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From Order to Chaos - Chaos in Tokamaks Due to Tearing Modes
KYLE ALT, JOSHUA MOLONEY, IRIS TAVAREZ, ESTHER UDUEHI, HALIMA ALI, ALKESH PUNJABI, Hampton University — In this and the next paper, we show how tearing modes create chaos in the ohmically heated tokamaks with standard q-profile, and how we can build barriers inside the chaos in these tokamaks. We have constructed a new symplectic map to calculate trajectories of magnetic field lines in generic tokamaks. The map is given by

$$\psi_{n+1} = \psi_n - k\partial\chi(\psi_{n+1}, \theta_n)/\partial\theta_n, \theta_{n+1} = \theta_n + k\partial\chi(\psi_{n+1}, \theta_n)/\partial\psi_{n+1}.$$

Poloidal flux, χ, is the generating function for the map, the toroidal flux, ψ, is the action, and the poloidal angle, θ, is the angle. We use the standard safety factor profile for the tokamaks. We apply the magnetic perturbations (m,n)=$\{$(3,2),(2,1)$\}$, each with the same amplitude δ. When δ=0, we see invariant tori. For δ from 1X10^{-4} to 7.5X10^{-4}, tori are destroyed and islands are formed. For δ $> 7.5\text{X}10^{-4}$, islands overlap, and finally create full-scale chaos. In the next paper, we show how we can erect a barrier inside this chaos to control transport. This we do by adding a term of order δ^2 to the generating function. This work is supported by the US DOE DE-FG02-02ER54673 and NASA SHARP PLUS.

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