## PLASMA DAMPING OF GRAVITATIONAL WAVES

C.Sivaram
Indian Institute of Astrophysics
Bangalore 560034, India

### Abstract

The possibility of the damping of plane gravitational waves while propagating in a plasma medium is considered. The gravitational plasma frequency, $\omega_G^2 \simeq G n_0 m_n$, is for a neutron star medium $\sim 10^3$ Hz, which is the same as the frequency of the gravitational waves emitted by a collapsing star. So resonant damping of such waves within a collapsing star is probable. Estimates are made for the damping length for dense and dilute plasmas (also in the presence of magnetic fields). Analogies with Landau damping are made. Applications to other astrophysical situations are outlined.

The propagation of electromagnetic waves $\omega \approx \omega_p$ in a plasma is drastically affected, leading to a shielding effect. Relative velocity between particles can fluctuate when a plane gravitational wave passes. For dense neutron star matter, the gravitational plasma frequency is $\omega_G^2 \simeq G n m_n \simeq 0.2 \cdot 10^4$ Hz and as a collapsing star emits gravitational waves with $\omega \simeq 0.1 \cdot 10^4$ Hz, this would drastically affect the propagation of such waves through the dense medium. The damping time is found to be proportional to the square of the wave frequency and varies inversely as the cube of the particle velocity. Perturbations in the charged particle trajectories due to the gravitational wave also generate electric currents in the plasma. In the presence of a magnetic field, as the gravitational waves are coupled to the electromagnetic waves, they can be cyclotron damped. The damping time is proportional to: $\omega_B / n T^{1/2} m_n^{3/2}$ ; and for conditions in a neutron star is $\sim 10^2$ sec. So these effects could be important for consideration of gravitational waves generated by a collapsing star.



*E. R. Priest and V. Krishan (eds.), Basic Plasma Processes on the Sun*, 62.