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Forecasting the Monogem TeV halo with CTAO

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The High-Altitude Water Cherenkov Telescope (HAWC) has detected TeV halos associated with two nearby pulsars and their pulsar wind nebulae (PWNe), Geminga and B0656+14, in the 8–40 TeV energy range. These TeV halos extend up to tens of parsecs from their central accelerators, indicating that the diffusion of electrons and positrons in the interstellar medium is suppressed by two orders of magnitude compared to typical Galactic values. Although Geminga and B0656+14 are at similar distances and located within the same field of view, they exhibit distinct evolutionary histories. Notably, B0656+14 likely remains within its parent supernova remnant, the Monogem Ring, observable in X-rays. In one of our previous works, we performed high-resolution simulations of the propagation of relativistic leptons around B0656+14 using a two-zone diffusion model within the GALPROP framework. These simulation results show that we need more robust GeV-TeV observations of this sky region to constrain TeV halo model parameters. In this project, we simulate observations of B0656+14 based on our theoretical predictions of the GeV–TeV gamma-ray spectrum and the CTAO instrumental response functions. These allow us to understand better the intrinsic properties of PWN such as the extent of the slow diffusion region around the PWN and its magnetic field strength. These properties are crucial for interprating cosmic ray (CR) propagation through the Galaxy and will provide new insights into the observed CR spectrum, particularly the electron and positron components.

Author: LI, Youyou (GRAPPA, University of Amsterdam)

Presenter: LI, Youyou (GRAPPA, University of Amsterdam)

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