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ORIGINAL ARTICLE

Short timescale intensity fluctuations of PSR B1133+16 and PSR B1237+25 due to interstellar scintillation at 1.54 GHz

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Abstract We report on the short timescale intensity fluctuations of PSR B1133+16 and PSR B1237+25 due to scintillation at 1.54 GHz. The structure functions of intensity fluctuations are constructed and the linear fittings are applied to the structure regime in log–log plots to get the slope values. The slope of the SFs for PSR B1237+25 are less than that of PSR B1133+16, and both of them are much less than 2. For PSR B1133+16, the slope values agree very well with a Kolmogorov spectrum predicted value 5/3, whereas PSR B1237+25 not. We investigate the dynamic spectrum and obtain its auto-correlation function (ACF). Scintillation parameters are obtained by fitting to the auto-correlation function of the dynamic spectrum. The observed diffractive interstellar scintillation (DISS) timescales agree well with the observations and are consistent with some expected values, but the observed de-correlation frequency bandwidths are much less than predicted ones. The expected refractive interstellar scintillation (RISS) timescales are also estimated by using our derived diffractive scintillation parameters. They are consistent with the timescales of slow pulse intensity fluctuations. We proposed that the short timescale of pulse intensity variations caused by the DISS are modulated by the slow variations due to the effects of RISS.

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1 Introduction

As the perfect point sources, pulsar signals are significantly affected by scintillation as they propagate through the interstellar medium (ISM), which includes angular and temporal broadening, intensity variations in time and frequency. More and more observations suggest that interstellar scintillation (ISS) is certainly the dominant cause of intra-day variability (IDV) and intra-hour variability (IHV) in some active galactic nuclei (Jauncey et al. 2000; Rickett 2002; Bignall et al. 2003; Lovell et al. 2003). Macquart and de Bruyn (2006) reported on the IDV of the quasar J1819+3845 at 1.4 GHz. The dynamic spectrum of this source clearly demonstrated that the short timescale (20–120 min) variations superposed on the long timescale (about 6 hour) variations. According to their point of view, the fluctuations on a shorter timescale were most likely related to the diffractive ISS (DISS), whereas the variations on a longer timescale matched those expected from refractive ISS (RISS). ISS is caused by the random electron density fluctuations in the ionized ISM. The strength of ISS will be weak if the *field coherence scale* ($s_0 = 1/(k\theta_d)$) becomes close to the *Fresnel scale* ($r_f = \sqrt{d/k}$), and be strong on the contrary, where k is the radio wavenumber and d is the pathlength through the turbulent medium. It's correlated with observation frequency f whether weak or strong scintillation. The transition frequency f_c, from weak to strong scintillation, is $f_c \propto d^{0.65}$. Observations of pulsars (distance $>$ 100 pc) at frequencies below 1 GHz usually fall in the strong scintillation regime, which comprises two scintillation branches,