First Detection of Methanol in a Class 0 Protostellar Disk

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ABSTRACT

emission detection

We report the detection of emission from methanol in a compact source coincident with the position of the L1157 infrared source, which we attribute to molecules in the disk surrounding this young, Class 0 protostellar object. In addition, we identify a spectral feature in the outflow corresponding to an ethanol transition. Using the Caltech Owens Valley Millimeter Array with a synthesized beam size of 2″, we detect spatially unresolved methanol in the 2_k – 1_k transitions at 3mm, which is coincident in position with the peak of the continuum emission. The gas phase methanol could be located in the central region (< 100 AU radius) of a flat disk, or in an extended heated surface layer ($\sim$ 200 AU radius) of a flared disk. The fractional abundance of methanol $X(CH_3OH)$ is $\sim 2\times10^{-8}$ in the flat disk model, and $\sim 3\times10^{-7}$ for the flared disk. The fractional abundance is small in the disk as a whole, but considerably larger in the warm portions. This difference indicates that substantial chemical processing probably takes place in the disk via depletion and desorption. The methanol desorbed from the grains in the warm surface layers returns to the icy grain mantles in the cooler interior of the disk, where it is available to become part of the composition of solar system-like bodies, such as comets, formed in the outer circumstellar region. This first millimeter–wavelength detection of a complex organic molecule in a young protostellar disk has implications for disk structure and chemical evolution and for potential use as a temperature probe.

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