Kinetic dispersion theory of linear dispersion relations in anisotropic plasmas: An alternative approach

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Extensive research has been done over the years to study the dispersion properties of various waves and instabilities considering simple Cartesian geometry or Cartesian geometry parameterized with cylindrical coordinates in such plasmas [1-7]. On the other hand, there are some certain astrophysical and laboratory plasma environments where the Cartesian geometry parameterized in spherical polar coordinates is used to explore the dispersion properties of the waves with anisotropy in momentum space. For example, the dispersion relations of high-temperature deconfined strongly interacting matter have been analyzed in a situation when there is an anisotropy in the momentum-space distribution function that plays an important role in the dynamical evolution of quark-gluon plasma [8,9]. A linear dispersion relation for an unmagnetized electromagnetic wave in ultra-relativistic anisotropic plasma with arbitrary temperature degeneracy have also been derived [10]. Such a study is reported to be important due to the desirable accounting for plasma oscillations on the dielectric constant including electron degeneracy and screening in the context of white dwarfs and neutron stars [11]. In the present investigation, we consider the particle distribution function of the form $f_0(|p|) = f_0(\sqrt{(p^2 + \xi(p.n)^2)})$ and derive the dielectric tensor to revisit longitudinal and transverse waves for the relativistic anisotropic plasmas. Compared to the previously known standard results derived using cylindrical coordinate systems, the present study may prove to be an important addition in the form of velocity integrals. The study may also prove to be important for the evaluating the plasma response functions for the regions where the relativistic effects predominantly exist with temperature anisotropy. The analysis may also be important in the regions where the plasma expands spherically. For example, a high-power laser that irradiates a spherical plasma where the anisotropy in the electron distribution function predominantly exists [12]. This is mainly due to the homogeneous heating of the plume by the energetic species giving rise to the anisotropic expansion of the plasma [13].

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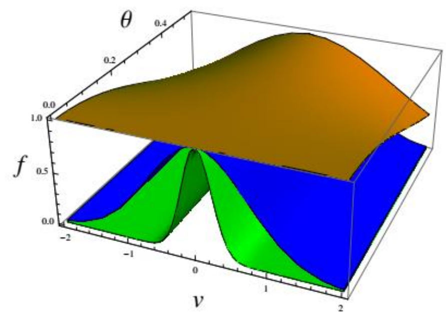

Fig.1 of the manuscript (submitted for publication)

Note: Abstract should be in (full) double-columned one page.