P116a Unveiling a Multiple System: Core and Disk Fragmentation in NGC 6334 I(N)

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Most stars form in massive, cluster-forming regions alongside high-mass stars, and nearly 60% form in multiple systems. The mechanisms driving multiple system formation remain unclear and are thought to involve turbulent core fragmentation, disk fragmentation, or dynamical interactions.

We present high-resolution ALMA observations of a multiple system within a condensation, SMA 6, in the massive protocluster NGC 6334 I(N). SMA 6 lacks bright infrared emission ($<$24 μm) and centimeter continuum but shows strong submillimeter emission and complex organic molecules. With an estimated bolometric luminosity of $\sim$2.1$\times$10^2 $L_\odot$ and a core mass of $\sim$15 $M_\odot$, it also hosts a 44 GHz Class I CH_3OH maser and a 3.5 μm infrared source south of the continuum peak, consistent with a blue-shifted outflow lobe.

ALMA observations (0.”02 resolution; 26 au at 1.3 kpc) reveal at least four fragments within SMA 6: SMA 6a, SMA 6b (85 au from SMA 6a), SMA 6c (370 au), and SMA 6d (500 au). The system exhibits a large CO outflow with a wide-opening blue-shifted lobe and a collimated red-shifted lobe. A velocity gradient perpendicular to the outflow axis is seen within the condensation enclosing SMA 6a and SMA 6b, while moment 1 maps show internal gradients in both fragments with aligned axes. The systemic velocity difference ($\sim$2 km s^{-1}) and separations between SMA 6a/b and SMA 6c imply that the core fragmentation formed SMA 6a/b, SMA 6c, and SMA 6d, while the close pair SMA 6a and SMA 6b likely resulted from additional disk fragmentation.