Pion Production in TeV Energy Region under Strong Magnetic Fields in Relativistic Quantum Approach

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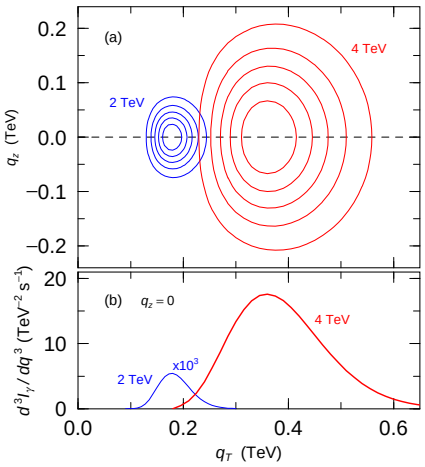
It is widely accepted that soft gamma repeaters correspond to magnetars [1]. The magnetars have also been proposed as an acceleration site for ultra high-energy cosmic rays. Synchrotron radiation can be produced by high-energy protons accelerated in a strong magnetic field.

In this work we study pion production from proton synchrotron radiation in the strong magnetic fields in the relativistic quantum approach including the Landau level and the anomalous magnetic moment [3]. We develop our method to give results for a very large number of the Landau levels 10^{12} by using the scaling relation [4]. Then, we have first succeeded to obtain momentum distribution of emitted pions.



In Figure we show the photon luminosity distribution per a proton when the magnetic field $B = 10^{15}$G at initial proton energies of 2 TeV (thin lines) and 4 TeV (thick lines). Their contour plots are presented in the upper panel and those at $q_z = 0$ in the lower panel. In these calculations we make an average of the luminosity over the proton angles.

In our approach, we will be able to calculate the emitted photon distribution and to obtain significant information about the magnetic structure of magnetars from observations of energetic photons.

[1] S. Mereghetti, Annu. Rev. Astron. Astrophys., **15**, 225 (2008).
[3] T. Maruyama et al., Phys. Rev. **D91**, 123007 (2015).
[4] T. Maruyama. M.-K. Cheoun, T. Kajino, G.J. Mathews, Phys. Lett. **B757**, 125 (2016).