Chemo-dynamical modeling of high-mass protostellar environments: from chemical composition to molecular emission

Star-forming regions are among the richest chemical environments in the universe, where atoms and simple molecules evolve into complex organic species under a wide range of chemical reactions and physical processes. Observations reveal a large diversity of chemical compositions among star-forming regions, but the origin of this diversity remains unclear. This is particularly true for high-mass star-forming regions, whose far away distances and rapid evolution make them more difficult to characterize observationally than their low-mass counterparts.

I will present results from a new modeling framework designed to investigate the physical and chemical evolution of high-mass protostellar environments. The model follows the collapse of a uniform molecular cloud onto a central massive protostar through an accretion disk, using a two-dimensional hydrodynamical approach coupled with a chemical kinetic code. The resulting chemical abundances are post-processed with a radiative transfer code to generate synthetic molecular emission maps and spectra. By directly comparing these predictions with observations, we assess how the evolutionary stage and source structure—particularly disk formation and inclination—affect the emission and spatial distribution of complex organic molecules.