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On the origin of the complex energy-dependent structure of HESS J1702-420

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HESS J1702-420 is an unidentified multi-TeV gamma-ray source with a peculiar energy-dependent morphology which most naturally can be explained as a composition of two independent emission components with significantly different spatial and energy distributions. Here we propose an alternative interpretation assuming that we deal with a single hadronic accelerator injecting protons with energies extending to at least 0.5 PeV. In the suggested scenario, both the extended (elongated) component of radiation with a soft gamma-ray spectrum and the compact point-like component with a very hard spectrum have the same origin associated with the interactions of injected protons with the surrounding dense gas environment but are produced at different stages of proton propagation. The component produced at the initial (quasi) ballistic regime of proton propagation has a compact image (angular distribution) focused on the accelerator and an energy spectrum which reflects the acceleration spectrum. The second (extended) component is the result of radiation at the stage when the protons enter the diffusion stage of propagation. Thus the image of this component reflects the spatial distribution of protons. Its spectrum is steeper because of the modulation of the proton spectrum in the course of diffusion. The joint analysis of these two components allows us to derive the power-law index of the acceleration spectrum and the proton injection rate, and the energy-dependent diffusion coefficient. Assuming the distance to the source d=0.3 kpc, the characteristic medium density of ~100 cm^{-3} and diffusion coefficient D(E)=3 x 10^{26} cm^2/s we argue that the system can be well described by the protons' injection rate ~6 x 10^{37} erg/s.

Track

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