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Sub-ion magnetic holes in the plasma injection region: origins and dynamics

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Recent spacecraft observations of plasma injections reveal abundance of small-scale nonlinear magnetic structures – sub-ion magnetic holes. These structures contribute to magnetosphere-ionosphere coupling and likely responsible for energetic electron scattering. Sub-ion magnetic holes propagate in plasma of two electron components with very different temperatures. Properties of such holes resemble properties of classical magnetosonic solitary waves propagating across the ambient magnetic field, but observations suggest that these holes do not disturb background ions. This study aims to generalize the linear theory of magnetosonic waves by including two electron components. In analog to the electron acoustic mode, cold electrons can act as ions for the generation of magnetosonic mode waves. This unstable electron magnetosonic mode can explain all properties of sub-ion holes in observations. We suggest that sub-ion holes can form during the nonlinear evolution this electron magnetosonic mode. We consider an adiabatic model for investigation of such nonlinear evolution and electron dynamical response to evolving hole electromagnetic field. This model describes slow formation of sub-ion magnetic holes from low-amplitude limit. The adiabatic electron response to such formation can include both electron colling and heating, for populations with different pitch-angles.

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