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Effects of Ion Temperature and Inertia on Kinetic Alfvén Waves

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Abstract: Kinetic Alfvén wave (KAW) has been an interesting topic for discussion extensively in the fields of laboratory, space, and astrophysical plasmas. A general dispersion equation is derived from the exact two-fluid model in this paper. Based on this dispersion equation, dispersion of Alfvén waves near the Alfvén frequency $\omega_A=v_Ak_{||}$ are discussed for arbitrary values of wavelength, where v_A is the Alfvén velocity, and $k_{||}=2\pi/\lambda_{||}$ is the wavenumber parallel to the ambient magnetic field. For the short wavelength cases of $k\lambda_i\gg 1$, where $\lambda_i=v_A/\omega_{ci}$ and ω_{ci} are the ion inertial length and gyrofrequency, respectively, our dispersion relations are appropriate for discussing effects of the ion temperature and inertia on KAWs. The present results show that both the ion temperature and inertia can affect considerably the behaviors of KAWs in propagation, resonance, and polarization. In particular, our results may be a great help to understanding some salient features of the low-frequency (in comparison with the ion gyrofrequency ω_{ci}) electromagnetic fluctuations frequently observed by the FREJA and FAST satellites in the auroral zone of the Earth's ionosphere and magnetosphere.

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