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Glitch Behavior of the Pulsar B1822−09 in the Range 0.1–2.3 GHz

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Abstract. Results of timing observations of the glitching pulsar B1822-09 made practically simultaneously at widely separated frequencies of 0.1 and 1.6/2.3 GHz during seven years since 1991 to 1998 are discussed.

1. Introduction

In 1994 and 1995 the pulsar B1822-09 underwent two glitches in its spin-down behavior and they had an unusual signature - an increase in rotational frequency was accompanied by a decrease in the magnitude of the frequency derivative. As a consequense, the observed post-glitch relaxation presented a continuous spin-up of the pulsar which lasted approximately 620 days (Shabanova 1998).

Here we present an analysis of these glitches based on a seven-year span of simultaneous observations of PSR B1822-09 made at the frequency of 0.1 GHz at Pushchino Radio Astronomy Observatory (PRAO), Russia and at the frequency of 1.6/2.3 GHz at Hartebeesthoek Radio Astronomy Observatory (HartRAO), South Africa.

2. Observations and results

Timing observations of PSR B1822-09 at the 26-m HartRAO radiotelescope were carried out at 1.6 or 2.3 GHz, using the system described by Flanagan (1993). At PRAO, the observations were made using the BSA radiotelescope, which is a linearly polarized transit antenna, operating at 102.7 MHz. Arrival times were estimated by template cross-correlation and referred to the barycenter of the Solar System at infinite frequency using the JPL ephemeris DE200 and the astrometric parameters from Arzoumanian et al. (1994). The pulse arrival times had uncertainties from 0.3 to 3 ms and were approximately the same at the three observing frequencies of 0.1, 1.6 and 2.3 GHz. The HartRAO and the PRAO barycentric data sets were combined and a second-order polynomial fit was performed to obtain residuals from a timing model.

Figure 1 shows the variations of the spin-down parameters $\nu, \dot{\nu}$ with time. As can be seen, the glitches have an unusual signature. The value of $\dot{\nu}$ decreases by ~0.7% at the time of the second glitch (arrow 2a). While the frequency

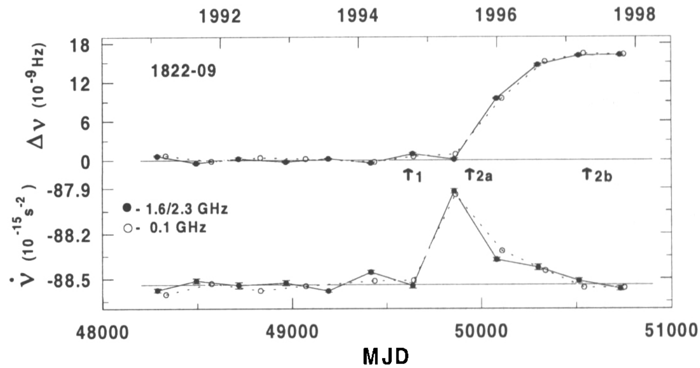

Figure 1. Frequency residuals, $\Delta\nu$, and the frequency derivative, $\dot{\nu}$, during a 7-yr interval of HartRAO and PRAO observations. The glitch epochs are marked by arrows.

derivative increases back to its initial value, a slow increase in the frequency rate during 620 days is observed (between arrows 2a and 2b). The gradual change in $\Delta\nu$ reflects the change in the $\dot{\nu}$. As seen, both the frequency residuals, $\Delta\nu$, and the frequency derivative, $\dot{\nu}$, have identical behavior at two observing frequencies and hence in the wide frequency range from 0.1 to 2.3 GHz during a 7-yr interval of simultaneous observations.

An analysis of the high- and low frequency phase residual curves showed that the glitches did not affect the pulse arrival times at different frequencies within 2 ms. The two sets of residuals were identical both for the pre-glitch interval and at the time of the glitches.

Delayed increases in rotation rate were previously observed in the 1989 glitch of the Crab pulsar (Lyne et al. 1992). It is possible, that we observed a similar glitch event in PSR B1822-09. The decrease in the slow-down rate at the time of the glitch has not been reported earlier. Identical behavior of ν and $\dot{\nu}$ in the wide frequency range from 0.1 to 2.3 GHz suggests that magnetosheric noise is the same at high and low frequencies.

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