§50. Electrostatic Potential Fluctuation Associated with the Geodesic Acoustic Mode

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There is a concern that the energetic-particle driven Alfvén eigenmode(AE) will enhance the radial transport of alpha particles in a D-T reaction that then leads to a deteriorate the performance of fusion reactors. Therefore, the study of the energetic-particle driven modes is a crucial issue in fusion research. Recently, it is indicated that the energetic particles drive geodesic acoustic mode (GAM) as well as AEs. GAMs have also been studied intensively as a branch of zonal flows which will play key roles in the transport of bulk plasmas in the area of turbulent-transport study. In the LHD, the GAM is observed by magnetic probes, reflectmetry, and ECE[1]. However, the electrostatic fluctuation, which is an essential parameter in the GAM oscillation, has not been identified. In this work, the electrostatic potential fluctuation associated with the energetic-particle induced GAM are measured locally and directly by a heavy ion beam probe(HIBP) in the LHD plasmas[2,3].

Figure 1 (a) shows the averaged electrostatic potential profile, and (b) and (c) show the potential fluctuation associated with the GAM. The root-mean-square and maximum of the GAM are about 300 and 900 volts, respectively. The GAM localizes near the magnetic axis as shown in Fig.2 (a). Since the observed GAM is accompanied by the magnetic fluctuation, the displacement of the magnetic surface(ξ) may induce the potential fluctuation at a measurement position; $\delta\phi(r) = E_r(r)\xi$. $\xi \le 0.15 \times a_{99} \sim 0.1\,(m)$ as shown in Fig.2(a) and $E_r < 1000\,(V/m)$ as shown inFig.1(a). Thus, the possible potential fluctuation due to ξ is less than 100 V, and the measured potential fluctuation is not attributed to the radial displacement of the magnetic surface. Therefore, it is confirmed that the observed GAM is accompanied by the electrostatic potential fluctuation. In addition to that, the gradient of the amplitude profile of the electrostatic potential fluctuation indicate that the GAM is accompanied by the radial field fluctuation.

The influence of the radial electric field is observed in the temporal behavior of turbulences in the high frequency range (>120 kHz): the envelope of the turbulence is modulated at the GAM frequency, and the coherence between the modulation and the GAM is significant[3]. One of the candidates of the modulation is the distortion of the frequency spectrum due to the Doppler shift induced by the *ExB* flow associated with the GAM. The other candidate is the dynamic shearing of the turbulence by the sheared *ExB* flow as predicted in Ref.4, where the turbulence is not suppressed completely and the amplitude of the turbulence observed at a fixed position is modulated at the GAM frequency. In either case, the modulation is caused by the *ExB* flow associated with the GAM, and the existence of the modulation is consistent with the observation of the radial electric field fluctuation. At present, the mechanism of the modulation is not clarified, because the both mechanisms depend on wave numbers of the turbulence and the GAM which have not been obtained. The influence on the turbulent transport by the energetic-particle induced GAM is a future issue.

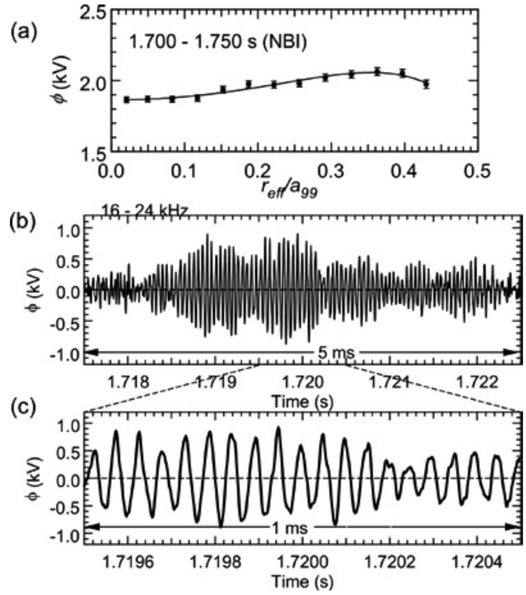

Fig.1 (a) Averaged potential profile. (b) and (c) show the potential fluctuation of the GAM extracted by use of a band-pass filter. The measurement position is at $r_{eff}/a_{99} \sim 0.1$, where r_{eff}/a_{99} is the normalized minor radius.

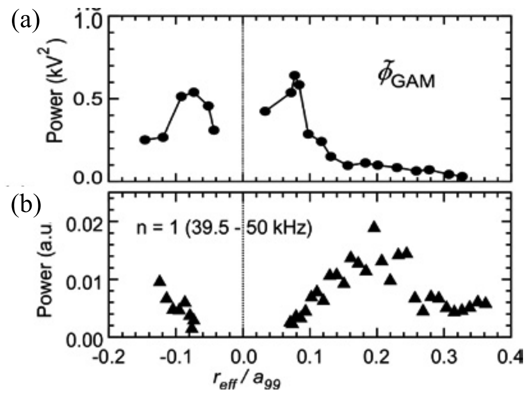

Fig.2 Radial profiles of the potential fluctuations associated with the GAM(a) and n = 1 mode(b)

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4) Itoh, K. et al.,: Plasma Phys. Controll. Fusion **47** (2005) 451.