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Electromagnetic waves in an axion-active plasma

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In the framework of Einstein-Maxwell-Vlasov-axion model we analyzed the dispersion relations for the perturbations in an initially isotropic and homogeneous axionically active ultrarelativistic plasma, which expands in the de Sitter-type cosmological background, and classify the longitudinal and transversal electromagnetic modes. We show that for the special choice of the guiding model parameters the transversal electromagnetic waves in the axionically active plasma can propagate with the phase velocity less than speed of light in vacuum, thus displaying a possibility for a new type of resonant particle-wave interactions.

The presence of the pseudoscalar (axion) field ϕ provides the plasma to become a gyrotropic medium, which displays the phenomenon of optical activity. The frequencies of transversal electromagnetic waves are shown to depend not only on the wavelength, but also on the gyration coefficient $p = \dot{\phi}$, and this dependence has a critical character. To be more precise, when $p \neq 0$, the dispersion equations admit some new branches of solutions in addition to the standard ones. If to consider the transversal electromagnetic wave propagation in terms of left- and right-hand rotating components, one can state, that one of the waves (say, with left-hand rotation) can have arbitrary wavelength, while the second wave can possess the wave number less than critical one; in this sense we deal with some kind of mode suppression caused by the axion-photon interactions.

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