Estimation of the coronal density over the South pole using dispersion measure of the Crab pulsar

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The Crab pulsar (PSR B0531+21) is a relatively young neutron star that emits exceptionally bright pulses called giant pulses (Staelin & Reifenstein 1968). The line-of-sight (los) of the Crab approaches to the Sun in mid-June as close as 5 solar radii over the South pole. In 1970s, Counselman & Rankin (1972, 1973) and Weisberg et al (1976) determined the coronal density using dispersion measure (DM) of the Crab. The DM is a parameter to represent the frequency dispersion observed in the pulsar signal, and also the integrated plasma density along the los. By taking difference between DMs when the Crab' s los is located close to and far from the Sun, one can determine the (integrated) coronal density over the South pole.

We started the Crab observation at the Toyokawa observatory since November 2016. This observation was performed during 4-8 minutes each day at a frequency of 327 MHz with 20 MHz bandwidth. As a result, we detected tens to hundreds giant pulses each day. This number is more than the previous studies, it is considered to indicate the high sensitivity of the Toyokawa radio telescope. These giant pulses enable determination of DM in short time because the amplitudes of giant pulse typically exceed those of normal pulses by several orders of magnitude. We determined DM from Toyokawa observations by searching the value at which the amplitude of giant pulse becomes a maximum. Our results obtained from this analysis indicate long-term variability in DM, which may represent variability of plasma density of the Crab nebula, interstellar medium, and solar corona.

Keywords: coronal density, Crab pulsar, dispersion measure