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Parameters of microstructure and noiselike intensity fluctuation in pulsar radio emission measured with submicrosecond time resolution provided by the S2 VLBI recording/playback system

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Abstract. Three bright pulsars (B0950+08, B1133+16, and B1929+10) were observed with the 70-m radio telescope in Tidbinbilla at a frequency of 1650 MHz using the S2 Data Acquisition System which provided continuous recording of pulsar signals in two conjugate bands of B=16 MHz each. Parameters of microstructure have been analyzed using the predetection dispersion removal technique.

1. Data reduction

The observations have been conducted with 70-m DSN radio telescope in Tidbinbilla on 24 April 1998 for pulsar B1929+10 (VLBI project with space radio telescope HALCA), and on 25 January 1999 for pulsars B0950+08 and B1133+16 (dedicated single dish observations). Standard S2 VLBI data acquisition system (Cannon et al. 1997; Wietfeldt et al. 1997) was used for continuous recording in two conjugate bands of 16 MHz bandwidth each with two-bit sampling mode.

S2 tapes were played back through Tape-to-Computer Interface (TCI) at CRESTECH to the hard disk storage of SUN Workstation Computer.

The core of data processing is dispersion removal procedure (Hankins 1971) which in our case was preceded by decoding of two-bit sampled signal.

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2. General results

We used four approaches in data analysis: short-term autocorrelation functions (ACF), distribution of amplitudes of detected signal, crosscorrelation functions (CCF) between conjugate frequency bands, and comparison with the amplitude modulated noise model (AMN), proposed by Rickett (1975).

Main results of our analysis can be summarized as follows:

1. Radio emission of all three pulsars B0950+08, B1133+16, and B1929+10 was found to have regular microstructure with time scale shorter than that was measured at lower radio frequencies ($\sim 100\mu s$).

2. Very short time scale feature is marginally seen in the mean CCF between radio emission in two conjugate 16-MHz bands for pulsar B1929+10. It has time scale of about $1\mu s$, and demonstrates superdispersion delay of about $5\mu s$.

3. Histograms of microstructure time scales show fast increase to shorter time scales down to some minimum value (different for different pulsars) where the histograms manifest sharp cutoff.

4. No micropulses with submicrosecond time scale and no unresolved micropulses were found to be present in radio emission of the investigated pulsars.

5. Intensity distribution normalized by current rms value was found to be the same for ON-pulse and OFF-pulse recorded signals what is in favour of AMN model, while modulation index and amplitudes of broad component of the ACF near zero-lag show deviation from the prediction of AMN model.

6. It was found, in general, the shorter is time scale the less is microstructure modulation index.

Our analysis of pulsar radio emission with the resolution of 62.5 ns has not detected any nanosecond structures. Such nanosecond single pulses still may be present in radio emission representing the source of "shot noise" postulated for AMN model (Cordes 1976). Probably nanosecond pulse might be observed as a seldom phenomenon like the "giant" pulses from the Crab pulsar. Micropulses in our presentation have durations of about $100\mu s$ and are thus ensembles of many emitters. The microstructure parameters in our understanding are related to the spatial properties of large scale plasma turbulence.

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References

Cannon, W. H., Baer, D., Feil, G., Newby, P., Novikov, A., Dewdney, P., Carlson, B., Petrachenko, W. T., Popelar, J., Mathieu, P., & Wietfeldt, R. D. 1997, Vistas in Astronomy, 41, 2, 297

Cordes, J. M. 1976, ApJ, 210, 780

Hankins, T. H. 1971, ApJ, 189, 487

Rickett, B. J. 1975, ApJ, 197, 185

Wietfeldt, R., Van Straten, W., Del Rizzo, D., Bartel, N., Cannon, W., & Novikov, A. 1997, A&A, 31, 549

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