URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

Upgrade of legacy ORT for pulsar observations

Bhal Chandra Joshi* [(1)], Arun Naidu[(1,2)], and P. K. Manoharan[(1,3)]
(1) National Centre for Radio Astrophysics (TIFR), Pune India - 411007, e-mail: bcj@ncra.tifr.res.in
(2) McGill Space Institute, McGill University, Montreal, Canada; e-mail: arunnaidu123@gmail.com
(3) Radio Astronomy Centre, Ooty, India – 643001; e-mail: mano.rac@gmail.com

Ooty Radio Telescope (Swarup et al. 1971) is 530-m long and 30-m wide cylindrical paraboloid equatorially mounted radio telescope located in southern India. With its large collecting area and low frequency of observations (326.5 MHz), it is a sensitive instrument suitable for steep spectrum sources, such as radio pulsars, which are bright at these frequencies. In the early 2000, pulsar observations at the ORT had stopped due to unavailability of a state-of-art backend. We started a project to upgrade the legacy ORT by equipping it with a new receiver and a state-of-art digital backend specifically designed for pulsar observations. This receiver, called Pulsar Ooty radio telescope New Digital Efficient Receiver (PONDER), is capable of real-time time-series observations of pulsars, inter-planetary scintillations and very long baseline interferometer (VLBI). It was designed and commissioned between 2008 – 2012 and significantly upgraded the science capability of the instrument. In this presentation, this instrument and the resulting science results are described.

The PONDER is capable of acquiring high time-resolution time-series data in real time using a beam formed after phasing all 22 modules of the ORT using its legacy beam-former system. It can acquire data from individual halves of the ORT or add/correlate the two halves with 16 MHz band at 326.5 MHz. In the pulsar mode, the PONDER can record raw baseband data or real-time coherently dedisperse data to the required time series to remove inter-stellar dispersion smear, which significantly degrades signal-to-noise ratio at these frequencies. The pulsar time series can also be folded real-time providing high precision time-stamped pulse profiles useful for precision timing. In the inter-planetary scintillation mode, the PONDER can generate spectra over 16 MHz as compared to those over 4 MHz in the legacy system leading to significantly improved signal-to-noise ratio.

The PONDER with upgraded legacy system has been operational now for more than 5 years. It has been used for sensitive single pulse studies, leading to a new intermediate nulling pulsar (Naidu et al. 2018). It has been used to study the inter-stellar medium using measurements of pulse-scatter-broadening of pulsars (Krishnakumar 2015, 2017) and for multi-epoch timing obervations of pulsars (Basu et al. 2018 – also see a presentation in J03). It has also been used to record data for VLBI experiment. It continues to be used for detecting pulsar glitches and as part of an experiment to detect gravitational waves (Joshi et al. 2018). A few of these results will be described in this presentation.

References :

Basu et al. 2018, A&A, 617, 22
Joshi et al. 2018, JApA, 39, 51
Krishnakumar et al. 2015, ApJ, 804, 23
Krishnakumar et al. 2017, ApJ, 846, 104
Naidu et al. 2015, Experimental Astronomy, 39, 319
Naidu et al. 2018, MNRAS, 475, 2375
Swarup et al. 1971, Nat. Phy. Sci. 2301, 185