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Laboratory experiments on nonlinear Electron MHD phenomena[1]

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In a large laboratory plasma highly nonlinear magnetic field-plasma interactions are studied in the regime of Electron MHD (EMHD). A pulsed magnetic field is applied with a loop antenna and the resultant field is measured with magnetic probes. Topologies of field-reversed configurations (FRC), spheromaks or strong mirrors are generated. These fields propagate as highly nonlinear whistler modes through the stationary ion background. *Whistler spheromaks* propagate along the ambient magnetic field at a speed which decreases with amplitude. The field tilts (precesses) with increasing amplitude. The field at the leading front steepens to a few c/ω_{pe}, i.e. forms a *whistler shock*. The electrons in the (predominantly) toroidal current ring are heated and produce visible light. The source of heating is not significantly modified by heat conduction and radiation losses. The collision of two counter-propagating whistler spheromaks leads to a *whistler FRC* with net zero helicity. *Whistler mirrors* are produced when the wave field adds to the ambient field. These structures propagate faster than spheromaks and linear whistlers. The toroidal current is predominantly an electron Hall current which produces no electron heating. Collisions between opposing whistler mirrors produces no significant electron heating by Fermi acceleration. Field topologies lacking axial symmetry, as in strong whistler turbulence, may be characterized by a mixture of magnetic energy convection and dissipation.

[1]In collaboraton with Manuel Urrutia and Kyle Strohmaier, UCLA.