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Revisiting light propagation over quantum Universe

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One of principal aspects in which the effects of quantum gravity are hoped to manifest itself through possible modification to a dispersion relation of electromagnetic (e-m) waves. By combining (i) the symmetry reduced approaches to spacetime quantization, including loop quantum cosmology or geometrodynamics framework, and (ii) the (extension of the) Born-Oppenheimer approximation of interacting fields, one can build a reliable though still quasi-phenomenological model for a description of propagation of the e-m radiation over a cosmological spacetime. The past works employing such approach indicated a pathological behavior - superluminal propagation at low energies. We reexamine the approach via systematic studies (using indicated method) of e-m wave propagation over a flat quantum Friedmann-Lemaitre-Robertson-Walker Universe using a synthesis of analytical and numerical methods. It turns out, that (i) the e-m wave propagation agrees with the one predicted by general relativity in the low energy limit, and (ii) loop quantum effects actually suppress the modifications to the dispersion relation in comparison with those predicted, where the geometry is quantized via geometrodynamics.

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