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Electromagnetic Polarization of Unstable Waves in the Solar Proton Temperature Anisotropy Instability

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The proton temperature anisotropy instability is widely thought of a constraint on the electromagnetic fluctuations in the solar wind. Based on the linear growth rate, the predicted relation of the parallel proton beta with the ratio of the perpendicular to parallel temperature is used to speculate the instability mechanism contributing to the observed fluctuations. Here we present a comprehensive analysis for the electromagnetic polarizations of unstable waves in solar wind plasmas containing the anisotropic proton component as well as the streaming proton and alpha particle components. The strongest electromagnetic ion cyclotron instability generates the left-hand circularly-polarized waves propagating along the background magnetic field. The strongest parallel firehose instability produces the right-hand circularly-polarized waves, propagating reversely to the background magnetic field. The mirror instability is prior to exciting the obliquely-propagating mirror waves with two anti-correlated perpendicular magnetic perturbations and the considerable large parallel electromagnetic perturbations. Besides, the oblique firehose instability excites the highly-oblique, forward propagating Alfven waves with the two unbalanced perpendicular magnetic perturbations that are nearly positive-correlated. Due to the effects of the streaming particles, the mirror and oblique firehose instabilities produce the unstable waves with a small frequency, different from the zero frequency in a motionless plasma. Combining the linear growth rate, these electromagnetic polarization features would be helpful for distinguishing the instability mechanism in the solar wind.