PROTOPLANETARY DISKS

Going with the flow

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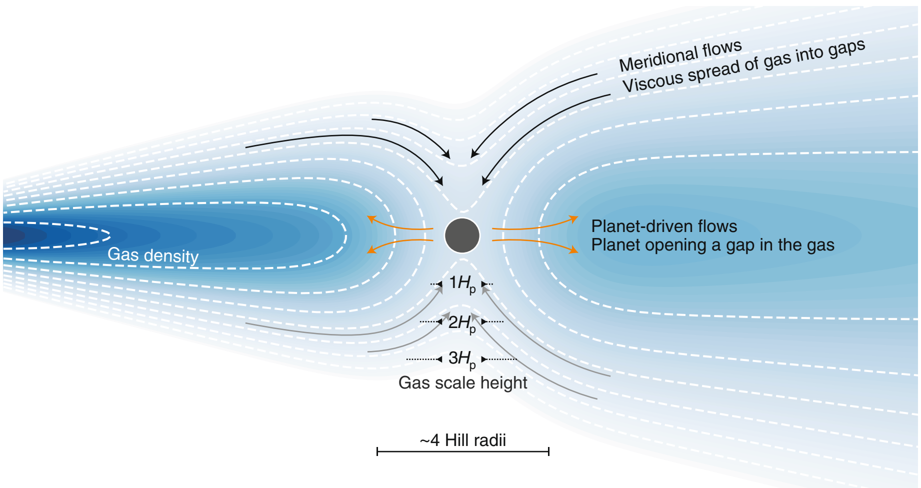

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High-spatial-resolution observations of protoplanetary disks (in particular from ALMA) show a variety of structures in the gas and dust constituents, including gaps and rings. Using an innovative technique, Richard Teague and colleagues used the emission from ^{12}CO molecules in the disk around HD 163296 to deconstruct the gas velocity profile of the disk surface, particularly around the disk features, revealing the processes that drive the evolution of the disk components.

Since ^{12}CO emission is optically thick, it traces the surface layers of the disk, down to an optical depth of ~1. However, the rotation maps that can be derived from such emission suffer from a projection effect that can be quantified by removing a Keplerian velocity component. Splitting the corrected rotation map into radial bins enables the separation of the rotational, radial and vertical velocity components, assuming that the disk inclination is well known (and in this case, it can be estimated from observations of the disk continuum). Expressing these velocities in terms of the local speed of sound (derived from the brightness temperature) gives a picture of the small-scale flows in the upper layers of the disk.

In this study, Teague et al. find three regions where the gas flow collapses, and these regions coincide with putative planet-carved gaps in the disk. Such velocity structures are likely to be meridional flows (see schematic), long-predicted and well-understood features of 3D hydrodynamic simulations. Meridional flows in disk gaps would drive volatile-rich molecular gas from intermediate layers down to the feeding zones of forming planets.

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