Geophysical Research Abstracts
Vol. 17, EGU2015-9026, 2015
EGU General Assembly 2015

Oscillatory patterns in three-dimensional kinetic simulations of space plasma

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We analyse kinetic simulations of the relaxation of a magnetic field configuration with multiple null-points. The power spectral density of the magnetic field is dissipative and exhibits two breaks: at ion-inertial and at electron-gyration scales; the slopes are steeper than observed in solar wind. Although different simulations in the same configuration show similar energetics, the local evolution pattern is rather chaotic. Most of the null-points in the simulations are of the spiral type, they are surrounded by twisted field lines, and powerful currents establish through them forming Z-pinches. Various instabilities are associated with the current channels, especially prominent is the kinking which drives secondary magnetic reconnection that dissipates the magnetic energy. In some regions the current channels produce thin secondary threads that show lower hybrid drift-like oscillatory characteristics.

Oscillatory patterns are also detected at the halo boundary above dipolar lunar anomalies in 3-D kinetic simulations. It is found that they are (at least partially) in relation to the position of the B=0 line across the halo formed due to the opposing directions of the dipolar and interplanetary magnetic field in the simulation set-up, as well is to the strength of both fields and the solar wind parameters. We investigate and compare the detailed characteristics of small-scale wave patterns in both 3D simulations of null points and lunar magnetic anomalies.