Geophysical Research Abstracts,
Vol. 11, EGU2009-11827, 2009
EGU General Assembly 2009

A unified framework for investigation of low frequency waves in the collisional ionosphere and collisionless magnetosphere

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We utilize a recently developed single fluid theory by Pandey and Wardle [1] that includes electrons, ions, neutrals and their collisions to investigate the waves in the Earth's ionosphere magnetosphere region. These equations capture the interaction between the ionosphere and magnetosphere and describe the transition region in a consistent fashion. It is shown that whereas ambipolar diffusion may affect the wave in the E layer and lower part of the F layer of the Earth, the Hall diffusion will operate throughout the ionosphere and magnetosphere, albeit with a decreasing inertial length scale. Since both Hall and ambipolar diffusion are caused by the collision in the medium, the large scale, low frequency waves in the medium will not be damped in general. In the ambipolar diffusion limit waves of only certain wavelength are undamped by the collision, and, in the Hall limit, the mixture of Alfven and whistler modes propagate undamped.

When the electrons and ions are highly magnetized, the relative drift between the plasma and neutral may significantly modify the wave characteristics. It is shown that in the presence of collision, the medium becomes inherently dispersive and the balance between dispersion and nonlinearity leads to derivative nonlinear Schrodinger equation. It is possible that such solitons may help explain the observed structures in the ionosphere—magnetosphere plasmas.

[1] B.P. Pandey and M. Wardle, MNRAS, 385, 2269 (2008).