Contribution ID: **67** Type: **not specified**

How small molecules betray dust evolution in planet forming disks

Thursday, 17 October 2019 12:20 (15 minutes)

Contributed talk

Abstract:
ALMA observations of planet forming disks over the past several years have firmly established that the grains responsible for the millimeter wavelength continuum emission have undergone a significant evolution in their radial and size distribution. Many disks show clear signs of both radial drift of grains and accumulation in rings. This grain evolution is expected to leave an imprint on both the temperature of the disk and the penetration of stellar ultraviolet, andaffect the freeze out of CO, the presence of deuterated species, and molecules that are thought to form in CO-ice mantles like H2CO and CH3OH. ALMA observations of the lines of DCO+, DCN, N2D+, H2CO, and CH3OH in the disks around HD163296 and HD169142 confirm these expectations. In many cases, a 'ring-like' distribution is found, correlated with, but not identical to, the rings seen in dust millimeter continuum. The lack of a one-to-one correspondence requires that a combination of temperature effects and photodesorption due to increased penetration of ultraviolet radiation is invoked to explain the observed distribution of molecules. These findings illustrate that these simple molecules can be used to provide constraints on the disk's dust size populations and offer critical observational tests of dust evolution models.

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Session Classification: Circumstellar Disks