§57. Spatial Structures of Energetic-particle Driven Geodesic Acoustic Modes

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Recently, geodesic acoustic mode(GAM), which is a branch of zonal flow, driven by energetic particles has been observed in some devices and attracts much attention. So far, radial electric field associated with the energetic-particle driven GAM has been identified in LHD plasmas by a heavy ion beam probe (HIBP)[1]. In this study, the spatial structure of the GAM has been investigated by HIBP and Mirnov coil installed on the vacuum vessel.

The energetic-particle driven GAM is accompanied by the magnetic field fluctuation as well as the electrostatic potential fluctuation. Relations between the potential fluctuation measured by HIBP and magnetic field fluctuation measured by the Mirnov coil are shown in Fig.1. The relations are roughly linear, and that seems to agree with the theoretical prediction[2].

Figure 2 (a) shows the radial profile of potential fluctuations with the GAM frequency. Here, the potential fluctuations are normalized by magnetic field fluctuations measured by the Mirnov coil in order to remove variation of the magnitude of each event. The result indicates that the fluctuations localizes near the magnetic axis.

Spatial structures of the potential and density fluctuations can be measured through the phase difference from the magnetic field fluctuation measured by the Mirnov coil. Figures 2 (b) and (c) show the phase differences of the electrostatic potential and density fluctuations, respectively. The phase of the electrostatic potential fluctuation is up-down symmetry. On the other hands, the phase of the density fluctuation is up-down asymmetry. The results are consistent with the theoretical prediction of the GAM: m = 0 for the electrostatic potential fluctuation and m = 1 for the density fluctuation, where m is poloidal mode number. The uniform phase of the potential fluctuation indicates that the mode is a standing wave in the radial direction, and the radial electric field fluctuation can be estimated from the profile of the amplitude of potential fluctuation in Fig.2(a).

Since the GAM is accompanied by the electrostatic potential fluctuation, the energy of GAM can transfer to bulk ions via the Landau damping. The observed radial electric field fluctuation is 43 kV/m. According to the theoretical model[3], the observed GAM can increase the ion temperature by 100 eV or more. Note that the above value of the radial electric field is limited by the dynamic range of the HIBP and that the radial electric field of the GAM is larger. The change in the energy spectra measured by a neutral particle analyzer(NPA) suggests the increase in the ion temperature[4]. Quantitative analyses are in progress.

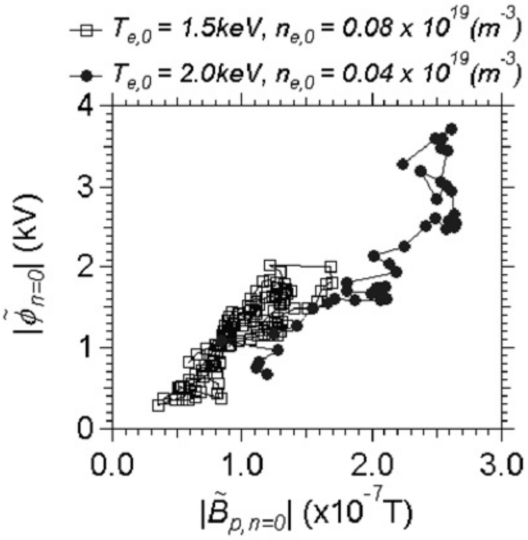

Fig.1 Relations between the electrostatic potential and magnetic field fluctuation.

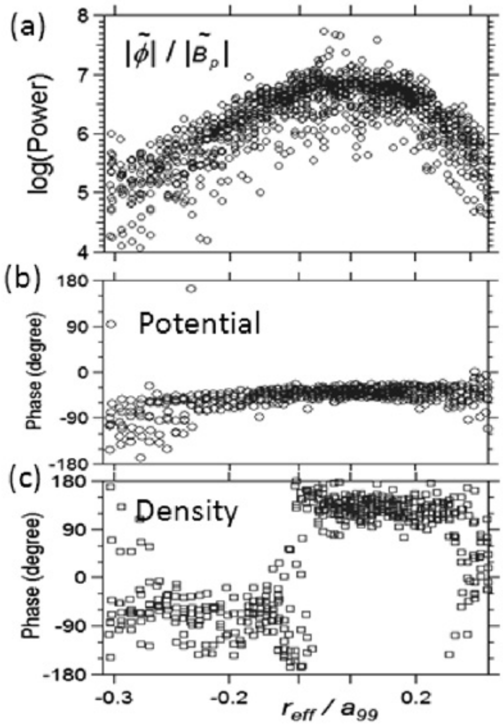

Fig.2 (a) Amplitude of the potential fluctuation normalized by the magnetic field fluctuation measured by a Mirnov coil. (b) and (c) show the phase of electrostatic potential fluctuation and density fluctuation, respectively. The horizontal axis is the normalized minor radius.

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3) Sasaki, M. et al.,: Plasma Phys. Control Fusion **53** (2011) 085017.
4) Osakabe, M., et al,: 5th IAEA-TM on EP, Austin(2011) No.O-3