EFFECT OF PARTICLE TRANSPORT ON THE MEASURED ELECTRON CYCLOTRON CURRENT DRIVE PROFILE*

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There are several important applications on ITER for the localized non-inductive current generated by electron cyclotron (EC) waves, including suppression of neoclassical tearing modes. While the strong absorption of EC waves guarantees that the power deposition is localized, radial transport of the current carrying electrons can make the resulting current drive profile significantly broader. For example, studies on the small TCV tokamak showed that CQL3D quasilinear Fokker-Planck modeling could be brought in line with measurements only by including radial transport at levels similar to the thermal energy transport.[1] This decreased the predicted electron cyclotron current drive (ECCD) magnitude by a factor of 5 and substantially broadened the ECCD profile. Conversely, experiments on the large JT-60U tokamak found that the ECCD profile determined using a motional Stark effect (MSE) diagnostic was in agreement with CQL3D modeling with radial transport turned off.[2] A well diagnosed series of ECCD experiments on the DIII-D tokamak have explored the intermediate size regime between TCV and JT-60U. Studies at low relative power density ($Q_{EC}/n_e^2 < 1$, where Q_{EC} is the EC power density in MW/m^3 and n_e is the electron density in units of 10^{19} m^{-3}) found that the width of the ECCD profile determined from MSE signals was consistent with the calculated width from CQL3D in the absence of radial transport.[3] However, more recent experiments at high relative power density ($Q_{EC}/n_e^2 > 1$) and radiation temperatures above 20 keV clearly demonstrated that the ECCD profile was reduced and broadened compared to the CQL3D prediction assuming no radial transport.[4] For $Q_{EC}/n_e^2 = 2.6$, an electron diffusion coefficient of ~0.4 m^2/s was required in CQL3D to reproduce the experimental ECCD profile, but smaller diffusion coefficients were needed to model the ECCD profile for lower Q_{EC}/n_e^2 cases. This level of transport is an order of magnitude less than the electron thermal diffusivity for these plasmas, but it can be comparable to the effective particle diffusion coefficient. Fortunately, this amount of radial transport will have only a small effect on the application of ECCD to ITER, and total neglect of electron diffusion may even be warranted given the low relative power density on ITER ($Q_{EC}/n_e^2 \ll 0.1$).

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3. C.C. Petty, et al., Nucl. Fusion **43**, 700 (2003).
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*Work supported by the US Department of Energy under DE-FC02-04ER54698, DE-FG03-97ER54415, DE-FG03-99ER54541, and W-7405-ENG-48.