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Improved predictions of ultra-high-energy neutrinos and cosmic rays from gamma-ray bursts

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Gamma-ray bursts (GRBs) conceivably contribute to the flux of ultra-high-energy (UHE) cosmic rays and neutrinos, with the latter expected to be produced in proton-photon interactions inside the relativistic plasma jets of GRBs. We consider UHE particle production in a model where cosmic rays are emitted both as neutrons and as protons that are able to overcome their magnetic confinement and "leak out" of the source. In this context, present-day cosmic-ray and neutrino observations and bounds are already able to constrain the possibility that GRBs are the main sources of both types of particles. Furthermore, we discuss particle emission using a simulated evolving GRB jet, where the total particle spectra result from the superposition of multiple internal collisions, each one occurring under different conditions of particle creation. Thus, we demonstrate the need for multi-messenger studies in order to build a complete and unbiased picture of cosmic accelerators. From our simulations, we also derive a new and robust minimal diffuse GRB neutrino flux prediction that could be tested in next-generation neutrino telescopes.

Collaboration

– not specified –

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