Abstract

Solar wind has no longer remain a mystery now as *in-situ* measurements by different satellites have provided us a deep picture of solar terrestrial plasma. However, it still contains some unexplained marvels which need further theoretical as well as observational investigations. One of these phenomena is the damping or growth of different kinds of waves in the solar wind and magnetosphere. On a micro scale, waves can grow as a result of different kinds of instabilities. In this dissertation, those instabilities are investigated which are generated by the departure of particle distribution function from thermal equilibrium. Such type of instabilities are termed as micro-instabilities and are dependent upon the shape of the distribution function. Different sources such as pressure or temperature anisotropies, relative drift or counter-streaming particles, temperature gradients, etc. can ignite micro-instabilities. In this dissertation we consider counter-streaming plasma and temperature anisotropies as the source of micro-instabilities.

Observations of solar wind particle velocity distribution functions generally contain nonthermal features which result in departure from Maxwellian distribution. These nonthermal features of the distribution functions are well characterized by relatively cool dense 'core', the energetic suprathermal tails 'halo' and the field aligned beam 'strahl'. It is found that cool dense population is composed of 95% of the total population and the rest is composed of halo and strahl population. *In-situ* observations reveal that near the Sun the energetic strahl and halo electron populations contain a drift in anti-sunward direction while core contains a drift generally towards the Sun. Such a drift among plasma species could generate Buneman or heat flux type of instabilities in solar wind frame depending upon the type of streaming. If core and halo electrons possess a counter relative drift in solar wind proton rest frame, it could excites magnetosonic, Alfvén or whistler heat flux instabilities. All of these instabilities are observed near 1 AU and widely studied in literature. However, whistler heat flux instability is reported to be the most unstable heat flux mode for realistic solar wind conditions. Though, in this dissertation it is highlighted that it is somewhat improper to call this left-handed evolved heat flux instability as right-handed whistler heat flux instability. The electron heat flux instability investigated here, basically evolves out as a primary left-hand heat flux mode, which result due to the interaction of Doppler-

upshifted whistler and left-handed proton cyclotron mode. However, for relatively smaller magnitude of counter-streaming drifts, only right-handed whistler heat flux instability takes place as reported in literature. Furthermore, our investigation revealed electron heat flux instability and electron firehose instability to be highly reminiscent though there sources of free energy are different. Electron heat flux instability is caused by counter-streaming of the plasma and electron firehose instability by excessive temperature parallel to the ambient magnetic field. Since solar wind plasma is anisotropic in nature, these temperature anisotropies, being the source of micro-instabilities, can excite both electron cyclotron and proton cyclotron type of instabilities. Of which here a comparison between electron heat flux instability and electromagnetic electron cyclotron (EMEC) wave is presented concomitantly. This comparison illustrated different polarizations of these two modes and confirms our assertion that heat flux instability is not right-handed. Also heat flux instability being left-handed mode and electromagnetic electron cyclotron being right-handed mode exhibit different characteristics when investigated concomitantly for relative streaming and temperature anisotropies.

Alfvén instability caused by the proton temperature anisotropies has frequently been reported in outer corona of the Sun, solar wind and terrestrial magnetosheath. In this dissertation, we studied Alfvénic fluctuations in the solar wind by analyzing the CLUSTER data. A linear theory is established based on the (r, q) distribution function to investigated the growth rate of Alfven waves in presence of electron and ion anisotropies as well as electron to ion temperature ratios. We found that growth rate also affected by electron to ion temperature ration which was not considered previously in literature. We also found that threshold instability curve sets in good agreement with instability-threshold-histogram plotted for observed temperature anisotropies versus beta.