§6. Effect of ECRH Driven Flux on Radial Electric Field in Heliotrons[1]

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Positive radial electric field, E_r, reduces the deviation of ripple trapped ion orbit from the magnetic surface and, thus, improves trapped ion confinement and neoclassical transport (electron root). It is observed that E_r can suddenly changes from negative to positive when ECR waves are applied to low density NBI heated CHS plasma[2]. Ripple trapped suprathermal electrons are created during ECRH. Their drift motions across the magnetic surfaces can enhance large electron radial flux, which would be responsible for this E_r transition phenomena.

In this paper the effect of ECRH driven flux on E_r is studied assuming the ambipolarity condition. Monte Carlo simulation code[3], based on a technique similar to the adjoint equation for dynamic linearized problems, is used to evaluate the ECRH driven flux. The linearized 5D drift kinetic equation for the deviation from the Maxwellian background $f_1(\underline{x}, \underline{v})$,

$$\vec{v} \cdot \nabla f_1 + \vec{a} \cdot \nabla_v f_1 = C(f_1) + S_{ql}^0,$$

is solved, where $C(f_1)$ is the linear Coulomb collision operator and S_{ql}^0 is the wave induced flux in velocity space (quasi-linear diffusion term) which is assumed to be a given function. The steady-state distribution function is evaluated through a convolution with a characteristic time dependent "Green function". The complex magnetic field configuration and finite-β effects on the electron motion are included using the Boozer coordinates based on the three-dimensional MHD equilibrium.

We can see that the enhanced electron flux driven by ECRH becomes comparable or larger than the neoclassical one (Fig. 1). We assume that E_r is determined by the ambipolarity condition of energetic particle fluxes (ECRH driven and NBI beam driven) and neoclassical ones (thermal ions and electrons), $\Gamma_e^{NC} + \Gamma_e^{fast} = \Gamma_i^{NC} + \Gamma_i^{fast}$.

A positive E_r appears in the region $r/a > 0.6$ when the ECRH power is increased. Maximum E_r strength is observed at $r/a \simeq 0.8$ (Fig. 2). It is also found that the enhanced radial flux driven by ECRH can change E_r from negative to positive for significant heating power and, consequently, that the ECRH driven flux play an important role in explaining the experimentally observed E_r transition phenomena in CHS.

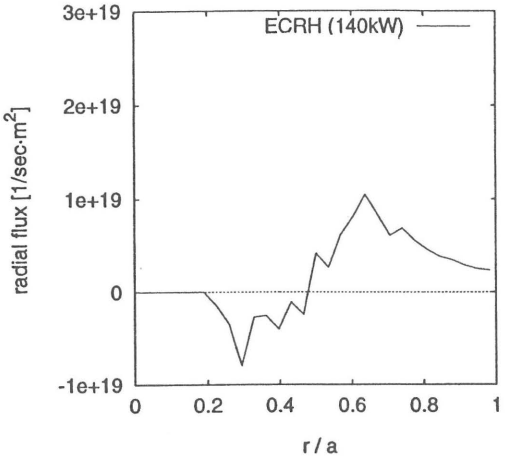

Fig. 1: *Radial fluxes due to ECRH generated suprathermal electrons (P_{ECRH} = 140kW).*

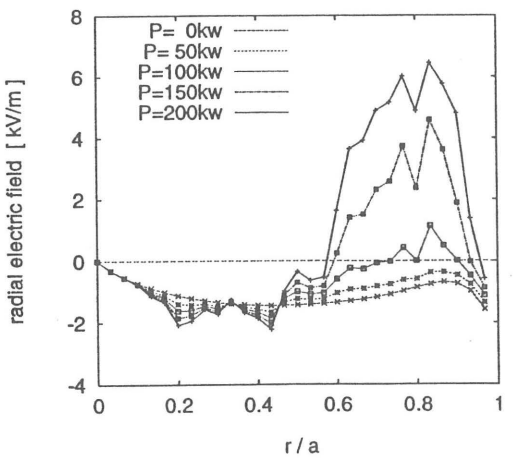

Fig. 2: *Enhancements of positive E_r by the ECRH driven fluxes.*

References

1) Murakami, S., et al, to be published in Plasma Physics and Controlled Nuclear Fusion Research 1996 (Proc. 16th Int. Conf. Montreal, 1996), IAEA/CP-6.
2) Idei, H., et al., Phys. Plasmas **1** (1994) 3400.
3) Murakami, S., et al, *Proc. 1996 Int. Conf. Plasma Phys.* (Nagoya, JSPSNFR) Vol. 1 (1997) p 1014.