

Observations of the interstellar scintillation of nearby pulsars at 1.7 GHz with the 32-m Toruń radiotelescope

Malgorzata Redmerska, Maciej Konacki, Wojciech Lewandowski
Toruń Centre for Astronomy, Nicolaus Copernicus University,
ul. Gagarina 11, 87-100 Toruń, Poland

Alex Wolszczan

Pennsylvania State University, Department of Astronomy and
Astrophysics, 525 Davey Lab, University Park, PA 16802, USA
Toruń Centre for Astronomy, Nicolaus Copernicus University,
ul. Gagarina 11, 87-100 Toruń, Poland

Abstract. Preliminary results of 1.7 GHz monitoring of the interstellar scintillation of low-DM pulsars with the TCFA 32-m radiotelescope are presented. The dynamic spectra of pulsar intensity variations have been measured with the PSPM-2 which is a $2 \times 64 \times 3$ MHz - channel spectrometer. The 192 MHz total bandwidth of this device provides an adequate frequency coverage to fully parametrize the observed scintillation. A distinct multiple imaging event has been identified in the dynamic spectra of PSR B1133+16.

Propagation of radio waves through the turbulent interstellar plasma leads to intensity scintillation of the observed pulsar signal in time and frequency (Rickett 1990). Particularly interesting is a relatively unexplored regime of weak scintillation that becomes important at shorter wavelengths and for low - DM pulsars. Under such circumstances, simple source imaging events are sometimes observed, because in the weak scattering regime the size of a source image is comparable to the Fresnel radius. In fact, interference patterns observed in the dynamic spectra of multiply imaged pulsars may take a form that is sufficiently uncomplicated to be useful in the investigations of the strongly refracting structures in the ionized interstellar medium. Furthermore, such measurements can be used to probe the pulsar magnetospheres themselves (Cordes & Wolszczan 1986; Wolszczan & Cordes 1987; Gupta et al. 1994).

In this paper, we present preliminary results of a multiple imaging monitoring program initiated in 1998 at the Toruń Centre for Astronomy (TCFA) in Poland with a 32-m radiotelescope and the Penn State Pulsar Machine - 2 (PSPM-2).

Observations were made with the 32-m TCFA radiotelescope at frequencies around 1.7 GHz on numerous occasions in 1998-99. A dual-circular polarization signal, mixed down to 150 MHz, was fed into the PSPM-2, which is a $2 \times 64 \times 3$ MHz - channel, computer - controlled radiometer. After detection and adding the opposite hands of circular polarization, the signal was 4 - bit quantized, sampled synchronously with the pulsar period and stored for further processing.

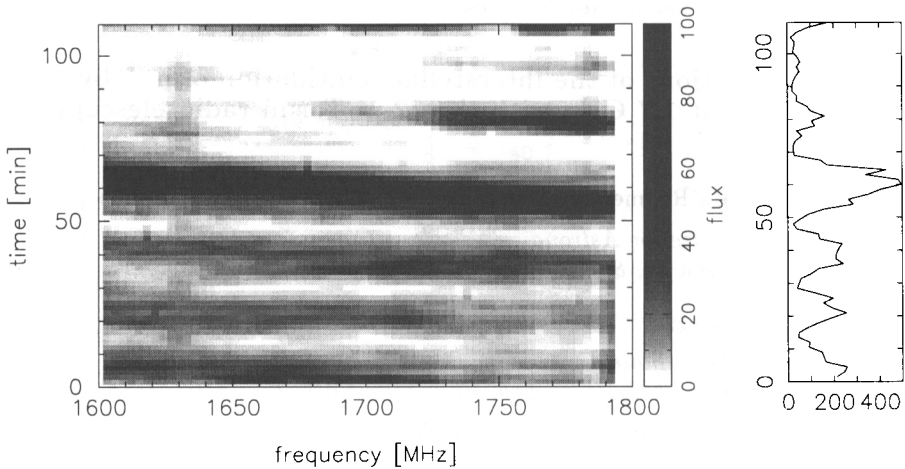


Figure 1. A multiple imaging event in the Nov. 10, 1998 dynamic spectrum of PSR B1133+16. The side panel shows intensity variations in time integrated over the entire 192 MHz bandpass.

The analysis involved computation of the 64 - channel dynamic spectra of the program pulsars, typically sampled at 60 s intervals over the periods of time ranging from 60 to 240 minutes. After bandpass calibration and man - made interference excision, 2-D autocorrelation functions of the spectra were formed to measure the characteristic time and frequency scales of the observed intensity variations.

A representative dynamic spectrum shown in Fig. 1 emphasizes the usefulness of the broad, 192 MHz bandwidth of the PSPM-2 spectrometer in high frequency monitoring of the interstellar scintillation of low-DM pulsars. In fact, among the data analyzed so far, the spectra of PSR B1133+16 are of particular interest. As shown in Fig. 1, the drifting, broadband intensity maxima in this spectrum are periodically modulated in time. Similar behavior of this pulsar has been observed in the past (Wolszczan et al. 1989; Smirnova et al. 1994) and interpreted in terms of a refractive multiple imaging of the source.

Full analysis of all the data collected so far for PSR B1133+16 and other program sources will be presented in the forthcoming paper.

References

- Cordes, J. M. & Wolszczan, A. 1986, *ApJ*, 307, L27
 Gupta, Y., Rickett, B. J. & Lyne, A. G. 1994, *MNRAS*, 269, 1035
 Rickett, B. J. 1990, *ARA & A*, 28, 561
 Wolszczan, A. & Cordes, J. M. 1987, *ApJ*, 320, L35
 Wolszczan, A., Bartlett, J. E. & Cordes, J. M. 1989, *Proc. Radio Wave Scattering in the Interstellar Medium*, AIP 174, 145