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Constraint on Parameters of Inverse Compton Scattering Model for PSR B2319+60

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Abstract. Using the multifrequency radio profiles of pulsar PSR B2319+60, two parameters of inverse Compton scattering model, the initial Lorentz factor and the factor of energy loss of relativistic particles are constrained.

Key words. Pulsar—inverse Compton scattering—emission mechanism.

1. Introduction

Among various kinds of models for pulsar radio emission, the inverse Compton scattering model (ICS) is the one that can well reproduce the observed radio pulse profile shapes, frequency evolution of profiles and polarization features (Qiao 1988; Qiao *et al.* 2001). Recently, efforts were made to constrain the model parameters (Zhang *et al.* 2007; Lee *et al.* 2009) for a few pulsars. In this paper, we report constraints for the parameters of ICS model for PSR B2319+60 when considering the uncertainties of inclination angle α between the rotation and magnetic axes.

2. Data analysis

The average pulse profiles of PSR B2319+60 at $f = 0.925, 1.408, 1.642, 4.85$ and 10.55 GHz are obtained from European Pulsar Network (EPN) database. The data are reduced in the following steps to constrain the parameters:

- The profiles are fit by 3 Gaussian components by Gaussian decomposition technique. We measure $\Delta\phi$, the pulse width at 10% peak intensity level of the reconstructed profile with Gaussians, which are $24.74^{\rm o} \pm 0.74^{\rm o}$, $23.55^{\rm o} \pm 0.99^{\rm o}$, $22.59^{\rm o} \pm 0.29^{\rm o}$, $19.75^{\rm o} \pm 0.62^{\rm o}$, $20.56^{\rm o} \pm 1.3^{\rm o}$ for the above corresponding frequencies.
- Calculate the angular radius of emission beam θ_μ according to widely used geometrical relations, which is a function of α, $\Delta\phi$ and the maximal slope rate of polarization position angle κ. The observed κ is -8, while the derived α varies from $12^{\rm o}$–$35^{\rm o}$ according to different groups (Kuz'min & Wu 1992; Kijak & Gil 1997).
- Fit the (θ_μ, f) data with the $\theta_\mu - f$ relation in ICS model to constrain the range of two model parameters, i.e., initial Lorentz factor γ_0 of relativistic particles and energy loss factor ξ, which are related by $\gamma = \gamma_0[1 - \xi(r - R)/R_{\rm e}]$.

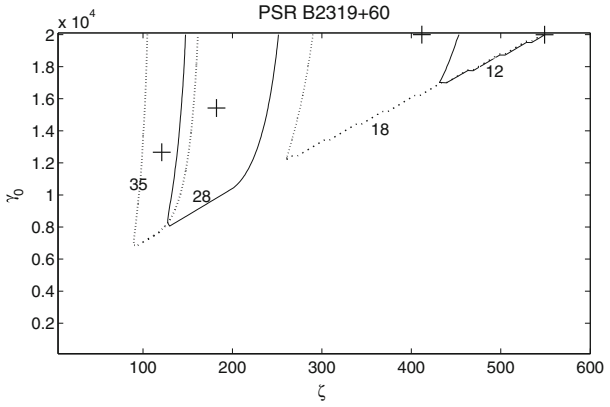

Figure 1. Allowable parameter space of the ICS model. The γ_0 and ξ are the initial Lorentz factor and energy loss factor of particles, of which the constrained region depends on inclination angle α. From right to left, the contours at 68% confidence level are shown for $\alpha = 12^o, 18^o, 28^o, 35^o$.

3. Results

Figure 1 presents the best fit regions at 68% confidence level for γ_0 and ξ, which depend on α. The main results are summarized as follows:

- γ_0 and ξ are larger than $\sim$6000 and $\sim$90, respectively. The allowed ranges show a trend of decreasing γ_0 and ξ as α increases.
- According to relation between ξ and γ, relativistic particles will lose about half of the kinetic energy at the height of six star radius when $\xi > \sim 90$.

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