Luminosity of synchrotron radiation in pulsar magnetospheres

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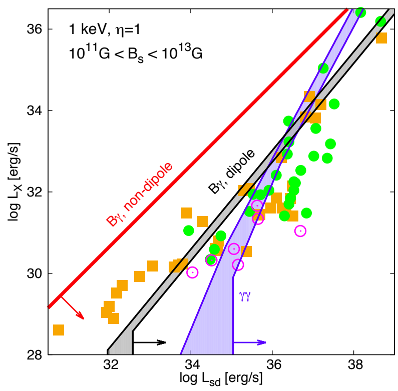

Figure 1: Synchrotron X-ray luminosity L_X from particles created through $\gamma\gamma$ (blue) and Bγ processes with dipole (black) and no-dipole magnetic field (red) at the emission region as a function of the spin-down luminosity L_{sd}. The circles are observed values. [1].

Synchrotron radiation is widely considered to be the origin of the pulsed non-thermal emissions from rotation-powered pulsars in optical and X-ray bands. The observed X-ray and optical emissions provide the energy flux of secondary particles created from curvature photons emitted by primary particles in the magnetosphere. Since γ-ray, X-ray, and optical emitting particles are related through a pair cascade process, their flux ratios are useful to understand the pair cascade process in the magnetosphere.

We study the synchrotron radiation emitted by the created electron and positron pairs in the pulsar magnetosphere to constrain the energy conversion efficiency η from the Poynting flux to the particle energy flux. We model two pair creation processes, two-photon collision ($\gamma\gamma$) and magnetic pair creation (Bγ). Using the analytical model, we derive the maximum synchrotron luminosity (Fig. 1). The synchrotron luminosity is proportional to the energy conversion efficiency η for all models. From the comparison with observations, we find that the energy conversion efficiency to the accelerated particles should be an order of unity to explain the observed luminosities, even though we make a number of the optimistic assumptions to enlarge the synchrotron luminosity. The obtained maximum luminosity would be useful to select observational targets in X-ray and optical bands.

References

[1] S. Kisaka & S. J. Tanaka, 2017, arXiv:1702.03365

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