

ALMA observations of 1 Ceres in 2021

*高橋 茂¹、飯野 孝浩¹、佐川 英夫²

*Shigeru Takahashi¹, Takahiro Iino¹, Hideo Sagawa²

1. 東京大学、2. 京都産業大学

1. The University of Tokyo, 2. Kyoto Sangyo University

Millimeter and submillimeter-wave observations are known to be a powerful tool to investigate the surface and atmospheric properties of solar system bodies (e. g., Takahashi *et al.* 2010, Iino *et al.* 2020). In particular, the high spatial resolution capability of the Atacama Large Millimeter/submillimeter Array (ALMA) has been enabled us to study disk resolved surface properties of asteroids. The first ALMA observations of an asteroid was the main belt asteroid 3 Juno (ALMA Partnership *et al.* 2015), and the ALMA attained an angular resolution of 0.''042 (60 km at 1.97 AU), which showed that the asteroids were of the ALMA observation candidates. With the spatially resolved continuum emission images, they revealed a geometric mean diameter as 259 ± 4 km and the resolved temperature distribution of 3 Juno's surface. From the surface brightness temperature distribution maps, they found the peak position of the temperature was deviated from the sub-solar point.

After the 3 Juno, several asteroid observations have been performed with the ALMA; e.g. 16 Psyche (Shepard *et al.* 2021), 1 Ceres (Li *et al.* 2020) and TNOs (Lellouch *et al.* 2017).

For 1 Ceres, Li *et al.* (2020) showed the disk-averaged brightness temperature and a rotational light curve at ~ 265 GHz continuum during 2015 and 2017 seasons and obtained a disk-averaged brightness temperature between 170 and 180 K in 2017. Comparison with the past thermal data, they confirmed that the brightness temperature of Ceres has a maximum around true anomaly 0° – 60° and a minimum around 240° – 300° . Their report indicates that the seasonal variation of the temperature has a thermal delay; a maximum temperature occurs after the perihelion and a minimum the aphelion.

In addition to the 2015 and 2017 data, Ceres was observed in 2021 and the data were recently opened to the public (Project code: 2019.1.01118.S). These new data are of interesting in studying Ceres in the post Dawn period. We started the analysis of the data which consist of 5 days observations carried out in Jul. 2021 in frequency range 340-355GHz. In this meeting, we will show initial results of the ALMA data of Ceres in 2021. The geometric parameters of Ceres at the observation date are as follows; $r \sim 2.8$ AU, $\Delta \sim 3.2$ AU, phase angle ~ 18 deg. and true anomaly ~ 243 deg, which means the Ceres was located after the aphelion and the brightness temperature would be around the minimum. We will present the averaged brightness temperature, distribution of the surface temperature and the peak position. The past radiometric data and *in-situ* observations by Dawn spacecraft will also be discussed.

References:

- ALMA Partnership *et al.* *ApJL* **808**, L2 (2015)
- Iino *et al.* *ApJ*, **903**, L1 (2020)
- Lellouch *et al.* *A&A* **608**, 21 (2017)
- Li *et al.* *AJ* **159**, 215 (2020)
- Shepard *et al.* *PSJ* **2**, 125 (2021)
- Takahashi *et al.* *PASJ*, **62**, L17 (2010)

キーワード : ALMA, Ceres, 小惑星

Keywords: ALMA, Ceres, Asteroid