The Dynamic, Chimeric Inner Disk of PDS 70

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Abstract

PDS 70 is a key system in studies of disk evolution and planet formation, but while its outer disk and two directly-imaged giant planets have been intensely scrutinized, much less is known about the _˜10 au-wide inner disk which is only marginally resolved by ALMA. Infrared and sub-mm observations show the inner disk to be gas-poor, with low CO, but detectable CO2, and H2O. We present new and archival data showing the system to be highly variable on day- to year-long timescales, including evolution between dipper-like and "scalloped" periodic variability in the optical, and the near-disappearance of infrared emission from the innermost disk for about one year. We model the disk's SED as a warm (< 600K) component and hot (_˜1200K) component and explain this variability in terms of the motion of the disk inner edge relative to the co-rotation radius and the dust sublimation point, resulting in gas-bearing dust being ejected along magnetic field lines, trapped at the co-rotation radius, or completely vaporizing exterior to the disk edge. This variabiity is driven by variability in the large-scale stellar magnetic field and/or accretion. We propose that this inner disk is a hybrid mixture of outer disk gas, depleted by trapping of solids (including CO ice) at a pressure bump, leaking across the gap, plus dust, H2O, and CO2 from evaporating/disintegrating/colliding planetesimals that are stirred by protoplanets within the inner disk. This means that observations of material close to the star can probe the products of ongoing planet formation in this system.

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