Part 3
Studies of Radio Emission

Section D. Instrumentation

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Analysis of PSR 1641–45 Using Specialized Capabilities of the S2 VLBI Correlator

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Abstract. The pulsar PSR 1641-45 was observed using the S2 VLBI Recording System at 1.6 GHz with radio telescopes at Tidbinbilla and Narrabri in Australia, and at Hartebeesthoek in South Africa. The data were correlated with the Canadian S2 VLBI Correlator using the 'fast-dumping' mode in conjunction with two independent pulsar gates. The high time and spectral resolution capabilities of this correlator permit a detailed examination of dispersion and dispersion-removal effects on individual pulses, and a comparison of these effects from pulse to pulse over the duration of the observation. We give a brief summary of the pulsar processing capabilities highlighted by examples from the PSR 1641-45 data.

The Canadian S2 Space VLBI Correlator (Carlson et al. 1999) was designed with specialized digital signal processing features, including two independent pulsar gates, and the unique ability to output correlator coefficients every millisecond. When these features are used in combination, the correlator can achieve a maximum spectral resolution of 41.6 kHz per channel over a 16 MHz bandwidth. The result is a powerful tool for generating high temporal *and* spectral resolution VLBI pulsar data.

Signal-to-noise ratio (SNR) can be dramatically improved in VLBI pulsar data by removing the effect of dispersion after correlation, and re-exporting the data for further analysis. Integrated pulse profiles can also be created from dispersion-corrected VLBI pulsar data by applying a Fourier transform to the pulse train, and subsequently applying an inverse Fourier transform to the envelope of the resulting spectra.

Studying the effects of dispersion on pulsar signals using VLBI may shed new light on the properties of the dispersion curve at high spatial resolution. By applying dispersion removal to strong, highly dispersed single pulses, we have the opportunity to observe changes in the value of Dispersion Measure over time. Also, by examining changes in pulse phase across the observing bandwidth over time, we may discern subtle changes over frequency and/or time in the dispersion curve. These examinations of high resolution VLBI pulsar data can explore the structure of the dispersion curve as a function of sky frequency.

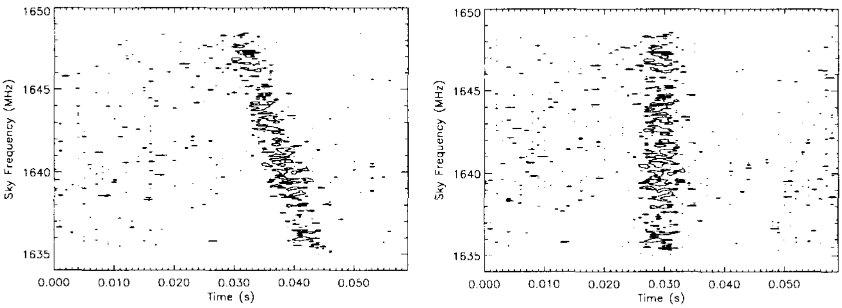

Figure 1. Magnitude contours (correlation coefficient amplitude) as a function of pulse arrival time vs. sky frequency for a single pulse detected on the TID x ATCA baseline. On the left, the raw pulse data. On the right, after post-correlation dispersion removal (DM=475).

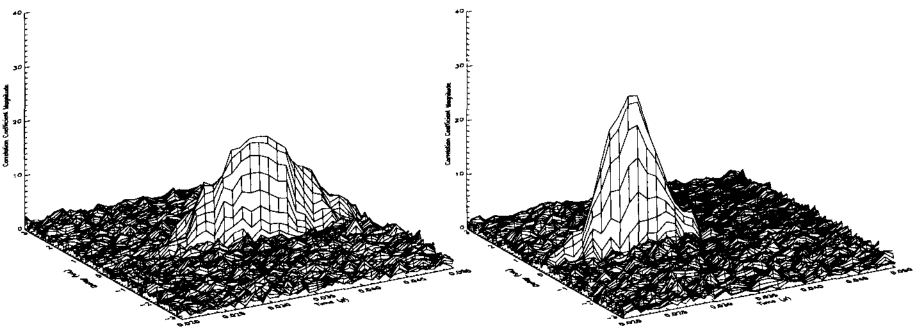

Figure 2. Correlation coefficient amplitude plotted as a function of pulse arrival time vs. delay channel. On the left, the raw pulse data. On the right, the same pulse after dispersion removal. Dispersion removal produces a stronger and more compact single pulse profile, increasing the SNR on an individual pulse by as much as a factor of 2, and revealing true features in strong, individual pulses at the limits of correlator time and spectral resolution.

References

Carlson, B. R. et al. 1999, PASP, 111, 1025-1047