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TITLE: Possibility of Detecting the H_2O Snowline in Protoplanetary Disks Using Spectroscopic Observations

ABSTRACT BODY:

Abstract Body: Inside the H_2O snowline in protoplanetary disks, H_2O evaporates from grain surfaces into the gas. On the other hand, it is frozen out on the grain surface in the cold region beyond the H_2O snowline. The H_2O snowline is thought to divide the regions of rocky planet and gas giant planet formation. Observationally measuring the position of the H_2O snowline in protoplanetary disks in exoplanetary systems will constrain modern theories of planet formation. In disks around solar-mass T-tauri stars, the H_2O snowline is thought to exist at a few AU from the central star. Therefore, it is difficult to detect the H_2O snowline of exoplanetary systems by direct imaging, since the spatial resolution of existing telescopes is insufficient. In this work, we propose a method of detecting the H_2O snowline directly by analyzing the velocity profiles of H_2O line spectra which can be obtained by high dispersion spectroscopic observations in the near future.

First, we use self-consistent physical models of protoplanetary disks (e.g., Nomura & Millar 2005, Nomura et al. 2007, Walsh et al. 2010, 2012) to investigate the abundance distribution of H_2O gas and the position of the snowline. We confirm that the abundance of H_2O gas is high not only inside the H_2O snowline near the equatorial plane but also in the hot surface layer of the outer disk. Second, we calculate the emergent intensity of H_2O emission lines from protoplanetary disks that are assumed to rotate with Keplerian velocity profiles. We can find information on the H_2O snowline through investigating the profiles of emission lines that have small Einstein A coefficients and large excitation energies. The wavelengths of the useful H_2O emission lines range from mid-infrared to sub-millimeter wavelengths. These lines will be observable with future high dispersion spectroscopic observations (e.g., ALMA, TMT).

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