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Suppression of the TeV pair-beam plasma instability by a weak intergalactic magnetic field

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Several gamma-ray observations from distant blazars show a suppressed GeV band emission of the inverse Compton cascade of the blazar-induced pair beams. There are two possible justifications, the first one is the deflections of the pair beam electrons and positrons by magnetic fields in the intergalactic medium. The second one is the drain of the pair energy by plasma beam instabilities resulting in heating the cold intergalactic plasma. Commonly, the analytical studies of the plasma instabilities of blazar-induced pair beams in the literature assume a non-magnetized intergalactic medium. However, the existence of an intergalactic magnetic field with sufficient strength suppresses the plasma instabilities as we show in this paper. In this work, we investigate the effect of a weak intergalactic magnetic field, with a spatial scale much smaller than the pair beam energy loss scale, on the plasma instability. We found that such weak fields, even if they don't modify the dispersion relation describing the electrostatic waves, they increase the angular distribution of the particles in the beam, which in turn reduce the linear growth rate of the electrostatic instability. Taking into account two damping processes of the electrostatic waves, we approximate the energy loss time scale for the beam instability for each IGMF strength and spatial scale. Comparing this time with that for the inverse - Compton scattering, we found the limit in the (B_{IGM}, λ_{B}) parameter space where the growth of the plasma oscillations starts to be suppressed.

Keywords

gamma rays: general - BL Lacertae objects: general - plasma instabilities - intergalactic magnetic fields

Collaboration

other Collaboration

Subcategory

Theoretical Results

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