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SNR G39.2–0.3, an hadronic cosmic rays accelerator

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Recent results obtained with gamma-ray satellites have established supernova remnants as accelerators of GeV hadronic cosmic rays, which produce detectable gamma-ray emission through interaction with particles from gas clouds in their surrounding. In particular, the rich medium in which core-collapse SNRs explode provides a large target density to boost hadronic gamma-rays. SNR G39.2-0.3 is one of the brightest SNRs in infrared wavelengths, and its broad multiwavelength coverage allows a detailed modelling of its radiation from radio to high energies. The collection of the available multiwavelength data certainly favours a hadronic origin of the gamma-ray emission. The GeV spectrum obtained from the re-analysis of the Fermi LAT data implies that the present acceleration of protons is limited to below 10 GeV, which in turn points to a drastic slow down of the shock velocity due to the dense wall traced by the CO observations, surrounding the remnant. Further investigation of the gamma-ray spectral shape points to a dynamically old remnant subjected to severe escape of CRs and a decrease of acceleration efficiency. The low-energy (below 1 GeV) peak of the gamma-ray spectrum, which suggests extremely low maximum energy of freshly accelerated protons, is, however, not easily reproduced within typical acceleration and evolution models. We discuss several scenarios that may explain such a spectral shape, one of which is the heavy composition of accelerated particles which is certainly expected for a core-collapse SNR with an environment enriched by heavy nuclei from stellar winds of the progenitor star. We also show that a widely discussed idea of gamma-ray production by compressed and re-accelerated pre-existing Galactic cosmic rays cannot explain the observed emission.

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