Transport Processes in the Vicinity of an Island

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Motivation

- **Usually there are magnetic islands in both 3D or 2D toroidal plasma confinement systems such as NCSX or NSTX.**

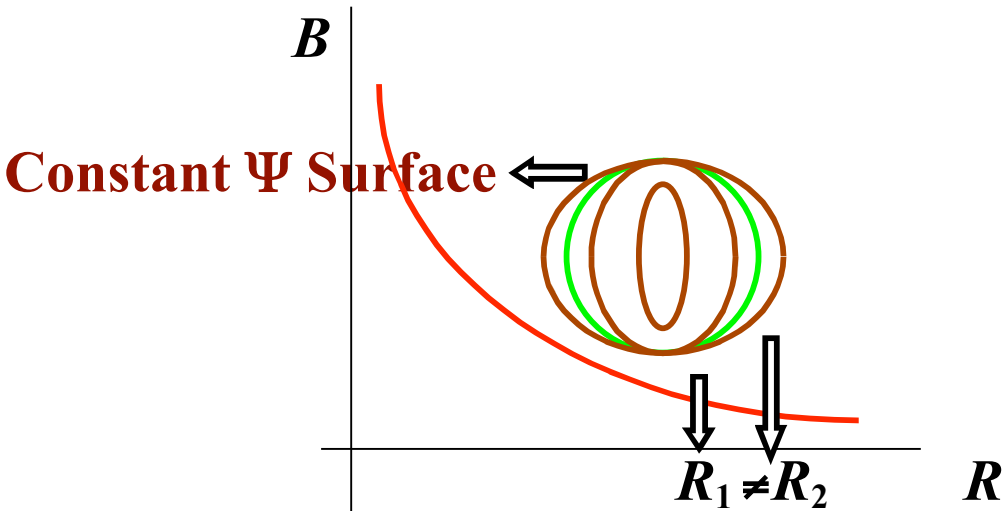
- **The existence of an island introduces additional variations in helical angles in $|B|$.**

- **This additional variations in $|B|$ can have important impact on plasma confinement, momentum transport, and MHD stability itself. [*e.g.* Shaing, PRL 2001, PoP 2002, 2003, Shaing and Spong, PoP2006].**

- **It would be interesting to investigate all these effects in NCSX.**

Island Induced Variation in |*B*|

- **In the vicinity of a magnetic island, there are additional variations in |*B*| triggered by the island itself:**



- **An example of |*B*| variation on the island surface:**

$$B/B_0 = 1 - \left[\frac{r_s}{R} \pm \frac{r_w}{R}\left(\overline{\Psi} + \cos\xi\right)^{1/2}\right]\cos\theta + \text{additional terms}$$

$\overline{\Psi}$: Normalized helical flux function,
ξ : $m\,(\theta - \zeta / q_S) + \omega t$, helical angle,
m : Poloidal mode number, ζ : Toroidal angle. r_w : A measure of the width of the island.

Island Induced Plasma Viscosity and Its Effects

- **The additional variation in $|B|$ lead to an enhanced plasma viscous force.**

- **Thus, transport processes in the vicinity of an island are modified.**

- **This usually leads to better plasma confinement because of the turbulence suppression [Shaing, et al., IAEA 1988] triggered by the fact that the radial electric profile has a spatial variation of the order of the island width.**

- **Thus, the existence of an island may have beneficial effect on plasma confinement. (TJ-2, LHD…)**

- **Island induced plasma viscosity also introduces an additional plasma current density. Thus, it modifies MHD stability nonlinearly. For example it affects island evolution.**

- **It also provides a mechanism to determine the island rotation frequency, and thus affects the stability of the island through the polarization term in the Rutherford equation.**

- **When the island induced viscosity dominates the toroidal momentum equation, there is an intrinsic steady state toroidal flow.**

- **The non-resonant version of the MHD activity induced plasma viscous force has been observed in NSTX [Zhu, Sabbagh, Bell, et al., PRL (2006)].**

- **It would be interesting to see if some of these new physics can be tested in NCSX.**

Conclusions

- **Island induced modification on $|B|$ has shown theoretically to have important consequences on 2D toroidal confinement systems.**

- **It would be interesting to work out the corresponding theoretical consequences in 3D, and compare them to 3D systems such as NCSX.**