[JJ] Evening Poster | P (Space and Planetary Sciences) | P-CG Complex & General

[P-CG22]New Developments of Planetary Sciences with ALMA

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The Atacama Large Millimeter/Submillimeter Array (ALMA) starated its science operation in 2011, and long-baseline observations have become available since 2014. ALMA, with its high sensitivity and resolution, has provided us with qualitatively new information on star and planet formation and small bodies in our Solar System. For example, the discovery of narrow gap structures in the protoplanetary disks around young stars HL Tan and TW Hya enabled us to actually compare the long-standing theoretical models of planet formation with real observations. In our solar system, 60km pixel-scale non-uniform brightness distribution and the rotation of the asteroid Juno are detected. Spatially-resolved thermal mapping of Europa icy surface enables us to search for thermal anomaly in possible plume source regions. As of Cycle 4, Solar observations are available, enabling us, for example, to determine the physical parameters of plasmoid quantitatively. In this session, we overview the latest results of ALMA observations in the field of planetary sciences. We also accept any theoretical and experimental works that are closely related to the observations and discuss the impact on the planetary science community.

[PCG22-P08]Band 3 continuum and CO molecular line observations towards HD 142527 with ALMA

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We present the observational results of dust continuum, $^{13}C^{16}O$ J = 1 − 0, and $^{12}C^{16}O$ J = 1 − 0 emissions from the disk surrounding a Herbig Fe star, HD 142527, taken in Band 3 (∼ 100 GHz) with ALMA in its Cycle 2. This study is the first to show the spatially and spectrally resolved J = 1 − 0 rotational emissions of the CO molecules. The synthesized beams of the observations are approximately 50 mas, and the spectral resolutions for the CO molecular observations are 0.04 km s−1.

The dust disk is observed to be divided into two parts, an inner disk and an outer disk, by a dust-depleted region. While the former is not resolved by the beam, the outer disk is detected out to a radius of 2 arcsec from the central star, and depending on the position angle its inner radius ranges from 0.5 arcsec to 1 arcsec. HD 142527 is known for its crescent-like outer disk in the millimeter and longer wavelengths, and our observation reveal the same non-axisymmetric features, where the disk northern region is brighter than the southern region. The peak intensity of the outer disk, as a function of position angle *P.A.* and radius *r*, shows a maximum of 11.5 mJy beam−1 at *P.A.* = 10°, *r* = 1.1 arcsec, and a minimum of 0.2 mJy beam−1 at *P.A.* = 237°, *r* = 1.3 arcsec; the contrast in intensity is thus about 60 between the two direction. The gas spatial distribution traced by $^{13}C^{16}O$ J = 1 − 0 line emission resembles that of the J = 3 − 2 of the same molecule; its integrated intensity is more axisymmetric and does not differ by more than a factor of two in the azimuthal direction.In addition, $^{13}C^{16}O$ is most probably optically thick as its brightness temperature is as high as 40 K even at 1 arcsec from the star. On the other hand, the distribution of the $^{12}C^{18}O$ J = 1 − 0 integrated intensity, unlike its J = 3 − 2 counterpart which shows an axisymmetric distribution around the central star, departs substantially from the azimuthal symmetry; its emission concentrates in the northern part of the disk that is about 25 K in brightness temperature, with almost no appreciable detection above a signal-to-noise ratio of 5 in the southern half. The distribution is therefore similar to the continuum emission.

We perform a quick analysis to derive the gas column density of the disk by assuming a gas-to-dust ratio of 100 and a uniform T_{ex} = 35 K (the brightness temperature, and physical temperature if optically thick, of $^{13}C^{16}O$ at the peak continuum emission) in the disk. We use the prescribed dust opacity by Beckwith et al. 1990, where the opacity is κ = 0.1(ν/10^{12} Hz)^{β} cm^2 $g^{−1}$. A certain degree of grain growth is expected in the disk, thus we let the spectral slope β to be unity. The resulting opacity is κ = 0.01 cm^2 $g^{−1}$ at 99.5 GHz. We derived the gas column density to be 21 g $cm^{−2}$ and 0.3 g $cm^{−2}$ at the location of the maximum and the minimum peak intensity, respectively. However, we understand that since the dust is most likely to sediment at the disk midplane and the gas-to-dust ratio may vary across the disk, estimation of the gas mass can be improved by using the results of CO molecular lines, which will be discussed in the presentation.