these sources coincide with infrared identified stellar sources associated with the central cluster. We used the accurate position of radio stars to register the radio and infrared frames at a smaller angular distance from Sgr A* (~5") than had been made in earlier studies based on SiO masers (Menten et al. 1997; Reid et al, 2003). Sensitive radio measurements should be able to potentially discover highly extincted stellar sources that are not detected at near-IR wavelengths. We discuss the origin of radio emission from stars in the central cluster. We also present dark features in Galactic Center radio images that are the imprints of envelopes of dusty stars and molecular clouds.

214.04 – A Census of Diverse Environments in Infrared Dark Clouds: Where Do Massive Stars Form?

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Infrared Dark Clouds (IRDCs) harbor the earliest phases of massive star formation and complex astrochemistry. IRDCs are extraordinarily dense and cold objects of dust and molecular gas arranged in filamentary or globule structures with compact cores. Many of the compact molecular and millimeter cores are known to host massive protostars from a variety of star formation indicators. We have used the GBT and the VLA to map ammonia and CCS in nine IRDCs to reveal the temperature, density, and velocity structures and explore chemical evolution in the dense cores. Ammonia is an ideal molecular tracer for these environments as its critical density is appropriate for IRDCs, and nitrogen-bearing species are not prone to dust-grain freeze-out even in these cold regions. The hyperfine structure allows unambiguous determination of the optical depth and thus the column density, and using two rotational transitions allows determination of the temperature. By imaging ammonia and CCS in these regions, we can use their abundance ratios as “chemical clocks” to determine whether the starless cores are indeed less evolved. With this data we will begin to address the questions of how these two classes of cores are alike and different and whether the quiescent cores are likely to eventually form stars or not. We further investigate the structure and kinematics of the IRDCs, revealing gradients and colliding sub-clouds that elucidate the formation process of these structures and their protostars. A comprehensive study of IRDCs in molecular gas tracers with both total power and high resolution is necessary to truly understand the relationship between IRDCs and massive star formation.

214.05 – Kinematics and Temperature Structures of Filaments in Serpens Main and Serpens South

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We present a study of filaments in Serpens Main and Serpens South cluster regions based on N2H+(1-0) observations from the CARMA Large Area Star-formation Survey (CLASSy) and dust continuum images from the Herschel Space Observatory. Serpens Main and Serpens South are active star formation regions with prominent filamentary structures; however, the role of the filaments in the cluster formation is unclear. This study of filament structure and kinematics with high-angular resolution data (7 arcsecs), particularly in revealing possible infall signatures, provides physical insight to this question. Using the Herschel data, we estimate the temperature in and along filaments for comparison with their gas kinematics, spatial distribution, and N2H+(1-0) emission, to better understand their role in current star formation activities.

214.06 – Dendrogram Analysis of Large-Area CARMA Images in Perseus: the Dense Gas in NGC 1333, Barnard 1, and L1451

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Contributing teams: CLASSy Team

We present spectral line maps of the dense gas across 400 square arcminutes of the Perseus Molecular Cloud, focused on NGC 1333, Barnard 1, and L1451. We constructed these maps as part of the CARMA Large Area Star-formation Survey (CLASSy), which is a CARMA key project that connects star forming cores to their natal cloud environment. This is achieved by leveraging CARMA's high angular resolution, imaging capability, and high efficiency at mosaicing large areas of the sky. CLASSy maps capture the structure and kinematics of N2H+, HCN, and HCO+ J=1-0 emission from thousand AU to parsec scales in three evolutionarily distinct regions of Perseus (in addition to two regions in Serpens). We show results from a non-binary dendrogram analysis of the Perseus N2H+ emission, which answers questions about the turbulent properties of the dense gas across evolutionary stages and across the range of size scales probed by CLASSy. There is a flat relation between mean internal turbulence and structure size for the dense gas in NGC 1333 and Barnard 1, but the magnitude of internal turbulence increases with nearby protostellar activity; the dense gas in the B1 main core and NGC 1333, which have active young stars, are characterized by mostly transonic to supersonic turbulence, while the filaments and clumps southwest of the B1 main core, which have no active young stars, have mostly subsonic turbulence. We have recently completed the observations of L1451, and results for that region will be revealed at the meeting. Released CLASSy data products can be found on our project website.

214.07 – PROTOBINARY EVOLUTION DRIVEN BY MAGNETIC BRAKING

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The majority of stars are in multiple systems, especially binaries. Such objects form in dense cores of molecular clouds that are observed to be strongly magnetized. Most previous studies of binary formation have either ignored magnetic fields or focused on the initial core fragmentation into binary seeds. Here I focus on the effects of the magnetic field on the orbital evolution of the protobinary during the main accretion phase, after a pair of stellar seeds have formed. By simulating a \'seed\' binary system with the sink particle treatment, we show that magnetic field plays a crucial role in removing the gas angular momentum and shrinking the binary separation. Through magnetic braking, strong magnetic field is very effective in suppressing the formation of circumstellar disks and circumbinary disk along with its spiral arm structures. The magnetic field can also be responsible for the population of the low mass-ratio binaries in the observed distribution. The magnetically-braked material will have equal chance of being accreted onto either binary seed, instead of the preferential accretion onto the secondary when magnetic field is absent. Furthermore, large field mis-alignment helps to produce rotationally-supported circumbinary disks even for relatively strong magnetic fields, by weakening the magnetically-dominated structure close to the binary. Hence to explain the observed properties of binaries, the magnetic effects deserve more careful considerations in the larger context of binary formation in future studies.

214.08D – From clouds to cores to envelopes to disks: a multi-scale view of magnetized star formation

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Magnetic fields are thought to play an important role in the formation of stars. However, that importance has been called into question by previous observations showing misalignment between protostellar outflows and magnetic fields (B-fields), as well as inconsistency in field morphology between 10,000 and 1000 AU scales. To investigate these inconsistencies, we used the 1.3 mm full-Stokes polarimeter — which I tested, installed, and calibrated for CARMA, a mm-wave interferometer — to map dust polarization with ~2.5" resolution toward 29 star-forming cores and 8 star-forming regions as part of the TADPOL survey. We find that a subset of the sources have consistent B-field orientations between the large (~20") scales measured by single-dish submm bolometers and the small scales measured by CARMA. Those same sources also tend to have higher fractional polarizations (measured by CARMA), presumably because the B-fields are less twisted by dynamic effects. However, even in these sources, which seem to have retained the memory of the global B-field direction, the fields in the cores are misaligned with the disks and outflows in the central protostars — a key result of the TADPOL survey. Furthermore, the cores with lower polarization fractions tend to have B-fields that are perpendicular to outflows, which suggests that in these sources the B-fields have lost the memory of the larger-scale global field, and have been wrapped up by core rotation. This is an important result for disk formation theory, as it suggests that field misalignment may indeed be the solution to the magnetic braking catastrophe. Finally, we find that all sources exhibit the so-called "polarization hole" effect, where the polarization drops significantly near the total intensity peak. When this effect was seen in low-resolution single-dish maps, it was attributed to the averaging of unresolved structure in the plane of the sky. However, the higher resolution maps we present here resolve these twisted polarization morphologies, and yet the drop in fractional polarization persists, suggesting that fields are twisted along the line of sight, or that grain alignment is poor in dense regions with high extinction and high collision rates.