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Plasma kinetic instability and its application to the solar wind electron

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The solar (stellar) wind plasma is known to originate in the upper atmosphere of the Sun (ordinary star) and expand through interplanetary space. Among multi- species particles, the electrons play important roles in driving the expansion of the solar corona and transporting the solar wind energy through the heat flux. The properties of solar wind such as low number density and high temperature imply that Coulomb collisional rates among particles remain very low for reaching thermal equilibrium. In a weakly collisional plasma, in situ measurements have shown that the velocity distribution function of solar wind electrons typically deviates from a Mawellian and exhibits non-thermal features such as temperature anisotropy, electron beams [1-3], and the differential flow of suprathermal halo electrons with respect to thermal core electrons [4]. Such non-thermal features could be possible sources of free energy that can drive many different types of plasma kinetic instabilities, resulting from the gradient of the velocity space. The enhanced fluctuations driven by instabilities scatter particles in phase space and eventually drive the velocity distribution functions toward marginally stable state through wave-particle interactions. Recently, many observations have revealed that those instabilities could occur in the solar wind and contribute to the dynamical evolution of particles. It is the purpose of the present talk to disseminate the idea that plasma kinetic instabilities are important for understanding the origin of the observed electron velocity distribution functions and the electromagnetic fluctuations of the electron scales in the solar wind [5-8]. Among various instabilities, we shall focus on the whistler and heat flux instabilities. By making use of both linear Vlasov theory and particle-in-cell simulation [9], we shall present the recent results associated with the solar wind electron dynamics.

References

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