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Production and Study of High-Beta Plasma Confined by a Superconducting Dipole Magnet[1]

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The Levitated Dipole Experiment (LDX) is a new research facility that is exploring the confinement and stability of plasma created within the dipole field produced by a strong superconducting magnet. Unlike other configurations in which stability depends on curvature and magnetic shear, MHD stability of a dipole derives from plasma compressibility. Theoretically, the dipole magnetic geometry can stabilize a centrally-peaked plasma pressure that exceeds the local magnetic pressure ($\beta > 1$), and the absence of magnetic shear allows particle and energy confinement to decouple. In this presentation, the first experiments using the LDX facility are reported. Long-pulse, quasi-steady state microwave discharges lasting up to 12 seconds have been produced that are consistent with equilibria having peak beta values of 10%. Detailed measurements have been made of discharge evolution, plasma dynamics and instability, and the roles of gas fueling, microwave power deposition profiles, and plasma boundary shape. In these initial experiments, the high-field superconducting floating coil was supported by three thin supports and later the coil will be magnetically levitated. The plasma was created by multi- frequency electron cyclotron resonance heating at 2.45 and 6.4 GHz, and a population of energetic electrons, with mean energies above 50 keV, dominated the plasma pressure. Creation of high-pressure, high-beta plasma is only possible when intense hot electron interchange instabilities are stabilized sufficiently by a high background plasma density. A dramatic transition from a low-density, low-beta regime to a more quiescent, high-beta regime is observed when the plasma-fueling rate and confinement times are sufficiently long. External shaping coils are seen to modify the outer plasma boundary and affect the transition.

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