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# Towards Predictive Modelling of Interstellar Scattering

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## 1. Extended Abstract

Interstellar scintillation occurs when density variations in the ionized interstellar medium (ISM) scatter radiation from a compact source, such as a pulsar, into many paths to the observer, each with a different delay. The observer moves through the resulting interference pattern, causing the flux to vary with both time and frequency. The flux variations and delays introduced by scintillation are a source of noise in observations of radio transients (especially at low frequencies) that complicates pulsar timing and measurements of fast radio burst (FRB) spectra. Recently, sensitive observations of pulsars have revealed unexpected structure in the scintillation pattern, which could arise from highly anisotropic scattering at a thin screen localized along our line-of-sight, with substructure in the screen producing dozens of discrete images that persist for weeks or months [1]. The longevity of this substructure suggests the possibility of predicting scintillation and removing it from observations. To better understand the scattering process, Brisken et al. [2] used global VLBI at 327 MHz to image the scattering screen of pulsar B0834+06 (whose scintillation spectrum exhibits striking substructure), and found a very shallow dependence of the locations of the individual images on frequency over the 32-MHz observing band.

Numerous mechanisms have been proposed to explain the anisotropic, localized scattering and the longevity of the individual images; I will focus on one: refractive lensing from current sheets closely aligned with our line-of-sight to the pulsar [3]. This theory makes direct observational predictions, including the expected change in the scintillation pattern over time and frequency [4]. If the current sheets are underdense compared to the ISM, the expected changes in the image locations with frequency are consistent with the shallow dependence observed by Brisken et al. [2] in pulsar B0834+06. To further test the predictions made by this model, the scattering screen must be imaged many times as the pulsar moves behind it to determine how the positions and brightnesses of the individual images change over time. To this end, we have observed pulsar B0834+06 with global VLBI eight times over a three month period with a similar set-up as the previous observations by Brisken et al. [2]. These observations allow us to test the consistency of the model with observations and determine the accuracy and limitations of predictions made by this model. Understanding the source of pulsar scintillation will not only provide us with insight into the processes that cause scattering in the ISM but will also allow us to better predict and remove the effects of scintillation in observations of compact radio transients. Finally, if the images of the pulsar on the scattering screen are long-lived and stationary, they can be used to perform interferometry on the pulsar itself with unprecedented resolution [5]. Understanding the scattering behaviour can provide insight into the limits of this technique.

## 2. References

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