Structure and statistics of turbulently generated blobs and holes in LAPD

T.A. Carter
Department of Physics and Astronomy, UCLA
Los Angeles, CA 90095-1547, USA

The Large Plasma Device (LAPD) at UCLA is a 17 m long, 60 cm diameter magnetized plasma column with typical plasma parameters $n_e \sim 1 \times 10^{12}\text{cm}^{-3}$, $T_e \sim 10\text{eV}$, and $B \sim 1\text{kG}$. A limiter is used to generate steep cross-field density gradients in LAPD. Intermittent broadband turbulence, with a strongly skewed amplitude probability distribution function (PDF), is observed in the shadow of the limiter, and a detailed study of the properties of this turbulence has been performed[1]. As in the edge of many other magnetic confinement devices, density enhancement events or "blobs" are observed in the low density limiter shadow. On the high density side of the limiter, density depletion events or "holes" are also observed in LAPD. The blobs propagate outward into the low density edge while the holes propagate back into the core plasma. The propagation speed for both is on the order of one tenth the sound speed. The high repetition rate (1 Hz) and high reproducibility of LAPD plasmas has allowed images of these structures to be obtained using movable probe pairs. Two-dimensional cross-conditional averaging reveals that the blobs are detached, outward-propagating filamentary structures with a clear dipolar potential. However, the holes do not appear to be isolated structures, and instead are part of a more extended turbulent structure. A statistical study of the average size of the structures versus plasma parameters including ion mass was performed. The size of the blobs is observed to scale with the ion sound gyroradius, and is on average ten times this scale. LAPD lacks typical interchange forces (such as magnetic curvature or magnetic field gradient) which are invoked to explain polarization (and subsequent cross-field propagation) of intermittent structures in toroidal devices. Even with the differences in plasma parameters, geometry, and interchange forces, the characteristics of intermittent turbulence in LAPD are very similar to that observed in toroidal devices such as tokamaks. A summary of these results will be presented, along with initial results from recent measurements including: magnetic field structure of blobs and holes (turbulence in LAPD is drift-Alfvén in nature), statistics of blob velocity and size with blob density, and decay of blobs in the limiter shadow.

[1] T.A. Carter, Phys. Plasmas 13, 010701 (2006)