§10. Reversal of Turbulent Particle Flux by Edge Electron Cyclotron Heating

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Turbulent transport in toroidal plasmas is affected by the ExB shear flows. Though most of the theoretical and experimental works have been concentrated on the shear flow turbulence suppression model [1], it becomes more evident that the radial electric field may also affect the fluctuation cross phase, so that the turbulent transport can be changed without the fluctuation suppression. Changes in the cross phase can lead to a radial reversal of the fluctuation-driven particle flux from outward to inward.

In CHS, we have studied whether or not the reversal of turbulent flux can be realized using electron cyclotron heating(ECH) [2]. Several ECH pulses of ~100 kW were applied to NBI sustained plasmas at the toroidal magnetic field of Bt=1.35 – 1.4 T, where ECR layer appears just inside the last closed flux surface affecting edge plasma parameters (Fig.1(a)). The ECH pulses modulate the edge electron temperature and change local radial electric field. An ECH enhanced electron loss as well as increased electron-temperature-gradient driven neo-classical flux is thought to be responsible for the modification of the radial electric field. The radial electric field shear dEr/dr (=Er') is also affected as shown in Fig.1(b). That is, Er' becomes considerably more positive at r ~0.95. The modulation of Er' affects the fluctuation-driven particle flux (Fig.1(b)). The flux is characterized by positive and negative bursts corresponding to the outward and inward directed "transport events". In this figure, time averaged flux (over 2ms) is shown. The time resolved turbulent particle flux is shown in Fig.2 for the time intervals before (Fig.2(a)), during (Fig.2(b)), and after (Fig.2(c)) the ECH pulse is applied to the plasma edge. The flux is outward before ECH pulse and is nearly symmetric (zero average) after the pulse. When the edge ECH is applied, the fluctuation-driven flux becomes inward directed in the radial region where the radial electric field shear is positive. The time-resolved flux is dominated in this case by the negative(inward) transport events seen in Fig.2(b). A statistically averaged value of the positive Er', which noticeably affects the fluctuation-driven flux, is found to be about 0.5×10^6 V/m^2.

References
1) K.H. Burrell, Phys. Plasmas 4, 1499 (1997).
2) M.G. Shats, K. Toi, K. Ohkuni et al., Phys. Rev. Lett. 84, 6042(2000).

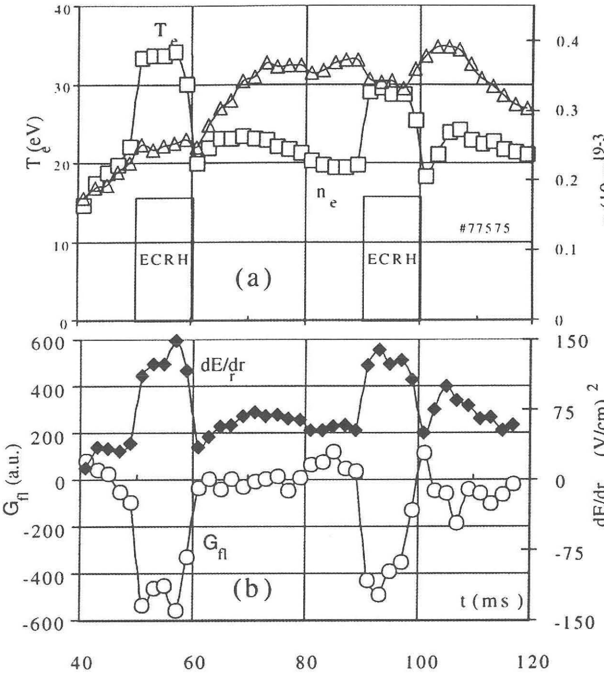

Fig.1 Time evolution of the electron temperature (squares) and density (triagles) (a), fluctuation-driven particle flux(circles) and of the radial electric field shear(diamonds)(b) at r/<a>=0.95 during the edge ECH discharge.

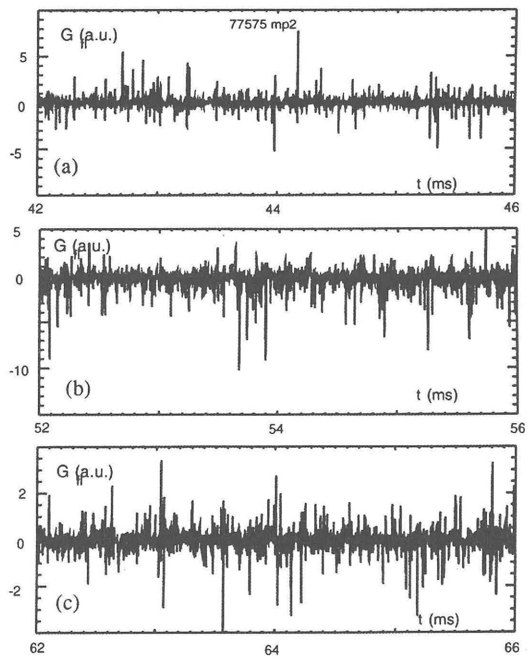

Fig.2 Time resolved fluctuation-driven flux at r/<a>=0.95 in the discharge shown in Fig.1 before (a), during (b), anf after (c) the ECH pulse.