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The electrostatic instability for realistic pair distributions in blazar/EBL cascades

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Abstract content

Very high-energy gamma-rays from TeV blazars interact with the extragalactic background light producing pair beams. These pairs emit secondary photons in the GeV range by the inverse Compton scattering. However, the measured GeV signal is smaller compared to one predicted from the full electromagnetic cascade. From what follows that the pairs are affected by some other physical processes leading to the reduction of their energy flux. One relevant mechanism is the electrostatic instability induced by the pair beams in the IGM plasma.
We revisited the linear growth rate of this instability analytically for the realistic distribution function of pairs without inverse Compton cooling. Our results indicate that the finite angular spread of the beam has a considerable effect on the electrostatic growth rate. Moreover, the growth rate is much higher than in the case when the inverse Compton scattering is included.
To explore the non-linear beam evolution, we made Particle-In-Cell simulations. The simulated beam loses 1% of its energy during the simulation, while the energy lose would achieve 100% after 100 simulation times.
Using analytical estimations, we extrapolated our results to the realistic pair beam parameters and found the lower limit on the relaxation time of the beam. The pair beam can dissipate its energy faster than the inverse Compton scattering, but a more accurate model is required to make firm predictions for individual blazars.

Primary author(s) : Dr. VAFIN, Sergei (Institute for Physics and Astronomy, University of Potsdam, D-14476 Potsdam, Germany)

Co-author(s) : Prof. POHL, Martin (DESY); Prof. NIEMIEC, Jacek (Institute of Nuclear Physics, Polish Academy of Sciences, ul. Radzikowskiego 152, 31-342 Kraków, Poland); Mr. RAFIGHI, Iman (Institute for Physics and Astronomy, University of Potsdam, D-14476 Potsdam, Germany)

Presenter(s) : Dr. VAFIN, Sergei (Institute for Physics and Astronomy, University of Potsdam, D-14476 Potsdam, Germany)

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