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EX/5-3: Observation of GAM Induced by Energetic Electrons and NL Interactions among GAM, BAEs and Tearing Modes on the HL-2A Tokamak

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The very low-frequency (LF) Alfvénic and acoustic fluctuations, such as beta-induced Alfvén eigenmode (BAE), and geodesic acoustic mode (GAM), are presently of considerable interest in the present-day fusion and future burning plasmas. The low-frequency waves can significantly affect the plasma performance, and induce the particle losses and reduce the plasma self-heating. These LF instabilities can play a key role in turbulence and anomalous transport regulation, especially, while there is significant fraction of high energy particles in plasma. They can be used as energy channels to transfer the fusion-born-alpha-particle energy to the thermonuclear plasma, i.e. GAM/BAE channeling.
The energetic-electron and magnetic-island induced BAEs had been observed and investigated on HL-2A in the previous works. In the present paper, we will present our further works about the LF Alfvénic and acoustic modes, and it is reported that the first experimental results are associated with the GAM induced by energetic-electrons (termed eEGAM) in HL-2A Ohmic plasma. The energetic-electrons are generated by parallel electric fields during magnetic reconnection associated with tearing mode (TM). The energy spectra, which detected by Cadmium-telluride (CdTe) scintillators, indicate that the energetic electrons redistribute during strong TM. The magnetic fluctuation spectrogram indicates that the eEGAM is always accompanied by TM and BAEs. The eEGAM is not observed in the absence of strong TM and BAEs, and its mode frequency always complies with f_GAM=f_BAE2-f_TM,f_GAM=f_BAE1+f_TM as well as f_GAM=(f_BAE1+f_BAE2)/2. The eEGAM localizes in the core plasma, i.e. in the vicinity of q=2 surface where the ion Landau damping gamma_i is larger than the edge due to gamma_i \propto exp(-q^2), and is very different from that excited by the drift-wave turbulence in the edge plasma. The analysis indicated that the eEGAM is provided with the magnetic components, whose intensities depend on the poloidal angles, and its mode numbers are |m/n|=2/0 which are consistent with the theoretical prediction. The new findings give a deep insight into the underlying physics mechanism for the excitation of the LF Alfvénic/acoustic fluctuation and zonal flows (ZFs).

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