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On photon splitting bound on Lorentz-violating mass scale from multi-TeV photon observations

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We discuss the loop-level process of photon splitting to three photons in quantum electrodynamics (QED) with broken Lorentz invariance at high energies. Concetrating to the model of standard QED with additional positive quartic term in photon dispersion relation, we calculate the rate of the process of photon splitting below the threshold of three-level process of photon decay to electron-positron pair. Although the rate of the spitting process is very small, it is very sensitive to primary photon energy, and may be compared with the rate of the photon decay at the energies of several tens TeV at the distances of several kpc or larger. Hence, photon splitting may lead to a suppression in high-energy part of spectra of known sources. Absence of such suppression in the high-energy part of spectrum of the Crab nebula is used to set lower bounds on the energy scale of Lorentz invariance violation. The bound on quartic Lorentz-violating term is better than the bound from the absence of photon decay to electron-positron pair as well as from photon timing observations, and seems to be the best in the literature. The bound would be further improved by the next generation of multi-TeV gamma-ray observatories.

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