

My research focuses on the molecular gas in the central five hundred parsecs of the galaxy (the Galactic center, or GC). The GC is a unique laboratory, as it is one of the harshest environments for molecular gas which can be resolved. Gas in this region is markedly different from gas in the Galactic disk: it has higher densities, temperatures, and line widths. My plan is to conduct high-resolution studies of this gas for comparison with models in order to understand the relevant physical processes, and their effect on star formation.

Constraining the Extreme GC Physical Conditions: The environment unique to Galactic nuclei leads to elevated temperatures and densities, but the maximum values in quiescent clouds are not well constrained. I have studied highly-excited lines of NH_3 in a sample of GC clouds, deriving rotation temperatures of 400-500 K ((Mills & Morris, in prep.), indicating the widespread presence of hot gas which must be heated by global processes in the GC. I next plan to constrain the processes responsible for heating the gas by increasing my sample size. I was also recently awarded VLA time to study nonmetastable NH_3 in GC clouds, which will identify the distribution of the densest gas ($n > 10^6 \text{ cm}^{-3}$) in these clouds.

High-resolution Studies of Molecular Cloud Structure: I am also leading a research project to determine the variation in physical conditions in the interiors of GC clouds. The subparsec-scale properties of these clouds are not well studied, meaning the dependence of their temperature and density on local processes (e.g. star formation, or supernova-driven shocks) is not known. To begin to characterize the interior conditions of GC clouds, I am PI of a VLA survey of 5 GC clouds (including the ‘Brick’, Figure 1; Longmore et al. 2012, ApJ, 746,117) to determine the variation in temperature in these clouds on 0.1 pc scales and ultimately identify their heating sources.

Do Galactic Center Stars Form Under Unusual Conditions? I further plan to conduct high-resolution ($\sim 1000 \text{ AU}$) ALMA follow-up of high-density tracers in the VLA cloud sample. The combination of these density limits and temperatures from the VLA survey will yield tight constraints on the physical conditions in individual clumps. With these spatially-resolved measurements of the density structure, I will also make the first clump mass function (CMF) measurements in the GC. Recent observations suggest that the CMF translates directly to the stellar IMF (e.g., Lada et al. 2008, ApJ, 672, 410). By comparing the slope and characteristic mass of the CMF in a sample of GC clouds to those derived in Galactic disk environments, I will test whether the GC environment causes the IMF to differ from that in the disk. By measuring the detailed velocity structure, I will further test whether the observed dense clumps are virialized, in a stable pressure equilibrium, or transient.

At the ZAH, I will be able to compare these data to ongoing simulations of clouds like the ‘Brick’. Together with these simulations, my work will begin to identify the mechanisms behind the unique GC gas properties, and quantify their effect on the initial conditions for star formation.

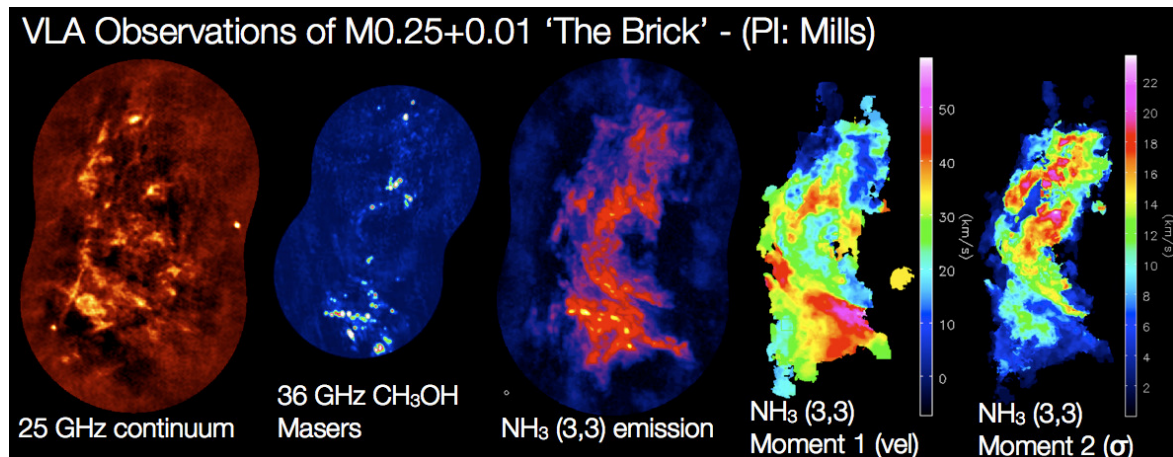


Fig. 1.— Example VLA data (Resolution: 0.1 pc) which I will use to characterize clouds like the ‘Brick’.