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Pulsar timing noise spectra of pulsars 0834+06, 1237+25,1919+21, 2016+28 from 1978 - 1999 yrs. observations

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Abstract. The long time series of observations of four pulsars made by the Pushchino Large Phased Array are analyzed to describe a pulsar timing noise. The analysis was made after making a standard fitting procedure.

Timing of "normal" pulsars is making at the Pushchino Radio Astronomy Observatory (PRAO) from 1978 yr. The longest observation series of PSR 1919+21 and PSR 0834+06 have several gaps due to some technical reasons. Observations were made at 102.746 MHz up to 1998 yr. and 111.4 MHz after. We have used for our analysis data reduced and fitted with "TIMAPR" routine (Doroshenko & Kopeikin, 1990). Parameters $N_0, \nu, \dot{\nu}, \ddot{\nu}, \alpha, \delta, \mu_\alpha, \mu_\delta$ were fitted. The initial set of Time of Arrivals (TOA) of pulsar pulses is shown on Fig.1.

To evaluate red noise power spectra the discrete Fourier transform (FT) was used. We have involved a spline procedure to get a quasi-uniform sequence of TOA.

Excluding points in the low frequency part of power spectrum distorted with fluctuations and points in the high frequency part below observational white noise limits we have got slopes of power spectra curves, that are shown in Tab.1.

PSR	B0834+06	B1237+25	B1919+21	B2016+28
Slope	-1.02	-0.97	-1.02	-1.00
Error	0.05	0.07	0.07	0.15

Table 1.

For all the pulsars above we have got the noise with $1/f$ - like spectra that is refered as a flicker noise in phase. It's possible that FT transformation is not convenient technique for these observational sequencies (Deshpande, D'Alessandro, & McCulloch 1996). It should be mentioned that analysis of some parts of observation of PSR 1919+21 and 0834+06 shows slopes ~ -1.5 at frequency window 2 - 5 yr^{-1}.

We are especially interested in behavior of so-colled Allan's $\sigma_y(\tau)$ variance of pulsar rotational frequency that is characteristic of a dimensionless stability of a pulsar as a high stable clock. The problem was discussed theoretically concerning single and binary pulsars (Ilyasov, Kopeikin, & Rodin 1998).

Result of calculation of the Allan's variance $\sigma_y(\tau)$ is shown on Fig.2. Curves for B0834+06 and B1919+21 pulsars fall down uniformly in 20 years interval.

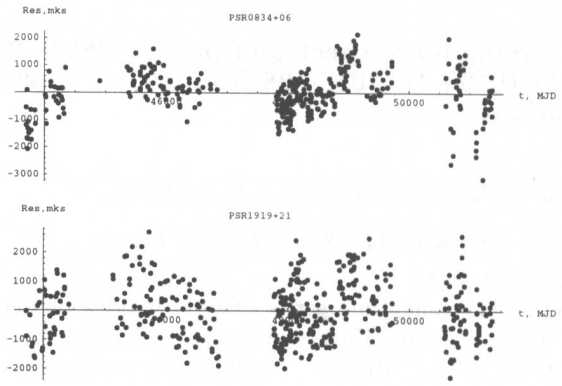

Figure 1. Post-fit residuals of PSR0834+06 and 1919+21 in 20 years interval

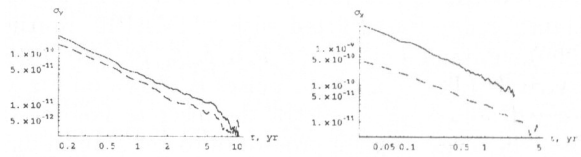

Figure 2. Allan's variance $\sigma_y(\tau)$ for pulsars B0834+06, B1919+21 (left graph), and B1237+25, B2016+28 (right graph), solid lines correspond to B1919+21 and B2016+28

There are not any meaningful jumps or flex points on the graph, that proves earlier statement about a fitness of singular pulsar as time standard in 10 - 20 years. The minimum value of Alan's variance is 3 10^{-12}.

The slope of both curves taken in whole interval is about -0.96, that corresponds -1.9 slope for σ_y^2. So, we can say that it's described with white phase noise and flicker noise in phase mixed models (Walls & Allan, 1986).

References

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