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Electromagnetic Cascades and Intergalactic Magnetic Fields

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The strength and structure of intergalactic magnetic fields (IGMFs) are an open problem in cosmology. Gamma-ray-induced electromagnetic cascades can be used to probe IGMFs as their charged components are sensitive to the underlying structure of the fields. For a complete Monte Carlo treatment of the effects of IGMFs on the development of electromagnetic cascades, GRPropa was developed. This novel tool enables the propagation of gamma rays and secondary electrons and photons in arbitrary magnetic field configurations, accounting for all relevant energy loss processes such as synchrotron emission and adiabatic losses due to the expansion of the universe, as well as interactions with pervasive photon fields including the cosmic microwave background and the extragalactic background light. Using simulations obtained with GRPropa the formation of blazar pair halos in the presence of intervening helical magnetic fields is studied. Combined, this and other studies can potentially be used to constrain the mechanisms whereby IGMFs originated.

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