Abstract Submitted
for the DPP16 Meeting of
The American Physical Society

Self-organizing Knotted Magnetic Structures in Plasma

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— Magnetic helicity, which can be seen as the self- and interlinking of magnetic field lines is approximately conserved in a resistive plasma. Using full-MHD simulations we investigate the evolution of linked and/or twisted rings of magnetic flux, and observe how the initial linking gives rise to a structure where magnetic field lines lie on nested toroidal surfaces. This structure is an hydrostatic equilibrium charaterized by a lowered pressure in the toroidal region around the innermost of the nested tori. The magnetic field in this structure is highly localized and the rotational transform varies slowly from surface to surface, giving rise to magnetic islands at rational surfaces. The higher the helicity in the initial linked configuration, the more energy is retained in this knotted quasi-stable magnetic structure. We relate the ordered, toroidal structure of the magnetic field to the linked fiber structures that naturally arise in maps from the hypersphere S^3 to the sphere S^2such as the Hopf fibration.

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Date submitted: 13 Jul 2016 Electronic form version 1.4