P127a Early fragmentation found in 70 μm-dark massive clumps

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Understanding the fragmentation process during the very early phases of high-mass star formation is crucial for unraveling the mechanisms behind cluster formation. We investigate fragmentation within thirty-nine 70 μm-dark massive clumps using high-resolution (1.2") ALMA observations at Band 6 (1.2 mm). We identify 839 embedded cores with masses ranging from 0.05 to 81 $M_{\odot}$ (Morii et al. 2023). Using the minimum spanning tree method, we estimate core separations ranging from 0.1 pc to 0.4 pc. By comparing observed core separations and masses to thermal and turbulent Jeans length and mass, respectively, we identify thermal Jeans fragmentation as the dominant mechanism driving the observed core properties. We uncover an inverse correlation between the number of cores and the virial parameter of sub-clumps, indicating that gravitationally unstable sub-clumps produce a higher number of fragments. Some clumps exhibit a wide dynamic range of core masses, spanning from low to high values, while others display a narrower range. This diversity in core mass distribution reveals distinct fragmentation behaviors occurring within the clumps. Moreover, we find a variety of fragmentation patterns, including both alignment and spread distributions, revealing the complex nature of the fragmentation process. These findings provide valuable insights into the mechanisms driving high-mass star formation.