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Overview of the Recent Research on the J-TEXT Tokamak

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The experimental research over last two years on the J-TEXT tokamak is summarized, the most significant results including observation of core magnetic and density perturbations associated with sawtooth events and tearing instabilities by a high-performance polarimeter-interferometer (POLARIS), investigation of a rotating helical magnetic field perturbation on tearing modes, studies of resonant magnetic perturbations (RMP) on non-local transport, plasma flows and fluctuations.

The POLARIS system has time response up to 1 μs, phase resolution < 0.1o and spatial resolution ~3 cm. Temporal evolution of the safety factor profile, current density profile and electron density profile are obtained during sawtooth crash events and tearing instabilities as well as disruptions. The effects of RMPs in Ohmic plasmas are directly observed by polarimeter for the first time. Particle transport due to the sawtooth crashes is analyzed. Recovery between crashes implies an inward pinch velocity extending to the center.

The J-TEXT RMP system can generate a rotating helical field perturbation with a rotation frequency up to 10 kHz, and dominant resonant modes of m/n = 2/1, 3/1 or 1/1. It is found that tearing modes can be easily locked and then rotate together with a rotating RMP. During the mode locking and unlocking, instead of amplifying the island, the RMP can suppress the island width. Further numerical studies extend the understanding of the experimental observations.

The effects of RMPs on plasma flows and fluctuations are studied. Both toroidal rotation velocity and radial electric field increase with RMP coil current when the RMP current is no more than 5kA. When the RMP current reaches 6kA, the toroidal velocity profile becomes flatten. Both LFZF and GAM are also damped by strong RMPs.

The effects of RMPs on non-local transport in J-TEXT have been studied by using horizontal SMBI and a static RMP. At relatively low density, nonlocal phenomena are easily achieved with SMBI injection, while the rotation response to the SMBI injection is reversed for strong RMPs. SMBI without an RMP makes a change of toroidal rotation in the counter-current direction.

We discovered a turbulent acceleration term for parallel rotation which has different physics from the residual stress, and is thus a new candidate mechanism for the origin of spontaneous rotation.

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