Submitted to both PCMI and ATPS

The physical process by which stars inherit their mass from the properties of their parental cloud is the fundamental issue that guides all star formation studies, and it has profound implications for many areas of astrophysics. The distribution of masses of dense, gravitationally bound cores, known as the Core Mass Function (CMF), was long assumed to directly determine the distribution of stellar masses at birth, the so-called Initial Mass Function (IMF).

However, the "CMF-to-IMF" paradigm, which posits that cores are the gas mass reservoir devoted to star formation, is now being debated because these reservoirs remain poorly defined despite efforts to establish them more physically. Accurately predicting the IMF that will emerge from the fragmentation of a given cloud requires moving beyond a static, single-scale description of star formation reservoirs. Instead, we must focus on the physical processes that shape and evolve the mass function of fragments throughout the multiscale hierarchy of clouds.

We started studying two key processes that influence the CMF, which differs in low and high-mass protoclusters: core subfragmentation, the splitting of a single core into multiple fragments due to turbulence and/or gravitational instabilities, and core mass growth, the accretion of additional gas onto existing cores from their surroundings. Using the graph-theory-based analysis tool FAMILY (Thomasson+ 2024), we characterized the fragmentation cascade of the W43-MM1 protocluster over two decades, from 300 au to 15 kau. We measured a low fragmentation level, high efficiency of gas mass transfer at smaller scales, and unbalanced mass partition between fragment siblings (Motte, Le Nestour, Veyry+ subm). Based on these observationally-derived parameters, we predict that the resulting IMF will be top-heavy, like those observed in young mass clusters (e.g., Hosek et al. 2019). Meanwhile, we also started studying the gas inflow through the protocluster and accretion rates toward cores, using N_2H^+(1–0) and DCN(3–2) lines. Notably, we constrain the evolution in mass of 25 cores in W43-MM1 and try to determine the evolution of the CMF (Veyry+ in prep).

By combining constraints of core subfragmentation and mass growth, we aim to move toward a predictive, time-dependent and multi-scale framework linking cloud properties to the mass function of gas reservoirs and ultimately the IMF.