SMA Observations of Infall and Rotation around Class 0 & 0/I Protostars to Investigate Disk Formation at the Early Evolutionary Stage

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Background:
Circumstellar disks around young stellar objects are sites of planet formation. When and how these disks form during star formation processes are still controversial. Disks with outer radii >100 AU have been often observed around T Tauri stars and Class I protostars, suggesting disks are already well developed at the Class I stage. It is unclear whether the presence of such large-scale (100 AU) disks is common among Class 0 protostars. The goal of this project is to estimate disk sizes of a sample of Class 0 protostars with SMA observations.

Method:
We studied the gas motions around 17 Class 0 or 0/I protostars observed with SMA in C\textsuperscript{18}O (2-1) at angular resolutions of 2''-8'' and velocity resolutions of 0.14-1.2 km/s. We constructed simple models of infalling and rotating envelopes with a conserved angular momentum, which have been observed around several protostars with our recent observations, to reproduce the velocity gradients observed with SMA, and estimated protostellar mass and size of Keplerian disks. Follow-up ALMA observations of L1527, directly revealing the disk, confirmed the SMA estimates, and the uncertainty of the SMA results is <50% of the measurements.

SMA C\textsuperscript{18}O (2-1) Results of 17 Class 0 or 0/I Protostars

Wide ranges of magnitude and orientation of velocity gradient observed. Estimated disk radii range from <5 AU to >500 AU, suggesting that the Class 0 stage is likely the stage to build a large-scale disk. The small number of protostars exhibiting smaller disk (<100 AU) suggests that large-scale disks can be well developed in a short time scale, or that suppression of disk formation is not common among Class 0 protostars.

Reference: