

Multi-Messenger Modeling of the Monogem Pulsar Halo

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The High-Altitude Water Cherenkov Telescope (HAWC) has detected TeV halos associated with two nearby pulsars/pulsar wind nebulae (PWN) - Geminga and B0656+14 (Monogem). These TeV halos extend up to tens of parsecs from the central accelerators, indicating that the diffusion of electrons and positrons in the interstellar medium has been suppressed by two orders of magnitude. Although Geminga and Monogem are at similar distances and in the same field of view, they have distinct histories. Notably, Monogem probably still resides within its parent supernova remnant, the Monogem Ring, which can be observed in X-rays. In this work, we perform high-resolution simulations of the propagation and emission of relativistic lepton pairs around B0656+14 using a two-zone diffusion model within the GALPROP framework. We compared the predicted inverse-Compton spectrum to the observations made by HAWC and Fermi-LAT and found physically plausible model parameters that resulted in a good fit to the data. Additionally, we estimated the contribution of this TeV halo to the positron flux observed on Earth. We conclude that future observations of the TeV halo and its synchrotron emission counterpart in radio frequencies and X-rays will be crucial to distinguish between various possible model parameter configurations.

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