Plasma Scattering and Instability Caused by Intense Waves

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In the field of the astrophysical plasma, collisionless shock waves play important roles in plasma dynamics. Supernova remnants, for example, have shock waves propagating outwards in which high-energy particles are generated. Gamma ray burst is another example of shock-wave-related phenomenon, where baryon kinetic energy is converted to gamma-ray-emission, according to the standard 'Fireball' model.

There are some observational results inconsistent with the estimation from theoretical models, including the strength of the magnetic field or efficiency of the particle acceleration. To explain these inconsequent things we need to consider nonlinear effects of the shock waves. That is, back reaction caused by the accelerated particles themselves, or modification of the upstream state by plasma waves emitted from the shock wave front.

In this study we will show the effects of intense plasma waves causing wave-wave interactions, known as Raman scattering and Brillouin scattering, and consequent modification of the plasma velocity distributions, by PIC simulation. We will also discuss about the Weibel instability and magnetic field generation which may be caused as the result of the modification of the plasma distribution function. The importance of the plasma wave scattering in the magnetized media will be considered in comparison with the scattering by incoherent photons, which basically is not affected by the presence of the magnetic field.