

# Are radiation driven islands the cause of the density limit?

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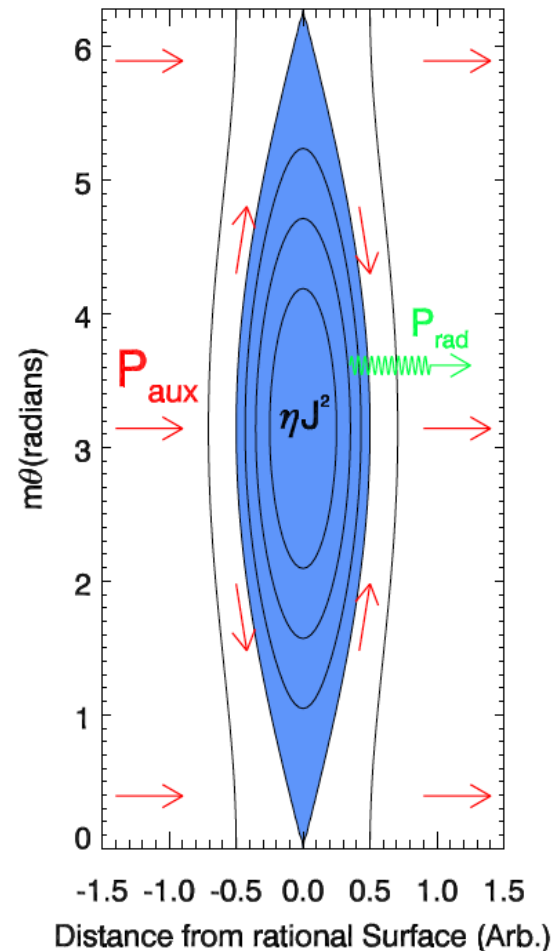
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# Radiation driven islands

- Inside an island impurities accumulate
- This cools the island,
- The lower temperature leads to increased resistivity
- This enhances the helical current perturbation
- the island grows causing the process to continue.

P. H. Rebut and M. Hugon, Plasma Physics and Controlled Nuclear Fusion Research 1984 (Proc. 10th Int. Conf. London, 1984), Vol. 2, IAEA, Vienna, 197, (1985).



# Onset condition determined by power balance

$$P_{rad} < \eta J^2 \quad \text{or} \quad n_e E_{ave} v_{eZ} < \frac{m_e v_{ei}}{e^2 n_e} J^2$$

$$n_e < \sqrt{\frac{m_e v_{ei} J}{e^2 E_{eff} v_{eZ}}}$$

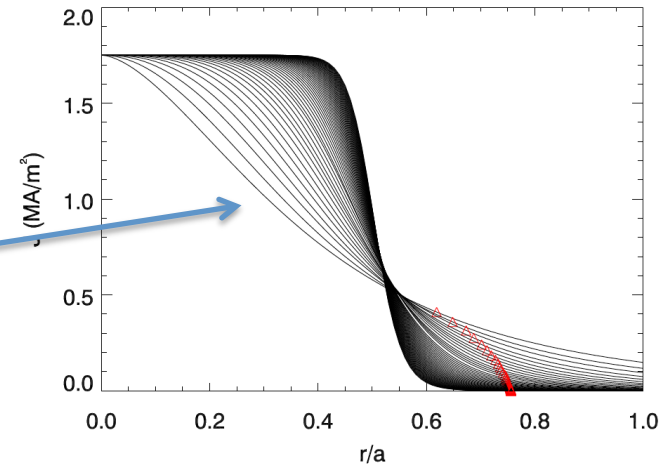
- Auxiliary power is shunted around the island by parallel conduction, explaining why the density limit does not depend on heating power
- Quantity in square root is nearly independent of temperature\*

\*F. W. Perkins and R. A. Hulse, Phys. Fluids **28** (1985) 1837.

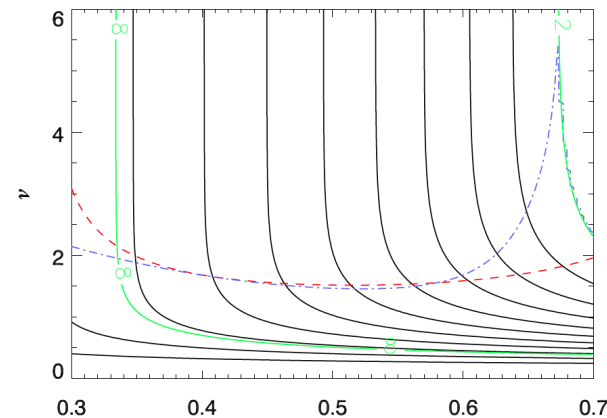
# Simple cylindrical model relates local density and current to global values

- Use a simple profile model

$$J = \frac{J_0}{\left(1 + \left(\frac{r}{r_0}\right)^{2\nu}\right)^{1 + \frac{1}{\nu}}}$$



- Add information on the dependence of  $I_i$  on  $q_{95}^*$  at the density limit and parabolic density profile



Contour plot of the total plasma current (black) as a function of the profile parameters  $\nu$  and  $r_0$ . Also shown in the plot are the contour of the current profile peaking at the density limit and the best fit contour of the radiation driven island criterion

\*J. A. Wesson, R. D. Gill, M. Hugon, F. C. Schuller, J. A. Snipes, et al., Nucl. Fusion **29** (1989) 641