Properties of firehose instability in magnetized inhomogeneous stellar winds

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We study properties of firehose instability in the presence of background velocity shear using anisotropic magnetohydrodynamic (MHD) model with heat fluxes. Collisionless or weakly collision plasma is described within the 16-momentum MHD fluid closure model that has already proved itself successful in the analysis of compressible perturbations in shear flows [1].

In present report we adopt low frequency incompressible formulation and analyze the classical firehose instability in the presence of velocity shear. Constant uniform background magnetic field is parallel to the flow direction. It seems that at low shear rates instability growth rate is modified by velocity shear independent of the heat flux anisotropy parameter $\gamma_\perp = S_\perp/P_\perp C_\perp$. Here $S_\perp, P_\perp, C_\perp$ are perpendicular to the magnetic field heat flux, pressure and sound speed. At higher shear rates heat flux anisotropy parameter becomes important at higher values of pressure anisotropy parameter $a = P_\perp/P_\parallel$. Moreover, instability shows spectral dispersion of the growth rate in the wave-number space and thus depends not only on the streamwise but also on the spanwise wave-numbers.

In general, velocity shear modifies the firehose neutral stability curve that limits perturbations propagating along the stellar winds. Indeed, deviation from standard firehose instability limit can lead observational signatures in solar wind observations that in principle can be used to estimate the spanwise velocity shear of the rarified magnetized flow.

References

[1] E. S. Uchava, B. M. Shergelashvili, A. G. Tevzadze, S. Poedts, Phys. Plasmas, **21**, 082902 (2014). doi:10.1063/1.4892402