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Scintillation Velocity of PSR B0329+54

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Abstract. We monitored PSR B0329+54 for one year using the Nanshan 25-m radio telescope, the scintillation velocity $V_{\rm ISS}$ shows evidence of systematic variation with the day of the year. States of interstellar medium (ISM) are discussed.

Key words. Pulsar—interstellar medium—interstellar scintillation.

1. Introduction

Based on a thin-screen model, the scintillation speed $V_{\rm ISS}$, the speed of the scintillation pattern relative to the Earth, can be derived by the decorrelation bandwidth $\Delta\nu$ and the characteristic time scale Δt (Gupta *et al.* 1994):

$$V_{\rm ISS} = 3.85 \times 10^4 \frac{\sqrt{x D_{\rm kpc} \Delta\nu_{\rm d,MHz}}}{\nu_{\rm GHz} \Delta t_{\rm d,s}} \quad {\rm km/s}, \tag{1}$$

where D is the pulsar distance and $x = L_{\rm o}/L_{\rm p}$ ($L_{\rm o}$ is the distance from the scattering screen to the observer and $L_{\rm p}$ is that from the screen to the pulsar). For a mid-placed screen, $x = 1$. The scintillation speed is also seen as the effective velocity of the relative motion between the pulsar, the ISM and the Earth. We simulate the expected speed $V'_{\rm ISS}$ using different x in equation (10) in Bogdanov *et al.* (2002). In this paper, we present the results of scintillation observations of PSR B0329+54 and discuss the implication to states of interstellar medium.

2. Results and discussion

The recent monitoring contains 29-epoch well-distributed observations throughout 2008. Time variation of $V_{\rm ISS}$ from this project is shown in Fig. 1. In earlier data, we find six sporadic observations from 2004 to 2007 on PSR B0329+54. As shown in Fig. 1, these points superpose over data observed in 2008 ignoring the particular year (e.g., Bignall *et al.* 2003). The plot reveals a connotative correlation between the two sessions of observations on PSR B0329+54, indicating a periodic variation component of scintillation parameters.

Neglecting the velocity of ISM, the simulations on $V'_{\rm ISS}$ in terms of $x = 1$ and $x = 2$ show that the maximum fluctuation in $V'_{\rm ISS}$ caused by Earth's velocity is

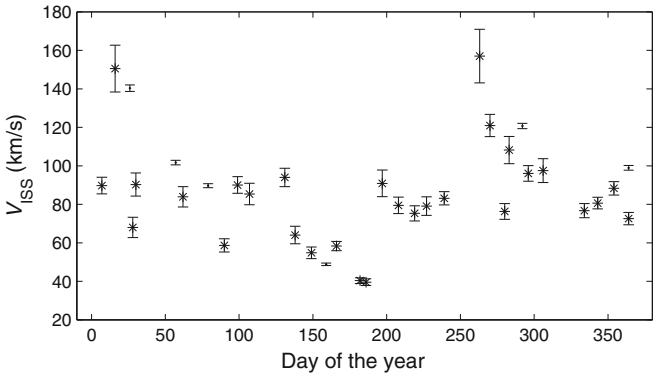

Figure 1. Plots of scintillation velocity $V_{\rm ISS}$ against the day of the year. Asterisks indicate results provided by monitoring data and dots indicate sporadic observations.

within the range of ± 10 km/s (this confirms the prediction in Cordes 1986) and not sensitive to x. Actually, the interstellar medium is moving with a magnitude of 10 km/s (e.g., Rickett *et al.* 2000). So the velocity of ISM is of same importance as the Earth's velocity in the definition of $V'_{\rm ISS}$. But it has stochastic or sometimes with persistent direction which is distinct from the Earth's velocity. From Fig. 1, $V_{\rm ISS}$ shows fluctuation with an amplitude of more than ± 50 km/s which can only be partially accounted for by the velocity of the Earth and ISM assuming $x = 1$.

As mentioned above, the scintillation parameter values obtained through two sessions of observations implied a secular, periodic change which cannot be fully interpreted as intrinsic temporal properties of the scattering medium. The remaining fluctuation beyond that is caused by the Earth and ISM could be ascribed to the fluctuation of the scattering medium for long-term scintillation observations.

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