Stability of compressible nonuniform anisotropic MHD astrophysical winds

A. G. Tevzadze and E. S. Uchava
E-mail: alexander.tevzadze@tsu.ge
Department of Physics, Faculty of Exact and Natural Sciences, Javakhishvili Tbilisi State University,
3 Chavchavadze ave. Tbilisi 0179, Georgia

We present linear stability analysis of the perturbation modes in anisotropic MHD flows with velocity shear and strong magnetic field. Collisionless or weakly collisional plasma is described within the 16-momentum MHD fluid closure model that takes into account not only the effect of pressure anisotropy, but also the effect of anisotropic heat fluxes. In this limit standard acoustic wave is revealed into a higher frequency fast thermo-acoustic and lower frequency slow thermo-acoustic waves. Thermo-acoustic waves become unstable and grow exponentially when heat flux parameter exceeds some critical value. It seems that velocity shear makes thermo-acoustic waves overstable even at subcritical heat flux parameters.

It seems that the radial decay laws of expanding outflows may define their local thermal stability far away from the source. Indeed, if magnetic field decays notable stronger then the density, i.e., the ratio of power law indices satisfy the condition $n/m > 2/3$, at some distance from the source heat flux parameter may exceed critical value and exponential instability will develop. Such situation can occur not only in strongly magnetized stellar winds, but also in specific types of jet outflows.

Phenomena described in the present paper may be also important in extremely rarified plasmas, such as intracluster gas or galactic winds. Galactic winds are thought to carry dynamo generated strong magnetic fields at larger scales, where they are observed. In such situation local exponential thermal instability will lead to destruction of a directed flow and buoyant generation of magnetic bubbles in the outflow. This mechanism will also limit the maximal value of magnetic field that such rarified ionized flow can sustain.