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Cascade Radiations of $e^{\pm}$ from $\gamma\gamma$-annihilation process as an extra component of the Early Optical/X-Ray Afterglows of Gamma-Ray Bursts

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Chromatic break and/or plateau observed in the early optical and X-ray afterglow light curves challenge the conventional external shock models of gamma-ray bursts (GRBs). Detection of TeV gamma-ray afterglows indicates strong gamma-ray production within the afterglow jets.
We investigate the cascade radiations of the $e^{\pm}$ production via the $\gamma\gamma$ interaction in the jets. Our numerical calculations show that the cascade synchrotron emission can make a significant contribution to the early optical/X-ray afterglows. The combination of the primary and cascade emission fluxes can shape a chromatic break and/or plateau in the early optical/X-ray light curves, depending on the jet properties. Applying our model to GRBs 050801 and 080310, we found that their optical plateaus and the late X-ray/optical light curves can be explained with our model in reasonable parameter values. We suggest that such a chromatic optical plateau could be a signature of strong $e^{\pm}$ production in GRB afterglow jets. The TeV gamma-ray flux of such kind GRBs should be significantly reduced, hence tends to be detectable for those GRBs that have a single power-law decaying optical afterglow light curve.

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