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Basic studies of blob dynamics in X-point configurations and interaction with suprathermal ions in the TORPEX device

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TORPEX is a flexible basic plasma device in which plasmas are created and sustained by microwaves at 2.45GHz using different gases. Different magnetic configurations of relevance for fusion are produced in TORPEX, including simple magnetized toroidal (SMT) configurations with a dominant toroidal field and a small vertical field component, or closed field-line configurations using a current-carrying toroidal conductor. This produces a poloidal magnetic field, which, combined with vertical field coils, allows configurations of increasing complexity, including X-points, and of more direct relevance to confined plasma experiments. Thanks to a continuously improving set of diagnostic techniques, of theoretical and modeling tools, together with a rigorous validation methodology, research on TORPEX today allows for quantitative comparisons between theory and experiment. In the past two years, most experiments have been conducted to investigate the interaction between suprathermal ions and intermittent turbulence associated with blobs and to study the propagation of turbulent structures in the presence of X-points. The experiments on suprathermal ion-turbulence interaction and the comparison with numerical simulations reveal different regimes for fast ion transport, resulting in the entire spectrum of suprathermal ion spreading: super-diffusive, diffusive, or sub-diffusive, depending on particle energy and turbulence amplitude. Time-resolved conditionally sampled two-dimensional data demonstrate that super-diffusive suprathermal ions in TORPEX plasmas are subject to bursty displacement events, associated with blob propagation, resulting in highly intermittent time traces, not observed in the case of sub-diffusion. The toroidal conductor system opens new research avenues on TORPEX. In present experiments, we investigate the blob dynamics in the presence of a first-order X-point. The blob motion is tracked and analyzed using multi-point data, showing an acceleration that is linked to the background radial flow and to the blob-induced electric potential dipole. The blob speed is quantitatively described by an analytical model that includes perpendicular and parallel currents. A crucial role is played by a geometrical parameter, expressing the length of the current path parallel to the magnetic field, along which the blob potential dipole is short-circuited.

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Primary author: Dr FURNO, Ivo (EPFL- CRPP)

Co-authors: Dr BOVET, Alexandre (SPC-EPFL); Prof. FASOLI, Ambrogio (CRPP-EPFL); Dr THEILER, Christian (SPC-EPFL); Dr AVINO, Fabio (SPC-EPFL); Mr FABIAN, Manque (SPC-EPFL); Dr BAQUERO, Marcelo (SPC-

EPFL); Prof. RICCI, Paolo (CRPP-EPFL)

Presenter: Dr FURNO, Ivo (EPFL- CRPP)

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