IAEA FEC 2014

Contribution ID: **23** Type: **Poster**

# Feedback of a Neoclassical Tearing Mode on Drift Wave –Zonal Flow Turbulence

*Tuesday 14 October 2014 08:30 (4 hours)*

We study the feedback loop of a spontaneous magnetic perturbation (neoclassical tearing mode) on a background of drift wave –Zonal Flows, in the framework of a 1D predator-prey model for the evolution of turbulence intensity I(x,t), Zonal Flow energy U(x,t), electron temperature gradient T(x) and island-width. A modified Rutherford equation describes the magnetic island dynamics. The magnetic island is driven by the neoclassical bootstrap current, and acts to damp turbulence-driven Zonal Flows, while turbulence also affects the island-chain evolution by flattening the temperature profile, thus depleting the bootstrap current.
A critical issue in fusion devices is what determines the threshold island width, set by a competition between parallel heat conduction along tilted field lines v.s. perpendicular diffusion across field lines. Since perpendicular heat diffusion is mostly turbulent, the threshold island width is determined by turbulence. As turbulence is regulated by Zonal Flows, this threshold is ultimately tied to Zonal Flow intensity and thus Zonal Flow damping. As the island grows, Zonal Flows are strongly (but locally) damped and turbulence remains unquenched in the vicinity of the island. In effect, they are two plasma regions divided by the island separatrix: Outside of the magnetic island, the plasma is ZF-dominated, whereas inside the island, the plasma is pushed back to a saturated turbulence regime (L-mode-like regime). Turbulence spreading across the island-separatrix occurs at quasi-periodic intervals and triggers temperature profile collapse, due to turbulent heat diffusion. Our results suggest that the threshold island-width is modulated by the microturbulence at the Limit-Cycle Oscillation frequency of the predator-prey system. Hence, the threshold island-width is ultimately set by ZF damping.

## Country or International Organisation

Korea, Republic of

## Paper Number

TH/P1-52

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**Session Classification:** Poster 1