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Emergence of large scale magnetic fields by relaxation in laboratory and astrophysical plasmas XIANZHU TANG, Los Alamos National Laboratory, ALLEN BOOZER, Columbia University — Magnetic relaxation is an extreme form of self-organization by which magnetic energy and helicity injected on small scales are transported to and accumulated on system scale magnetic fields by plasma fluctuations. Many fusion concepts rely on magnetic relaxation to generate and sustain the confining magnetic field. Examples include the reversed field pinch, spheromak, and spherical torus. Naturally occurring plasmas such as that in the giant radio lobes powered by the accretion disks of super-massive black holes are also subject to magnetic relaxation. A unified physics description of these relaxation processes can be found by an analogy to the familiar driven nonlinear oscillator. The fully relaxed Taylor state corresponds to the linear oscillator limit, where a primary resonance confines the energy input to the system scale magnetic fields. Like a nonlinear oscillator, the linear resonances are regularized by any of plasma inertia, finite pressure, and non-uniform normalized parallel current density in a partially relaxed plasma. The bifurcated regularized solutions are shown to have distinct physics interpretation and significance, and are intimately connected to the nonlinear dynamics that facilitate the relaxation. References:X.Z.Tang and A.H.Boozer, PRL, 225004 (2005); PRL, 155002 (2005); Phys. Plasmas, 102102 (2005).

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