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An inhomogeneous jet model for the rapid variability of TeV blazars

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Abstract. We present a new time-dependent inhomogeneous jet model of non-thermal blazar emission, which reproduces the entire spectral energy distribution together with the rapid gamma-ray variability. Ultra-relativistic leptons are injected at the base of a jet and propagate along the jet structure. We assume continuous reacceleration and cooling, producing a relativistic quasi-Maxwellian (or "pile-up") particle energy distribution. The synchrotron and synchrotron self-Compton jet emissivities are computed at each altitude. Klein-Nishina effects as well as intrinsic gamma-gamma absorption are included in the computation. Due to the pair production optical depth, considerable particle density enhancement can occur, particularly during flaring states. Time-dependent jet emission can be computed by varying the particle injection, but due to the sensitivity of pair production processes, only small variations of the injected density are required during the flares. The stratification of the jet emission, together with a pile-up distribution, allows significantly lower bulk Lorentz factors, compared to the ones obtained with the commonly used one-zone models, in better agreement with observational and statistical constraints. Applying this model to the case of PKS 2155-304 and its big TeV flare observed in 2006 with H.E.S.S., we can reproduce simultaneously the average broad-band spectrum of this source from radio to TeV, as well as the TeV light curve of the flare with a bulk Lorentz factor lower than 15.

Additional Information

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