Contribution ID: **61** Type: **Poster**

Applying the new principles of plasma self-organization to tokamak

Wednesday, 19 October 2016 08:30 (4 hours)

Understanding sustainment of stable equilibria with helicity injection in HIT-SI has led to a simple picture of several tokamak features. Perturbations cause a viscous-like force on the current that flattens the j/B profile, which sustains and stabilizes the equilibrium. An explanation of the mechanism is based on the two properties of stable, ideal, two-fluid, magnetized plasma. First, the electron fluid is frozen to magnetic fields and, therefore, current flow is also magnetic field flow. Second, for a stable equilibrium the structure perpendicular to the flux surface resists deformation. This mechanism provides an explanation for the level of field error that spoils tokamak performance, the rate of poloidal flux loss in argon-induced disruptions in DIII-D, why transport barriers depend on the E X B shearing rate, and why a divertor may help in forming a pedestal. This paper is based upon work supported by the U.S. Department of Energy Office of Science, Office of Fusion Energy Sciences under Award No. DE-FG02-96ER54361.

Paper Number

EX/P3-33

Country or International Organization

USA

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Session Classification: Poster 3

Track Classification: EXS - Magnetic Confinement Experiments: Stability