

Recent advances in the solar system science brought by ALMA observations

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A large number of successful discoveries has been constantly produced by ALMA. Its powerfulness is not only limited to the cosmological or astronomical fields but also can be applied to solar system planetary science. This paper reviews the recent advances in the solar system sciences achieved by ALMA observations.

ALMA's high sensitivity enables us to observe thermal emission from small minor bodies located at the far distance in our solar system (e.g., TNOs [Lellouch et al., 2017]; Pluto [Lellouch et al., 2017]), and the high spatial resolution provides a quite unique remote-sensing capability to spatially-resolve Jovian icy moons (e.g., Europa [Trumbo et al. 2018]) and asteroids (Juno [ALMA partnership, 2015]). Moreover, heterodyne receiver's high frequency resolution is one the most interesting observation techniques for the planetary atmospheric study. It can precisely measure the spectral line shape of molecular absorption, from which we can derive the abundances of minor chemical species even with the concentration as low as part-per-billion (e.g., nitriles and hydrocarbons in Titan [e.g., Thelen et al., 2019]). The atmospheric wind can be derived via observing the Doppler-shift of the molecular lines (e.g., super-rotation of Titan thermosphere [Lellouch et al., 2019]).

In addition, we will discuss ALMA's potential synergetic sciences with the planned space-born explorations such as JUICE and MMX and with future optical/infrared telescopes such as TMT and JWST.

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