A.; Rastorgueva-Foi, Elizaveta; Sergeev, Sergey G.; Tornikoski, Merja; Troitsky, Ivan S.; Thum, Clemens; Wiesemeyer, Helmut
Publication: *The Astrophysical Journal, Volume 813, Issue 1, article id. 51, 14 pp. (2015). (ApJ Homepage)*
Publication Date: 11/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...813...51C

Title: Mass Assembly of Stellar Systems and Their Evolution with the SMA (MASSES). Multiplicity and the Physical Environment in L1448N
Authors: Lee, Katherine I.; Dunham, Michael M.; Myers, Philip C.; Tobin, John J.; Kristensen, Lars E.; Pineda, Jaime E.; Vorobyov, Eduard I.; Offner, Stella S. R.; Arce, Hector G.; Li, Zhi-Yun; Bourke, Tyler L.; J√∏rgensen, Jes K.; Goodman, Alyssa A.; Sadavoy, Sarah I.; Chandler, Claire J.; Harris, Robert J.; Kratter, Kaitlin; Looney, Leslie W.; Melis, Carl; Perez, Laura M.; Segura-Cox, Dominique
Publication: *The Astrophysical Journal, Volume 814, Issue 2, article id. 114, 16 pp. (2015). (ApJ Homepage)*
Publication Date: 12/2015
Abstract: http://adsabs.harvard.edu/abs/2015arXiv151101141L

Title: Dispersing Envelope around the Keplerian Circumbinary Disk in L1551 NE and Its Implications for Binary Growth
Authors: Takakuwa, Shigehisa; Kiyokane, Kazuhiro; Saigo, Kazuya; Saito, Masao
Publication: *The Astrophysical Journal, Volume 814, Issue 2, article id. 160, 18 pp. (2015). (ApJ Homepage)*
Publication Date: 12/2015
Abstract: http://adsabs.harvard.edu/abs/2015arXiv151008353T

Title: Deeply Embedded Protostellar Population in the 20 km s-1 Cloud of the Central Molecular Zone
Authors: Lu, Xing; Zhang, Qizhou; Kauffmann, Jens; Pillai, Thushara; Longmore, Steven N.; Kruijssen, J. M. Diederik; Battersby, Cara; Gu, Qiusheng
Publication: *The Astrophysical Journal Letters, Volume 814, Issue 2, article id. L18, 7 pp. (2015). (ApJL Homepage)*
Publication Date: 12/2015
Abstract: http://adsabs.harvard.edu/abs/2015arXiv151004901L

Title: Early Science with the Large Millimeter Telescope: CO and [C II] Emission in the z = 4.3 AzTEC J095942.9+022938 (COSMOS AzTEC-1)
Authors: Yun, Min S.; Aretxaga, I.; Gurwell, M. A.; Hughes, D. H.; Monta√±a, A.; Narayanan, G.; Rosa-González, D.; Sánchez-Argüelles, D.; Schloerb, F. P.; Snell, R. L.; Vega, O.; Wilson, G. W.; Zeballos, M.; Chavez, M.; Cybulski, R.; Díaz-Santos, T.; De La Luz, V.; Erickson, N.; Ferrusca, D.; Gim, H. B.; Heyer, M. H.; Iono, D.; Pope, A.; Rogstad, S. M.; Scott, K. S.; Souccar, K.; Terlevich, E.; Terlevich, R.; Wilner, D.; Zavala, J. A.
Publication: *Monthly Notices of the Royal Astronomical Society, Volume 454, Issue 4, p.3485-3499 (MNRAS Homepage)*
Publication Date: 12/2015
Abstract: http://adsabs.harvard.edu/abs/2015MNRAS.454.3485Y

Title: The Disk-outflow System in the S255IR Area of High-mass Star Formation
Authors: Zinchenko, I.; Liu, S.-Y.; Su, Y.-N.; Salii, S. V.; Sobolev, A. M.; Zemlyanukha, P.; Beuther, H.; Ojha, D. K.; Samal, M. R.; Wang, Y.
Publication: *The Astrophysical Journal, Volume 810, Issue 1, article id. 10, 18 pp. (2015). (ApJ Homepage)*
Publication Date: 09/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...810...10Z

Title: Near-IR Polarized Scattered Light Imagery of the DoAr 28 Transitional Disk
Authors: Rich, Evan A.; Wisniewski, John P.; Mayama, Satoshi; Brandt, Timothy D.; Hashimoto, Jun; Kudo, Tomoyuki; Kusakabe, Nobuhiko; Espaillat, Catherine; Abe, Lyu; Akiyama, Eiji; Brandner, Wolfgang; Carson, Joseph C.; Currie, Thayne; Egner, Sebastian; Feldt, Markus; Follette, Kate; Goto, Miwa; Grady, Carol A.; Guyon, Olivier; Hayano, Yutaka; Hayashi, Masahiko; Hayashi, Saeko S.; Henning, Thomas; Hodapp, Klaus W.; Ishii, Miki; Iye, Masanori; Janson, Markus; Kandori, Ryo; Knapp, Gillian R.; Kuzuhara, Masayuki; Kwon, Jungmi; Matsuo, Taro; McElwain, Michael W.; Miyama, Shoken; Morino, Jun-Ichi; Moro-Martin, Amaya; Nishimura, Tetsuo; Pyo, Tae-Soo; Qi, Chunhua; Serabyn, Eugene; Suenaga, Takuya; Suto, Hiroshi; Suzuki, Ryuji; Takahashi, Yasuhiro H.; Takami, Michihiro; Takato, Naruhisa; Terada, Hiroshi; Thalmann, Christian; Tomono, Daigo; Turner, Edwin L.; Watanabe, Makoto; Yamada, Toru; Takami, Hideki; Usuda, Tomonori; Tamura, Motohide
Publication: *The Astronomical Journal, Volume 150, Issue 3, article id. 86, 9 pp. (2015). (AJ Homepage)*
Publication Date: 09/2015
Abstract: http://adsabs.harvard.edu/abs/2015AJ....150...86R

Title: An Extreme High-velocity Bipolar Outflow in the Pre-planetary Nebula IRAS 08005-2356
Authors: Sahai, R.; Patel, N. A.
Publication: *The Astrophysical Journal Letters, Volume 810, Issue 1, article id. L8, 6 pp. (2015). (ApJL Homepage)*
Publication Date: 09/2015
Abstract: http://adsabs.harvard.edu/abs/2015ApJ...810L...8S

Title: Complex molecules in the W51 North region
Authors: Rong, Jialei; Qin, Sheng-Li; Zapata, Luis A.; Wu, Yuefang; Liu, Tie; Zhang, Chengpeng; Peng, Yaping; Zhang, Li; Liu, Ying
Publication: *Monthly Notices of the Royal Astronomical Society, Volume 455, Issue 2, p.1428-1437 (MNRAS Homepage)*
Publication Date: 01/2016
Abstract: http://adsabs.harvard.edu/abs/2015arXiv151005641R

Title: ALMA probes the molecular gas reservoirs in the changing-look Seyfert galaxy Mrk 590
Authors: Koay, J. Y.; Vestergaard, M.; Casasola, V.; Lawther, D.; Peterson, B. M.
Publication: *Monthly Notices of the Royal Astronomical Society, Volume 455, Issue 3, p.2745-2764 (MNRAS Homepage)*
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