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256.03 – Extreme Star Formation in the Center of Our Galaxy

The central region of our Galaxy, referred to as the central molecular zone (CMZ; the inner 500 pc), provides an excellent laboratory for testing star formation theories due to its extreme environment at close proximity. Current observations suggest that the star formation rate in the CMZ is of an order of magnitude lower than predicted by current models. To improve our knowledge of star forming activity in this region, we have used the Sub-Millimeter Array (SMA) to conduct the first ever large scale, high-resolution survey of the CMZ taking advantage of the SMA's unique wide-area mapping capabilities. The resulting data set provides the best ever glimpse into this intriguing region of the Galaxy. A combination of the large scale and sub-pc resolution of the SMA survey have allowed us to use a variety of techniques designed to determine and characterize the rate of star formation in different locations around the CMZ. We have studied the population of gas clouds by mapping the temperature distribution of a number of clouds using the line ratios of formaldehyde emission at ~218 GHz. We have also measured the dense gas fraction and turbulent line width in order to understand how the star formation rate is affected by different environmental conditions. It is expected that the results from this survey will shed light on the nature of star formation in extreme environments and will be used to further constrain star formation laws. Analysis is ongoing and preliminary results are presented

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256.04 – An Investigation of Three Methods for Determining Young Star Spectral Types

We present an investigation of several spectral typing techniques applied to 6 young, low-mass binary systems in the Taurus star-forming region (2 Myr). Spectra of resolution ~2000 were taken in the K band at Keck II using NIRC2 in grism spectroscopy mode where adaptive optics allowed us to resolve subarcsecond separations. We tested three different methods to determine spectral type to compare and contrast the strengths and weaknesses of each method. First, we used fits to standard star spectra to determine spectral types, extinctions, and K-band excesses. This method resulted in anomalously high extinctions not supported in the literature. It was also often difficult to distinguish between best fits. Second, we used the equivalent width ratios of IRTF SpeX standards to determine linear relationships onto which we plotted the equivalent width ratios of our sample stars. This method was complicated by low signal to noise in weak lines and the presence of significant circumstellar material around some of our sample of young stars, which may have inconsistently veiled and skewed our results. Third, we used K-band spectral indices and solar metallicity models to infer effective temperatures for our sample. This promising approach, applicable for the M-type stars in our sample, yields effective temperatures of several hundred degrees Kelvin lower than the other methods. Our main goal in this work is to highlight the uncertainties inherent in the typical procedures used for determining young star spectral types and encourage a concerted effort to define a more accurate and precise approach to the measurement of pre-main sequence effective temperature. Temperature is a fundamental stellar property without which our calibration of young star evolution, and by inference planet formation, is highly uncertain, even in the face of precisely measured stellar masses.

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256.05 – Mass Assembly of Stellar Systems and their Evolution with the SMA (MASSES)

We present the first results from a legacy project of the SMA: Mass Assembly of Stellar Systems and their Evolution with the SMA (MASSES). The MASSES project surveys a complete sample of all 73 known protostars in the Perseus molecular cloud complex, with both dust continuum and molecular line observations in a variety of dense gas and outflow tracers. The goal of the project is to understand how stars gain their mass through core and disk fragmentation, the formation and evolution of protostellar disks, and outflow-regulated mass accretion. The survey is complementary to a VLA protostar survey with dust continuum (Tobin et al, in prep), which shows a high fraction of multiple protostars. With this larger, unbiased sample and better sensitivity, MASSES will build on results from previous protostar surveys to discern evolutionary trends and to provide a better understanding of the stellar mass assembly process.

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256.06 – 6.7 GHz Methanol Masers Associated with Jets in Very Early High Mass Protostars

6.7 GHz (or class II) methanol masers have been detected exclusively toward high mass star forming regions and may be a tracer of an accretion disk around a highly embedded high mass protostar. Several studies have shown a lack of radio continuum associated with methanol maser emission, which could indicate that these masers are related to the earliest stages of high mass star formation. We recently performed a large, high sensitive (~3-10 uJy) Karl G. Jansky Very Large Array (VLA) survey to search for radio continuum emission from a sample of hot molecular cores and infrared dark cloud cores, previously undetected in the radio continuum at 1 mJy sensitivity. The morphology and spectrum of most of our radio detections are consistent with being ionized jets. As models of star formation predict that jets are collimated by accretion disks, we have selected 6 prominent examples of ionized jet candidates to study the behavior of the masers with respect to the jet and to understand the role that both disks and jets play in the process of high mass star formation. Using the VLA, we performed simultaneous observations of the radio continuum and the 6.7 GHz methanol maser, obtaining accurate relative positions between them. From the accuracy of our observations, we found that all the methanol masers detected are associated with the radio continuum from the jet. Furthermore, for some sources the maser spots show a linear distribution with a velocity gradient nearly perpendicular to the ionized jet, a further indication of emission from an accretion disk.

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256.07 – Ammonia and HC^7N Emission in Starless Dense Cores

Dense cores represent the transition between the turbulent, diffuse ISM and protostars. Thus, understanding dense cores' chemical and physical properties provides valuable information about the early stages of low mass star formation. We present an analysis of 13 starless dense cores in the Taurus Molecular Cloud using new data taken with the Green Bank Telescope. Our observations consist of ammonia (NH^3) (1,1) and (2,2) and HC^7N (J=21-20) emission. We present new detections of HC^7N (a carbon chain bearing species) in four cores and confirm detection in two cores. We also present temperature and velocity gradient maps. These results are the foundation of a more complete survey and illustrate an important relationship between ammonia and the carbon chain bearing species HC^7N.

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256.08 – The Star Formation in Radio Survey: Mapping Star Formation in Nearby Galaxies with 33GHz Emission

We present initial results from the 33GHz phase of the Star Formation in Radio Survey (SFRS), including a gallery of 2" resolution Jansky Very Large Array (VLA) images and spatially resolved thermal / synchrotron emission models in a subset of sources. The SFRS is targeting 118 galaxy nuclei and extranuclear star-forming regions in 56 nearby (d < 30Mpc) galaxies included in the Spitzer/SINGS and Herschel/KINGFISH legacy programs. VLA observations of the entire sample have recently been completed at 3GHz (S band), 15GHz (Ku band) and 33GHz (Ka band). For an initial subset of 9 targets, we have also obtained 90GHz ALMA continuum and line imaging during cycle 1 observations.
The frequency spacing of our complete radio data set will allow us to accurately measure the radio spectral index of these targets, in order to model the physical processes that produce the radio emission. In particular, 33GHz observations of HII regions probe free-free emission, providing a sensitive, dust-unbiased measure of the current star formation activity in each complex. We can use the differences between 33GHz derived star formation rates and those derived with other tracers such as synchrotron radiation, extinction corrected UV and Hα emission, and infrared luminosity to examine the dependence of each tracer on separately measured variables such as extinction, metallicity and ionizing radiation field strength. Consequently, these data will help calibrate other empirically-derived star formation rate diagnostics that are more easily measured for high redshift studies, and help interpret rest-frame 33GHz observations from a new generation of deep high frequency (>10GHz) radio surveys.
As an example of the science that can be done with SFRS data, we have used our images along with an archival 1.4GHz and a new 5GHz VLA image to map the spectral index, spectral curvature, and the separated thermal and synchrotron components of NGC1266, a low level AGN with a mass outflow rate of > 50 $M_\odot$ / yr. These maps are currently being used to model the age and diffusion history of synchrotron electrons that were presumably accelerated by the AGN.

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