The excitation mechanisms of KAW by linear instability in solar and space plasmas

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Kinetic Alfven waves (KAWs) can play an important role in the heating of high-temperature plasma, the acceleration of high-energy particles, and the anomalous transport of plasma particles, which occur commonly and frequently in various plasma environment from laboratory to space and astrophysics. Therefore, the excitation mechanisms of KAWs have attracted much attention. Plasma, especially magneto-plasma, is a very energetic medium that is far from the equilibrium both in dynamics and kinetics, and hence can provide rich sources of free energy to drive various wave instabilities. Like other plasma waves, KAWs can be generated or excited by various linear and nonlinear instabilities in plasmas.

In this talk, we introduce the excitation of KAWs by plasma linear instabilities driven by the temperature anisotropy, field-aligned drift electric current in a homogeneous plasma and the excitation of KAWs driven by the density gradient in an inhomogeneous plasma. First, taking into consideration that when a static ambient magnetic field presents, the temperature anisotropy is an intrinsic characteristic for a magnetized plasma because the kinematic difference of the plasma particles in the plane perpendicular to and along the magnetic field, especially for the cases of collisionless plasmas, we investigate excitation of KAWs driven by the ion and electron temperature anisotropy, respectively, in high-beta plasmas (i.e., beta~1) based on the kinetic description of plasma by the Vlasov equation.

Second, considering that field-aligned currents can often present in a magnetic plasma, such as Birkeland currents in the polar magnetosphere and current-carrying loops in the solar atmosphere, we report excitation of KAWs by the field-aligned current carried by electrons drift motion along magnetic field lines. Three case studies of plasma beta parameters are considered: the low-beta plasma with beta<2me/mi<<1, the intermediate-beta regime of 2me/mi<beta<1, and the high-beta case of beta>=1, In addition, in a high-beta plasma, the variation of critical condition for the temperature anisotropy due to the presence of field-aligned currents is also discussed.

Field-aligned density striation is one of the most common inhomogeneity phenomena in magnetic plasmas, such as in the solar coronal plasma and in the terrestrial auroral plasma, where KAWs can play an important role in the inhomogeneous heating of solar coronal plasmas as well as in the local acceleration of auroral energetic electrons. Finally, by use of the two-fluid model of plasma, we discuss the excitation of KAWs by density gradient in an inhomogeneous plasma.

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