Contribution ID: **9** Type: **not specified**

Modified Alfvén wave of multi-ion species in the upper ionosphere of Mars

Thursday 17 October 2024 18:02 (10 minutes)

Cold-modified Alfven waves of multi-ion species propagating perpendicular to an ambient magnetic field have been investigated. We derive the linear dispersion relation for any number of species. In addition to the conduction current density, we consider the displacement current density. The derived dispersion relation suggests a magnetized plasma mode to propagate at the long-wavelength for every ion species. At the short-wavelength, the propagating mode for every ion species saturates at a resonance frequency equal to the cyclotron frequency of that ion. The Alfven wave mode is shown to be the long-wavelength mode for the heaviest ion species, while the Whistler wave mode corresponds to the less massive ion species. It is found that the displacement current density excites another mode to exist in the electron fluid, which is known as the magnetized plasma analog of Langmuir mode. The consequences of varying the magnetic field, and the total plasma density and the mixing ratios of the ion species on the resonance, the cutoff frequencies, and the propagating modes are inspected. Investigation of this model on the observed linear ULF waves on the upper ionosphere of Mars is introduced.

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