A quasilinear analysis of Co-existence and transition of electromagnetic proton cyclotron and electron fire hose instability.

$Z.Ali^{1}$, $M.Sarfraz^{1,2}$ and $P.H.Yoon^{2}$

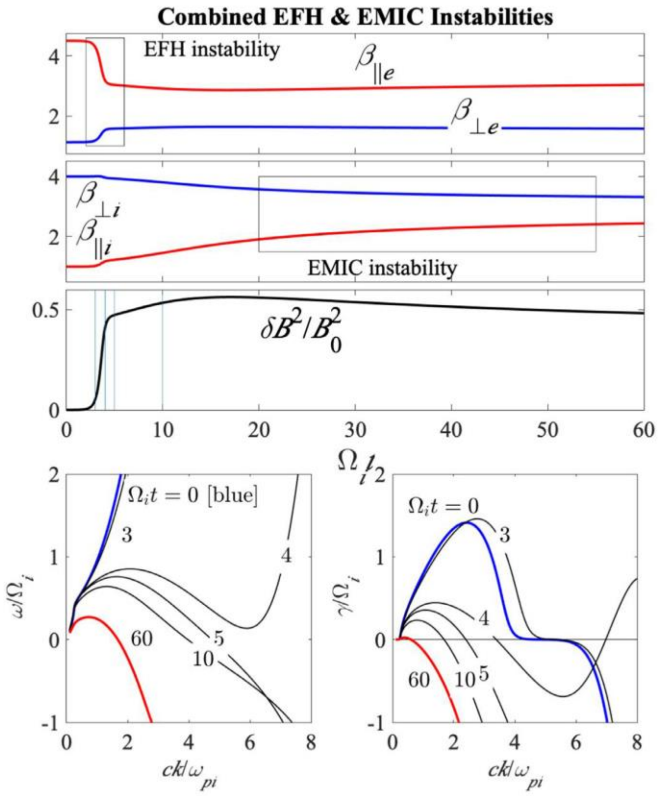
1 → Department of Physics, Government college university, Katchery road Lahore 54000, Pakistan

2 → Institute for physical science and technology, University of Maryland, College Park, Maryland 20742, USA

e-mail (speaker): zain.ali.gcu@gmail.com

When we discuss the expansion of solar wind into the interplanetary space, it generates the temperature anisotropy that cannot be justified by adiabatic fluid theory. Kinetic instabilities driven by the interplay between electrons and protons temperature anisotropy may be operative in order to explain the actual state of solar wind reported by satellite observations. Based on the temperature anisotropy, $T_{\perp}/T_{\parallel}$, and alternative different plasma beta, β, regimes of solar wind species, we have investigated the unified wave spectrum where left-hand polarized electromagnetic proton cyclotron instability driven by excessive perpendicular proton temperature anisotropy ($T_{\perp i} > T_{\parallel i}$) and electron firehose instability driven by excessive parallel electron temperature anisotropy ($T_{\perp e} < T_{\parallel e}$) may co-exist or transit with each other. Linear stability analysis catches the co-existence/transition of these instabilities in the different propagation domain. A moment-based quasilinear approach is adopted to highlight the feedback effects of these instabilities on the initial distributions and also to validate the transition during the non-linear (or quasilinear) time-evolution of the instabilities. Looking at the solar wind observations, we assume a bi-Maxwellian dual core-halo electron and proton model that allows solar wind species temperatures to vary in time t in addition. By incorporating the radial expansion effects and inhomogeneities, our present findings may be applicable to the First Solar Parker Probe observations.

Some of the sample results of combined electron firehose and EMIC instability are shown in the following figure.



References

Z. Ali, M. Sarfraz, and P. H. Yoon, Mon. Not. R. Astron. Soc. 499, 659 (2020).