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O3.103 Energetic-particle-driven MHD instabilities and their control by ECH/ECCD in helical plasmas

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Energetic alpha particles generated by D-T fusion reaction and beam ions for plasma heating interact resonantly with shear Alfvén waves through damping process when their velocity is comparable with Alfvén velocity, resulting in excitation of energetic particle (EP)-driven MHD instabilities. Several types of EP-driven MHD instabilities including toroidicity-induced AEs (TAEs), helicity-induced AEs (HAEs), global AEs (GAEs), energetic particle modes (EPMs) have been observed in NBI-heated plasmas of stellarators/heliotrons, Heliotron J, TJ-II and LHD. We have successfully demonstrated that electron cyclotron heating (ECH) and current drive (ECCD) are effective to mitigate and suppress the EP-driven MHD instabilities in the three devices [1-4]. The experimental and theoretical results suggest that the mode excitation in the shear Alfvén continua and the continuum damping related to magnetic shear have a key role on mode suppression. Some GAEs and EPMs have been stabilized in both co- and counter-ECCD in the low shear Heliotron J device, indicating that the magnetic shear is an important factor regardless of its sign. They are also suppressed by both on- and off-axis ECH in a magnetic field condition in TJ-II, while they are stabilized or destabilized in Heliotron J and LHD, depending on ECH power and deposition location. Discussed are the change in energetic ion profile by ECH through the change in bulk plasma, and/or the collisional damping due to trapped electrons in terms of AE stability.

[1] K. Nagaoka, et al., Nucl. Fusion, 53 (2013) 072004.
[2] K. Nagasaki, et al., Nucl. Fusion 53 (2013) 113041
[3] S. Yamamoto, et al., Nucl. Fusion 57 (2017) 126065
[4] S. Yamamoto, et al., 27th IAEA FEC, 2018, Gandhinagar, EX/1-3Ra

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