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Electron Cyclotron Emission Measurements of Rotating and Interacting Magnetic Islands in DIII-D

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2D images of rotating magnetic islands were resolved by fast electron cyclotron emission (ECE) measurements in the DIII-D tokamak. Islands of various poloidal/toroidal mode numbers m/n were identified, including modes that are ambiguous on the basis of magnetic measurements. For example, observations of an island on both the low and high field side allow the determination its poloidal parity. Island O- and X-points were radially and toroidally localized by ECE. The shape and internal structure of magnetic islands was also measured in detail and transport and confinement within the island were inferred. It is shown that, when locked to each other, a well-developed 3/2 mode deforms the 2/1 island and gives rise to a 4/2 component. This is ascribed to the attraction between parallel filaments of current. Ergodization of the islands was also observed, in the very last stage before locking. Although the highest precision and best spatial resolution were achieved when the island rotates at few kHz prior to locking, or for balanced neutral beam injection, it was possible -by adequate filtering and cross-correlations with magnetic probe signals- to isolate from the background noise islands rotating as fast as 40kHz or with associated temperature fluctuations of few tens of eV. It is discussed how to further improve the diagnostics and analysis to resolve even faster and smaller islands, which would be equivalent to moving backward in time in the evolution of the island and possibly reconstruct seeding phenomena.

The first results from a new oblique ECE radial and phase detector of NTMs will also be presented. This diagnostic tracks the movement of the island directly along the ECCD launch direction. As a consequence, ECE experiences the same Doppler broadening and relativistic downshift as ECCD and can be used for its modulation, with no need for equilibrium reconstructions or complicated helical extrapolations.