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Modelling external inverse Compton emission of gamma-ray burst afterglows in the very-high-energy regime

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Gamma-ray bursts (GRBs) comprise of short, bright, energetic flashes of emission from extragalactic sources followed by a longer afterglow phase of decreased brightness. Recent discoveries of GRB 180720B and GRB 190829A afterglow emission up to very-high-energy γ-rays by H.E.S.S. have raised questions regarding the emission mechanism responsible. We interpret these observed afterglows to be the result of inverse Compton (IC) emission of ultrarelativistic electrons in an external radiation field, and present predictions of spectra corrected for the γ-ray attenuation by absorption of photons through their interaction with the extragalactic background light (EBL). Thus, we fit an attenuated model of the form $dN/dE = (dN/dE)_{\mathrm{EC}} e^{-\tau(E,z)}$, where $(dN/dE)_{\mathrm{EC}}$ is the intrinsic external Compton spectrum, the exponential term corresponding to the attenuation, and τ is the energy-dependent optical depth for a source at redshift z, to the data. Our model reproduces an increase in attenuation, due to the EBL, with source distance (above $z \approx 0.1$), whereas nearby GRBs experience less attenuation, requiring a smaller correction due to EBL absorption and allowing the intrinsic spectrum to be determined. These findings constrain the GRB environment assuming an IC emission mechanism which mitigates the particle energy requirements for the emission observed at late times and has consequences for the future observations of GRBs at these extreme energies.

Track

GRBs

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