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Bayesian Modeling of Galactic Cosmic-Ray Propagation

Recent measurements from advanced cosmic-ray detectors have revealed spectral features that includes a hardening in the GeV–TeV energy range, challenging standard model of cosmic-ray acceleration and propagation. The re-acceleration of cosmic rays by weak shocks in the Galaxy offers a promising explanation, accounting for the observed spectral features of different nuclei and the boron-to-carbon (B/C) ratio. In this picture, cosmic rays are accelerated by strong supernova shocks before diffusing through the Galaxy. During propagation, they undergo re-acceleration upon encountering expanding supernova remnant shocks. Since older remnants are more likely to be encountered than younger ones due to larger size, re-acceleration is predominantly driven by weaker shocks, resulting in a softer particle spectrum below $\sim$ 100 GeV. At higher energies, the spectrum is dominated by cosmic rays from young supernova remnants. In this study, we use the Markov Chain Monte Carlo (MCMC) method to determine key parameters governing cosmic-ray transport, such as diffusion properties, re-acceleration strength, and solar modulation, using observational data from the AMS-02, CALET, CREAM, DAMPE, and Voyager experiments. In this contribution, we present the initial results of this analysis.

Collaboration(s)

Author: YADAV, Ankit

Co-authors: EICHMANN, Björn (Ruhr-University Bochum); RACHEN, Jörg Paul (IMAPP / Radboud University Nijmegen); THOUDAM, Satyendra (Khalifa University)

Presenter: YADAV, Ankit

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