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The effects of magnetic topology on the edge turbulent transport in the first island divertor plasma operation of the J-TEXT tokamak

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In tokamaks, suppression of edge turbulence which is widely considered to play an important role in the edge heat and particle transport, could improve the plasma confinement [1, 2]. In recent years, 3D magnetic perturbations and their potential applications to control the edge plasma transport and instabilities have been of increasing interest in plasma physics research. It was observed that the edge turbulence properties and turbulent transport reveal a strong dependence on the magnetic topology [3].

Recently, the first attempt on the application of the island divertor configuration on tokamak has been performed on J-TEXT. In this experiment, resonant magnetic perturbations (RMPs) with a dominant m/n = 3/1 component were used to excite edge 3/1 static magnetic islands with a width of 2~3 cm. After the formation of edge islands at the q = 3 surface, the island chain was pushed outwards to intersect with the limiters by increasing the toroidal plasma current, thereby forming the island divertor configuration. Results from a series of q_a-scan and configuration-scan experiments provide experimental evidences that the edge plasma profiles and turbulent transport are significantly affected by the perturbed magnetic topology. Inside the remnant island, a flat electron thermal pressure profile has been observed. However, neither electron temperature or density profiles are not flat. Furthermore, the radial turbulent particle flux measured by reciprocating probe in the island is rather small.

A beta-induced Alfvén eigenmode (BAE) [4] with a m/n = 3/1 standing wave structure in which the nodes are located at the X- and O-point of the magnetic island was observed inside the magnetic island. As shown in figure 1, during the process of opening the edge 3/1 magnetic islands, the BAE still was found to exist in the remnant island, but its amplitude decreased as the width of the remnant island became smaller.

References
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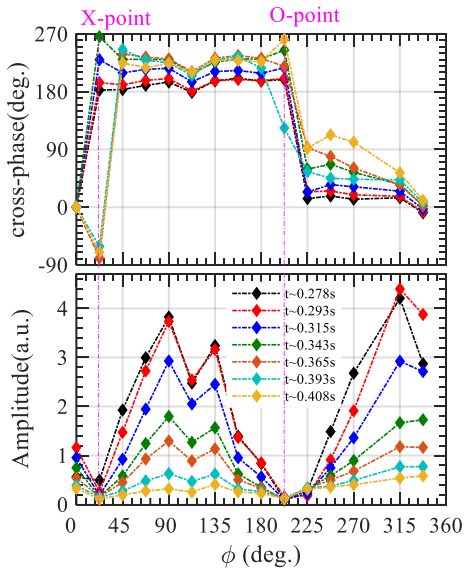

Figure1. Cross-phase analysis of toroidally distributed poloidal magnetic fluctuations for different time slots during the opening process of the edge 3/1 magnetic island. Here, the poloidal magnetic fluctuations were measured by a set of toroidally distributed Mirnov coils. The cross-phase (upper) and amplitude (lower) are obtained in the frequency range of from 29 kHz to 34 kHz, where the BAE mode was observed.