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Basic Investigations of Turbulence and Interactions with Plasma and Suprathermal Ions in the TORPEX Device with Open and Closed Field Lines

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TORPEX is a flexible device dedicated to investigating basic plasma physics phenomena of importance for fusion. It can feature a simple magnetized toroidal (SMT) configuration with a dominant toroidal magnetic field and a small vertical field component, or accommodate closed field-line configurations using a current-carrying conductor suspended in the center of the chamber. This produces a poloidal magnetic field with a rotational transform, which, combined with vertical field coils, allows magnetic configurations of increasing complexity and of more direct relevance to confined plasma experiments. Among these are simple plasmas limited by the vessel on the low field side, single or double-null X-points, and even advanced divertor configurations like snowflakes. Using an extensive set of diagnostics, systematic studies of plasma instabilities, their development into turbulence and meso-scale structures, and their effects on both thermal and suprathermal plasma components are performed. The impact of the experimental results obtained on TORPEX is enlarged by their systematic application to model validation, performed using rigorous methodologies for quantitative experiment-theory comparisons.

In the past two years, we conducted investigations of supra-thermal ion-turbulence interaction, a basic issue for burning plasmas, on SMT plasmas. These investigations reveal that the transport of supra-thermal ions is generally non-diffusive and can be super- or sub-diffusive depending on two parameters: the suprathermal ion energy normalized to the electric temperature and the electric potential fluctuations normalized to the electron temperature. The orbit averaging mechanism predicted to reduce the effect of turbulence on the suprathermal ions in burning plasmas has been clearly identified, both for gyro- and drift-orbits.

To better mimic the SOL-edge magnetic geometry in tokamak, we have installed a new system that creates twisted field line configurations. First experiments are devoted to the characterization of the background plasma and fluctuation features in the presence of quasi circular-shaped flux surfaces. Measurements of toroidal and poloidal wave numbers indicate field aligned modes. Further studies are under way to compare the experimental measurements with the simulation results and assess the main instability driving mechanism.

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