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A Markov Chain Monte Carlo technique to sample transport and source parameters of Galactic cosmic rays

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We implemented a Markov Chain Monte Carlo (MCMC) technique within the USINE propagation package to estimate the probability-density functions for cosmic-ray transport and source parameters within an 1D diffusion model. From the measurement of the B/C ratio and radioactive cosmic-ray clocks, we calculate their probability density functions, with a special emphasis on the halo size L of the Galaxy and the local underdense bubble of size r_h. We also derive the mean, best-fit model parameters and 68% confidence intervals for the various parameters, as well as the envelopes of several elemental ratios. Additionally, we verify the compatibility of the primary fluxes with the transport parameters derived from the B/C analysis before deriving the source parameters (slope, abundance, and low-energy shape). Finally, we investigate the impact of the input ingredients of the propagation model on the best-fitting values of the transport parameters (e.g., the fragmentation cross sections) in order to estimate the importance of the systematic uncertainties. We conclude that the size of the diffusive halo depends on the presence/absence of the local underdensity damping effect on radioactive nuclei. Moreover, we find that models based on fitting B/C are compatible with primary fluxes. The different spectral indices obtained for the propagated primary fluxes up to a few TeV/n can be naturally ascribed to transport effects only, implying universality of elemental source spectra. Finally, we emphasise that the systematic uncertainties found for the transport parameters are larger than the statistical ones, rendering a phenomenological interpretation of the current data difficult.

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