Heat flux modeling using ion drift effects in DIII-D H-mode plasmas with resonant magnetic perturbations

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(Dated: version Nov. 6, 2013; printed December 9, 2013)

Abstract

The heat flux patterns measured in low-collisionality DIII-D H-mode plasmas strongly deviate from simultaneously measured CII emission patterns, used as indicator of particle flux, during applied resonant magnetic perturbations. While the CII emission clearly shows typical striations, which are similar to magnetic footprint patterns obtained from vacuum field line tracing, the heat flux is usually dominated by one large peak at the strike point position. The vacuum approximation, which only considers applied magnetic fields and neglects plasma response and plasma effects, cannot explain the shape of the observed heat flux pattern. One possible explanation is the effect of particle drifts. This is included in the field line equations and the results are discussed with reference to the measurement. Electrons and ions show different drift motions at thermal energy levels in a guiding center approximation. While electrons hardly deviate from the field lines, ions can drift several centimetres away from field line flux surfaces. A model is presented in which an ion heat flux, based on the ion drift motion from various kinetic energies as they contribute to a thermal Maxwellian distribution, is calculated. The simulated heat flux is directly compared to measurements with a varying edge safety factor q_{95}. This analysis provides evidence for the dominate effect of high-energy ions in carrying heat from the plasma inside the separatrix to the target. High-energy ions are deposited close to the unperturbed strike line while low-energy ions can travel into the striated magnetic topology.

PACS numbers: 52.55.Fa, 52.70.Kz, 05.45.-a, 05.45.Pq, 52.65.Cc