Crabパルサーを用いた太陽コロナの電波掩蔽観測

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Radio observation of the Solar Corona from Occultation of the Crab Pulsar

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The Crab Pulsar (PSR B0531+21) is a relatively young neutron star located in the center of the Crab Nebula. The Crab emits broadband pulses with an emission interval of 33ms over a wide spectrum range from radio waves to gamma rays, and also occasionally emits extremely strong pulses called 'giant pulses' with intensity 1000 times greater than the regular pulses. Counselman & Rankin (1972, 1973) and Weisberg et al. (1976) determined the mean electron density of the solar corona from measurements of radio-frequency dispersion measure (DM) for the Crab in mid-June, when the line-of-sight (los) of the Crab approaches to the Sun as close as 5 solar radii over the South pole. The DM is the integrated column density of free electrons between an observer and a pulsar, therefore one can determine the integrated coronal density by measuring the Crab's DMs in mid-June.

We have observed the Crab using Solar Wind Imaging Facility Telescope (SWIFT) at the Toyokawa radio observatory since November 2016. The observation frequency of SWIFT is 327 MHz, and the effective area is 1970 m^2 (at zenith). In mid-June 2018, we conducted Crab observations for seven days to estimate the coronal density. As a result, we detected an increase of ~0.01 pc cm^{-3} in DM on June 16 when the Crab's los was closest to the sun. This DM increase is consistent with the integrated coronal density model along the los. Our data also showed relatively high pulse temporal broadening and low giant pulse detection number in the same period. These may suggest an increase in pulse scattering due to density fluctuations in the corona.