Theoretical Insights into Star Formation: from the Early to the Present Day Universe

Contribution ID: **60** Type: **Poster**

Dynamics and infall properties observed at 5000 AU in the ALMAGAL sample.

The formation of high-mass stars remains a complex and not fully understood process, differing significantly from that of low-mass stars. Understanding their early evolutionary stages is crucial for uncovering the mechanisms governing their formation and their impact on galactic evolution.

In this poster I present a study of the infall dynamics of dense cores (1000-3000 AU) associated with high-mass star formation. The dataset is drawn from ALMAGAL (Molinari et al. 2025 e Sanchez-Monge et al. 2025, accepted), an ALMA large program designed to investigate all stages of massive star formation across the Galaxy. The ALMAGAL survey offers the opportunity to study this process with an unmatched combination of a uniformly spatial resolution (~1000 AU) and sample size (1013 Clumps observed), allowing for a comprehensive analysis of the physical and kinematic properties of cores. In this study, we use a 5000 AU core catalogue built using the same specifications of the 1000 AU catalogue presented in Coletta et al. 2025. This approach enables a connection to previous studies on clump scales (~1 pc, Traficante et al. 2018), providing a multi-scale perspective on accretion dynamics.

To identify infall candidates, we analysed the H2CO line, selecting sources exhibiting distinctive asymmetric profiles indicative of infall motion. The robustness of this selection is ensured by additional checks on optically thin lines (DCN, HCCCN, CH3CN and CH3OCHO) to exclude potential spurious sources. This approach results in 142 candidates, the largest sample of infall candidates identified at core- envelope scales (~5000 AU), providing a statistically significant basis for estimating accretion rates.

The derived infall velocities span a range consistent with values reported in the literature on clump scales (Vin: 4.06 × 10^ (−3) km/s to 9.05 km/s, with a median value of 0.24 km/s), likely suggesting that the bulk of the accretion process occurs on smaller spatial scales. The estimated mass accretion rates tend to be lower than those inferred on larger scales (Ṁacc: 0.05 × 10^(−4) M⊙/yr to 269 × 10^(−4) M⊙/yr, with a median value of 2.74 × 10^(−4) M⊙/yr), in agreement with the fact that the velocities dispersion generated by infall motion originates primarily at smaller scales, where the integrated mass at 5000 AU is lower, leading to reduced accretion rate. Notably, the accretion rate distributions remain relatively constant when categorized by evolutionary phase, though a subset of sources shows particularly high values of infall motion (5 sources with Vin > 5 km/s), possibly suggesting episodic accretion bursts.

Primary author: BERTI, Leonardo (Istituto Nazionale di Astrofisica (INAF))

Co-authors: COLETTA, Alessandro (Istituto Nazionale di Astrofisica (INAF)); TRAFICANTE, Alessio (Istituto Nazionale di Astrofisica (INAF)); SANCHEZ-MONGE, Alvaro (Institute of Space Sciences (ICE, CSIC)); JONES, Beth (Univ. Koln); BATTERSBY, Cara (University of Connecticut); MININNI, Chiara (Università degli Studi di Firenze - INAF); FULLER, Gary (University of Manchester, Univ. Koln); BEUTHER, Henrik (Univ. Heidelberg); BELTRAN SOROLLA, Maria Teresa (Istituto Nazionale di Astrofisica (INAF)); HO, Paul (ASIAA - Institute of Astronomy and Astrophysics, Academia Sinica); SCHILKE, Peter (Universitaet zu Koeln); ZHANG, Qizhou (Cambridge); KLESSEN, Ralf (Universität Heidelberg, Zentrum für Astronomie, Institut für Theoretische Astrophysik, Albert-Ueberle-Str. 2, 69120 Heidelberg, Germany); MOLINARI, Sergio (INAF - Istituto di Astrofisica e Planetologia Spaziale); WALCH, Stephanie (Univ. Koln); TANG, Ya-Wen

Presenter: BERTI, Leonardo (Istituto Nazionale di Astrofisica (INAF))

Session Classification: Session 1b