Scattering study of Pulsars below 100 MHz

Karishma Bansal[1], Greg Taylor[1], Kevin Stovall[2], and Jayce Dowell[1]

[1] Physics and Astronomy, University of New Mexico, Albuquerque NM
[2] National Radio Astronomy Observatory, Socorro, NM

The interstellar medium (ISM) consists of an ionized plasma which affects radiation as it traverses the medium. The observable ISM effects are the dispersion, scattering, angular broadening, and interstellar scintillation. Pulsars are compact and emit short pulses thus making them good candidates to study and understand all the above effects. Furthermore, all of these effects are stronger at lower frequencies, though in the case of scattering the pulsar profiles also grow asymmetrically broader at lower frequencies which can complicate the analysis.

Different ISM models predict different frequency dependencies for the scattering time-scale τ_{sc}. For gaussian inhomogeneity the scaling relation is $\tau_{sc} \propto \nu^{-4}\ DM^2$, while for a Kolmogorov distribution of irregularities, the expected relation is $\tau_{sc} \propto \nu^{-4.4}\ DM^{2.2}$. In previous scattering studies, the scattering index has been found to agree with the theoretical models as well as show deviations across all ranges of DM. Scattering index below 4 is believed to be due to either limitation of underlying assumptions of thin screen model or anisotropic scattering mechanism. The effect of this anisotropy can be seen in the power spectra of the dynamic spectra as scintillation arcs. However, identifying such features has been difficult at low frequencies.

We present a study of scattering for seven pulsars (DM < 50 pc cm^{-3}) observed at low frequencies ($10 - 88$ MHz), using the first station of the Long Wavelength Array (LWA1). We examine the scattering index and DM variation over a period of about two years. The results yield insights into the small-scale structure of ISM as well as the applicability of the thin screen model for low DM pulsars.