Modeling of Trapped Electron Effects on Electron Cyclotron Current Drive for Recent DIII–D Experiments*

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In recent DIII–D experiments [1], off-axis electron cyclotron current drive (ECCD) efficiency has been observed to exceed results calculated from the bounce-averged Fokker-Planck theory, which predicts significant degradation of the current drive efficiency due to trapped electron effects. The standard theory is based on an assumption that electron response to external perturbations is collisionless and trapped electrons are allowed to complete the banana orbit at all energies. The collisonless assumption might be justified in reactor-grade tokamak plasmas, in which the electron temperature is sufficiently high or the velocity of resonant electrons is much larger than the thermal velocity so that the influence of collisionality on current drive efficiency can be neglected.

For off-axis deposition in the present-day experiments, the effect of high density and low temperature is to reduce the current drive efficiency, but the increasing collisionality reduces the trapping of current-carrying electrons, leading to a compensating increase in the current drive efficiency. In this work, we present a quantitative study of the effect by applying adjoint techniques to calculate the collisionality dependence of ECCD efficiency in general tokamak geometry. Both approximate analytic and numerical solutions of the adjoint equation for current drive (without invoking bounce average) are considered. The impact of finite collisionality on off-axis ECCD in recent DIII–D experiments and the projection to high performance advanced tokamak conditions in DIII–D will be discussed.

[1] T.C. Luce *et al.*, Proc. 17th IAEA Conf., Yolohama (1998), to be published.

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