Geophysical Research Abstracts
Vol. 17, EGU2015-1053, 2015
EGU General Assembly 2015


# Nonlinear interactions of magneto-Poincare waves in rotating space plasma

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Magneto-Poincare waves are playing important role in solar tachocline studies (thin layer inside the sun is above the convective zone). These waves are also used to study the dynamics of atmospheres of neutron stars. To describe these systems the magnetohydrodynamic shallow water approximation is used.
Shallow water systems are used when transverse length scales are much larger than the water layer height and when vertical variations are inessential. Rotating magnetohydrodynamic shallow water equations are obtained from classical magnetohydrodynamic equations for incompressible inviscid heavy fluid layer with free surface in a non-inertial frame of reference, which is rotating with fluid layer by vertical averaging. The pressure is asumed to be hydrostatic, the water layer height is much less than horizontal scales. These equations are playing important role in space plasma same as classical shallow water equations in neutral flows.
Linear analisys give us the solutions for small oscillations of the layer height, velocity field and magnetic field. Most works on magnetohydrodynamics shallow water systems consider initially toroid magnetic fields, as in tachocline researches. In neutron stars studies and in their applications it makes sense to consider the vertical magnetic field and rapid rotation. These approximations lead to to magnetogravity waves (or magneto-Poincare waves) and magnetostrophic waves. Magnetostrophic mode disappears without the external magnetic field.
We have investigated the interaction of wave packets in the magnetohydrodynamic shallow water. Using the asymptotic multiscale methods we received that in magneto-Poincare mode three waves interact, in magnetostrophic mode there are three waves interactions, and also there are intermode interactions: two magnetostrophic waves and magneto-Poincare wave, two magneto-Poincare waves and magnetostrophic wave. In all cases we obtained the nonlinear interaction conditions, the non-linear interaction equations for the waves amplitudes, we analyzed decay instabilities of magneto-Poincare wave.