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Effects of electron temperature anisotropy on proton beam instability in the solar wind

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Solar wind observations often show that the drift velocity of proton beam relative to background proton decreases with the heliocentric distance. Proton-beam instability has been suggested to play an important role in the deceleration of the proton beam velocity; the effects of electron temperature anisotropy on the proton-beam instability have not been examined. Based on a general kinetic dispersion relation solver for magnetized plasma (PDRK), we investigate the effects of electron temperature anisotropy on the oblique Alfven/ion-cyclotron (A/IC) and parallel magnetosonic/whistler (M/W) instabilities driven by proton beams in the solar wind. The results show that the growth rates, real frequencies, and threshold conditions for both instabilities are sensitive to the electron temperature anisotropy T_eperp/T_eparal and the parallel electron beta beta_eparal. In the low-beta regime with beta_eparal<¥beta_eparal^c ~ 0.5, where beta_eparal^c is a critical plasma beta for which the threshold velocities of both instabilities are equal, the growth rate of the oblique A/IC instability is weakly dependent on the electron temperature anisotropy. In the high-beta regime with beta_eparal>beta_eparal^c, the growth rate of the parallel M/W instability increases with decreasing T_eperp/T_eparal. Moreover, the threshold velocities of both instabilities are shifted to lower values as T_eperp/T_eparal decreases, especially for the parallel M/W instability in the regime with beta_eparal > 1. The theoretical results for the threshold velocity together with the observed parallel electron beta and/or electron temperature anisotropy are used to explain the observed proton-beam drift velocity in the solar wind.

References

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