High-Frequency Interstellar Scattering of Pulsar B1937+21

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Aspen Center for Physics: Physical Applications of Millisecond Pulsars

NANOGrav
International Pulsar Timing Array
NSF
PIRE
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Stochastic Gravitational Wave Background and the ISM


Demorest et al. 2012
The ISM and Coherent Deconvolution

\[ y(t) = h(t) \ast x(t) \]

\[ Y(\nu) = H(\nu)X(\nu) \]

\[ S_y(\nu; \alpha) = H(\nu + \alpha/2)H^*(\nu - \alpha/2)S_x(\nu; \alpha) \]

\[ S_y(\nu; \alpha_n) = H_{ISM}(\nu + \frac{\alpha_n}{2})H^*_{ISM}(\nu - \frac{\alpha_n}{2})I(n)S_0 \]

From Demorest et al. 2011
A Brief Overview of Cyclic Spectroscopy

- Demorest 2011 – on the arXiv at 1106.3345
- 4 MHz subband bandwidth
- ASP @ 430 MHz
- But how will CS perform in weakly scattered cases?

The cyclic spectrum: amplitude and phase (simulated data)

Best-fit IRF (impulse response function) from ISM
CS aims to deconvolve the ISM’s IRF from original pulse profile
Here, we simulate IRFs for a scattering time of $\tau$ $\mu$s and a SN value of the corresponding CS and recover their centroids (compared with input centroids).
AO Observations of B1937+21: 2012 Sep 28 with PUPPI: 32 x 6.25 MHz raw bands
B1937+21 observations: results based on simcyc code (G. Jones) (available @ https://github.com/gitj/pycyc)
B1937+21 observations: best fit $h(t)$ / IRF and $h(f)$ in its phase and amplitude
Conclusions

- CS successfully deconvolves IRF from pulse profile for B1937+21 at 430 MHz
- Deconvolution at L-band is a work in progress with promising first results for a best-fit IRF (a more weakly scattered case is more challenging)
- Similar study is also underway for J1713+0747 at 430 MHz (another weakly scattered case) – Nipuni Palliyaguru
- Next: incorporate entire 200MHz baseband PUPPI bandwidth