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Ultrahigh-energy cosmic-ray signature in GRB221009A

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The brightest long gamma-ray burst (GRB) detected so far by the \textit{Swift}-BAT and \textit{Fermi}-GBM telescopes, GRB~221009A, provides an unprecedented opportunity for understanding the high-energy processes in extreme transient phenomena. We find that the conventional leptonic models for the afterglow emission from this source, synchrotron and synchrotron-self-Compton, have difficulties explaining the observation of
$gtrsim 10$ TeV γ rays (as high as 18 TeV) by the LHAASO detector. We modeled the γ-ray spectrum estimated in the energy range 0.1-1 GeV by the \textit{Fermi}-LAT detector. The flux predicted by our leptonic models is severely attenuated at > 1 TeV due to $\gamma\gamma$ pair production with extragalactic background light, and hence an additional component is required at
$gtrsim 10$ TeV. Ultrahigh-energy cosmic rays can be accelerated in the GRB blast wave, and their propagation induces an electromagnetic cascade in the extragalactic medium. The line-of-sight component of this flux can explain the emission at
$gtrsim 10$ TeV detected by LHAASO, which requires a fraction of the GRB blast wave energy to be in ultrahigh-energy cosmic rays. This could be an indication of ultrahigh-energy cosmic-ray acceleration in GRBs.

Primary author: DAS, Saikat (Yukawa Institute for Theoretical Physics, Kyoto University, Japan)

Co-author: Prof. RAZZAQUE, Soebur (Center for Astroparticle Physics, Department of Physics, University of Johannesburg, South Africa)

Presenter: DAS, Saikat (Yukawa Institute for Theoretical Physics, Kyoto University, Japan)

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