8th Asia-Pacific Conference on Plasma Physics (AAPPS-DPP2024) at Malacca, Malaysia

Influence of cosmic rays on the Jeans instability in magnetorotating self-gravitating galactic gaseous clouds

J. Turi[1], A. P. Misra[1]
[1] Department of Mathematics, Visva-Bharati
e-mail (speaker): jyotituri.maths@gmail.com

We investigate the generation of different kinds of magnetohydrodynamic (MHD)[1] waves and study their stability/instability properties in galactic gaseous clouds consisting of the thermal gas and cosmic rays incorporating the effects of the magnetic field, the self-gravitating force, the Coriolis force due to the rotation of the cosmic fluids. The coupling of Jeans, Alfvén and magnetosonic waves and the condition of damping or instability are studied in different wave propagation directions. We have found that stability/instability characteristics are significantly modified due to Coriolis force, self-gravitating force, cosmic ray pressure and cosmic ray diffusion[2]. It is noticed that the deviation of the axis of rotation from the direction of the static magnetic field gives rise to the coupling between Alfvén and classical Jeans mode.

The Jeans instability criterion[3] and critical Jeans wave number are extensively changed due to the presence of Coriolis force and self-gravitating force. Moreover, Jean's instability is found to exist when self-gravitating force dominates over the Coriolis force[4]. Furthermore, due to the effects of cosmic ray diffusion, a new wave mode (may be called fast Jeans mode) exists in the intermediate frequency regimes of slow and fast Alfvén waves.

The dispersion properties and instability criterion of various wave modes studied in this work can be essential in studying the forming galactic structures at different length scales.

References:

[1] E. N. Parker, "The dynamical state of the interstellar gas and field", The Astrophysical Journal 145, 811 (1966).
[2] F. Herrnegger, "Effects of collisions and gyroviscosity on gravitational instability in a two-component plasma", Journal of Plasma Physics 8, 393 (1972).
[3] R. Prajapati, A. Parihar, and R. Chhajlani, "Self-gravitational instability of rotating anisotropic heat-conducting plasma", Physics of Plasmas 15, 012107 (2008).
[4] J. H. Jeans, "The stability of a spherical nebula", Philosophical Transactions of the Royal Society of London. Series A, Containing Papers of a Mathematical or Physical Character 199, 1 (1902).

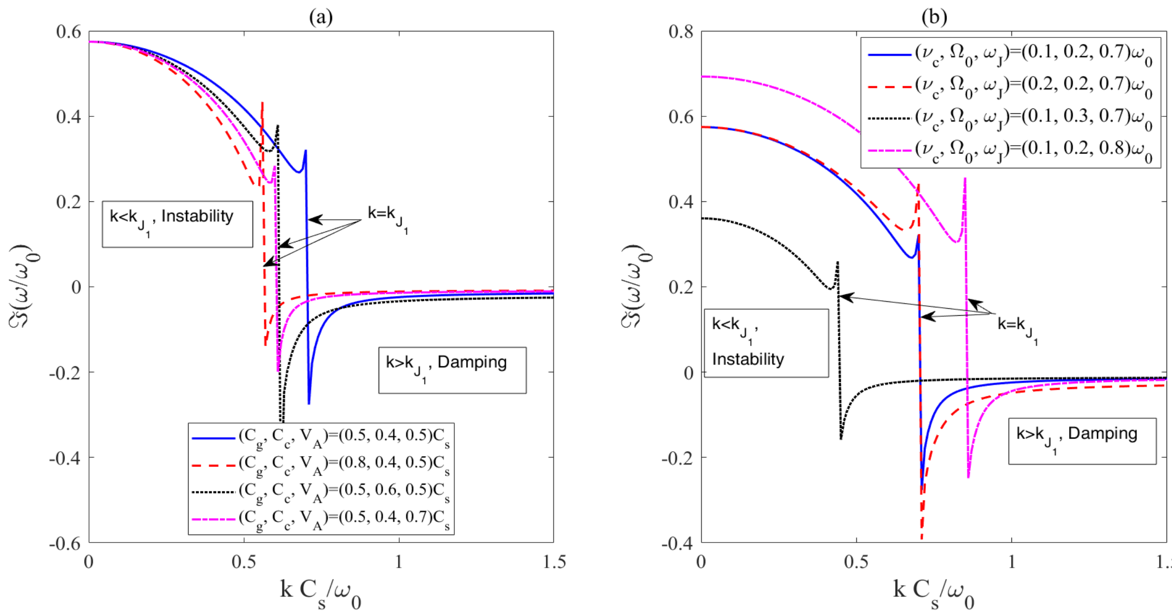

Figure 1. The growth and damping rates are shown for the Jeans Alfvén magnetosonic wave when self-gravitational force dominates over the Coriolis force. The peaks of the curves appear at the critical value k = kJ1. The wave instability occurs [$\Im(\omega/\omega_0)>0$] in the region k < kJ1 and the wave gets damped [$\Im(\omega/\omega_0)< 0$] in the other region k > kJ1.