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Neoclassical Tearing Modes: Revisting Theoretical Foundations *

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Tearing modes, especially Neoclassical Tearing Modes (NTMs), are large-scale, symmetry-breaking, magnetic-island structures that spontaneously arise in many tokmak experiments and degrade confinement. The Rutherford island evolution equation has provided a very productive framework for understanding NTMs, especially the island size, the time scale for evolution, which is governed by classical flux difusion., and the level of Electron Cyclotron Current Drive (ECCD) power required to supress fully saturated islands. Previous results based on appropriate helical averages of the ECCD level required for supression of NTMS are extended to include offsets between of the current drive layer and the mode rational surface. The Rutherford equation, however, is only an approximate solution to island evolution: it utilizes just one Fourier harmonic to describe the island shape, and it ignores changes in Δ' resulting from island size and/or the effect of ECCD on equilibrium current density profile and hence on Δ'. Stochastic regions, driven by toroidicity, should be present along the boundaries of the helical islands and, in turn, alter bootstrap current profiles and the growth of small islands. This contribution revisits the theoretical foundations of the Rutherford equation and casts the tearing mode problem as a flux-diffusion evolution through a series of helical states, each one in mechanical equilibrium. The goal is to address the deficiencies noted above thereby improving agreement with observations and strengthening extrapolation to an ITER-class facility.

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