Abstract

In recently years, there has been increasing interest in the theoretical and experimental study of Quark-Gluon Plasma (QGP), which is believed to have existed in the early universe.

Normal nuclear matter is made up of protons and neutrons, which are themselves made up of quarks, antiquarks and gluons. When a nuclear matter is compressed and heated, it transforms to Quark-Gluon Plasma (QGP) and protons and neutrons lose their identity. Scientists at CERN and RHIC laboratories have performed a number of experiments over the last 15-20 years aimed at trying to create Quark-Gluon Plasma (QGP) in the laboratory. Some signals from these experiments do indicate the formation of this new state of matter called Quark-Gluon Plasma (QGP). Discussion of the same constitutes the first part of the thesis.

The second part of the thesis describes the mathematical apparatus for QGP state and develops the covariant relativistic formulation. We apply the same for the ultra-relativistic case for electron plasma. An interesting result is obtained i.e., the linear Landau damping disappears.

In the third part of the thesis we apply the same model to study the linear Landau damping in Quark-Gluon Plasma (QGP). We calculate the polarization tensor and then split that into transverse and longitudinal parts. Assuming the plasma particles to be ultra-relativistic i.e., their thermal velocity is nearly the velocity of light c; we find that, for $\omega \rangle kc$, the imaginary part of both the longitudinal and transverse components of polarization tensor vanishes. This shows that the linear Landau damping in Quark-Gluon Plasma (QGP) is zero.

This has to do with the fact that the phase velocity of the wave is less than the particle velocity, which was taken to be c. Hence there is no resonance between the wave and the particle ruling out exchange of energy. We therefore conclude that the Landau damping in Quark Gluon Plasma (treated as ultra-relativistic) is zero.