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Transition from Galactic to Extragalactic Cosmic Rays

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Understanding the nature of the transition from Galactic to extragalactic cosmic rays (GCRs and EGCRs) has become a challenge in light of recent spectral and composition data. Galactic contributions appear to be disfavoured at energies beyond 10^{17} eV where the composition becomes lighter, and extragalactic sources appear to inject mixed compositions, complicating the description of the EGCR contribution below "ankle" energies. As a result, the measured flux in the transition region cannot easily be accounted for. With the model-dependence of proposed extensions to both the Galactic and extragalactic contributions, a deeper understanding of CR propagation is in order, particularly within the Galactic magnetic field (GMF) as propagation herein shifts from diffusive to ballistic at these energies, which is expected to lead to a range of effects on CRs.

Using CRPropa3, we study these effects for rigidities between 10^{16-20} V. We identify various features at rigidities where the gyroradius equals typical length scales of the Galaxy, suggesting causes related to changes in the propagation regime. We further quantify modifications in the spectrum, composition and arrival direction of GCRs and EGCRs. We find that the GMF naturally induces a flux suppression of GCRs towards higher rigidities. This, in consequence, would lead to an increase in the mean mass of GCR primaries up to energies around the "ankle" in the cosmic ray spectrum. The distribution of GCR arrival directions is also shown to be correlated with the Galactic plane for rigidities above 10^{17} V. EGCRs experience no flux modification in the GMF if injected isotropically. Injection of pure dipoles, as well as single source scenarios indicate that the GMF isotropises injected anisotropies below 10^{18} V, but can still cause flux modifications depending on the direction of the anisotropy. Overall consequences to the transition of GCRs to EGCRs will be discussed.

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