Abstract Submitted
for the DPP20 Meeting of
The American Physical Society

Discovery of Magnetic Island Heteroclinic Bifurcation in Tokamaks LASZLO BARDOCZI, TODD EVANS, General Atomics - San Diego — We report empirical observations of magnetic island heteroclinic bifurcation for the first time. This new class of bifurcations is predicted to occur in tokamaks when multiple, rotationally coupled tearing modes (TMs) of the same helicity grow simultaneously [1]. In this process a second island forms within the original island, resulting in a composite structure of two islands with disjoint O-lines. This behavior is observed in coupled 2/1 TMs in DIII-D. Poincare maps fully constrained by magnetic data show bifurcation from heteroclinic to homoclinic topology in the 2/1 island as the 4/2 relative amplitude (R42) decreases. Initially, the local electron temperature (Te) peak in the 2/1 island splits, consistent with 2 O-points. As R42 decreases a single Te peak forms, consistent with 1 O-point. Electron cyclotron current drive (ECCD) can be an effective method for controlling homoclinic 2/1 island growth. However, heteroclinic bifurcation splits the ECCD between the O-points which can complicate or prevent active stabilization. This imposes challenges on the EC wave launch geometry which is not accounted for in present tokamaks nor in the ITER research plan. These observations call for developing tearing stability theory and control solutions for heteroclinic islands in tokamaks.

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Date submitted: 23 Jun 2020 Electronic form version 1.4