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Measurement of Fast Ion Loss induced by Fast Ion Driven MHD Activities

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In a magnetic confinement fusion reactor, alpha particles produced by Deuterium and Tritium fusion reactions with energy of 3.5MeV heat and sustain the burning plasma. When the velocity of fast ions such as alpha particles corresponds to the Alfven velocity, the resonance between waves and particles occurs and magnetohydrodynamics (MHD) waves may be excited. So far, MHD bursts excited by fast ions injected by neutral beam injection (NBI) heating were observed in many fusion experimental devices. Such anomalous transports of fast ions is serious issue in fusion reactors and one of the most important topics of burning plasmas such as international thermonuclear experimental reactor (ITER). However, much is not understood about anomalous transport yet. In order to investigate the anomalous transport mechanism of fast ions, a directional Langmuir probe (DLP) is applied for local measurement of fast ions. DLPs can measure co-going particle flux and ctr-going particle flux separately, so it can evaluate fast ion and bulk plasma components, each other. DLPs also have high spatial resolution, which is difficult in the last closed flux surface (LCFS) so far. In this symposium, we will present the experimental observation in the compact helical system (CHS) about fast ion behavior induced by energetic particle modes (EPM), which is MHD burst modes excited by fast ions.

In CHS plasma heated by NBI, EPMs are excited in the condition that the fast ion pressure is almost same as bulk plasma pressure, and significant increase of fast ion loss is also observed out side of the LCFS in the decreasing phase of each EPM bursts. This phenomenon is considered that the gradient of fast ion excites EPMs and enhances of fast ion loss, then EPMs become stable. In order to investigate the transport mechanism of fast ions due to EPM bursts, the fast ion flux has been measured in by a DLP. Two types of fast ion transport behavior due to EPM bursts have been observed inside of the LCFS and the spatial structures have also been revealed in the normalized minor radius region of r/a=0.80-1.05, which are shown in Figs.1 and 2 in case of r/a=0.83. Fast responses to the fluctuation amplitude of EPM bursts are observed in the glowing phase of the burst. The fast responses can be clearly observed inside of LCFS (inside of r/a=0.95) and decrease toward outside of the plasma. A heavy ion beam probe measurement showed that the spatial profile of the EPM burst has peak around r/a=0.6 and its amplitude also decreases toward outside of the plasma. Thus, the fast response of fast ions observed by DLP corresponds to the deviation of fast ion orbit due to the magnetic fluctuation. On the other hand, the slow response observed in decreasing phase of EPM burst can be clearly observed in the outside region of r/a=0.83, and the observation outside of the LCFS agrees well with that of a lost ion probe measurement. Therefore, it is the slow response component that final loss of fast ions toward outside of the plasma due to the EPM burst. The production mechanism of the slow response and production region can not be understood yet, and which is left for future study. We have also observed the fast ion response to TAE modes, which appear in higher frequency region than that of EPM, and we will also study the fast ion transport physics due to TAE.