Anisotropic firehose instability in shear flows with heat fluxes

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Abstract

We study the effects of heat flows and velocity shear on the parallel firehose instability in the collisionless of weakly collisional plasma flow. For this purpose we use anisotropic 16-momentum MHD fluid closure model that takes into account the pressure and temperature anisotropy, as well as the effect of anisotropic heat fluxes. The linear stability analysis of the firehose modes is carried out in the incompressible limit, where the flow is parallel to the background magnetic field, while the velocity is sheared in the transverse to the flow direction.

We analyze the effects of the velocity inhomogeneity in the low shear rate limit. It seems that normally parallel firehose perturbations acquire transverse components proportional to the velocity shear parameter. On the other hand, velocity shear introduces asymmetry of the growing firehose modes: perturbations propagating streamwise and in the opposite directions exhibit growth rate asymmetry.

The effect of heat fluxes is most profound for modes with oblique wave-numbers k_{\perp}/k_{\parallel} < 1$. We have derived the effective heat flux parameter that shows the importance of the anisotropic heat effects. It seems that effects due to the heat fluxes grow with the parameter of the pressure asymmetry and plasma beta parameter. We discuss the implications of the presented study on the observational features of the solar wind and possible measurement of the wind shear based on the theoretical predictions.