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CRPropa high statistic simulations for UHECR anisotropy studies

Despite the great progress made by modern cosmic ray observatories, the origin and acceleration mechanism of ultra-high-energy cosmic rays (UHECRs) remains an unsolved problem to this day. However, there is experimental evidence for an anisotropic component in the UHECR arrival direction greater then few EeV. The search for UHECR sources is further complicated by two main factors: during extragalactic propagation UHECRs interact with background photon fields (like the CMB and the EBL) and, since they are electrically charged, they are deflected by extragalactic and galactic magnetic fields (EGMF and GMF). Moreover, the strength, structure and origin of the EGMF are still not well known, causing reconstructing the deflection of UHECRs a non-trivial task. In this work we consider several EGMF models obtained from constrained MagnetoHydroDynamics (MHD) simulations of our local Universe to study the propagation of UHECRs through such a structured environment. We simulate propagation, interactions and observation of UHECRs by using the Monte Carlo code CRPropa3. We also take into account the effect of the GMF by adopting a lensing procedure of the arrival UHECR sky map. We explore several combination of source distribution, EGMF structure and mass composition. As a reference, we also simulate scenarios without the EGMF and with a statistically homogeneous field. We use our simulation results to compute UHECR observables, such as the energy spectrum, the angular power spectrum and the arrival direction map (before and after the GMF) in order to obtain constraints on possible combinations of source distributions and EGMF models.

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