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TITLE. HELICITY DISSIPATION IN THE PLASMA EDGE

AUTHOR(S) R. A. Nebel, CTR-6

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MASTER

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

HELICITY DISSIPATION IN THE PLASMA EDGE

R. A. Nebel

Los Alamos National Laboratory

It has recently been suggested[1] that the cause of the increased loop voltage observed in certain RFP experiments is helicity dissipation in the highly resistive edge plasma region. The simple explanation for this phenomena, roughly put, is that the "RFP dynamo" "works harder" in the highly resistive edge to maintain $J_{\parallel} \sim B$ in this region. Hence, the helicity dissipation term, $\int_v \eta \vec{J} \cdot \vec{B} dv$, scales like the resistivity and the size of the plasma edge region. The net result is, of course, that the loop voltage increases.

In order to test the conjecture, we have done some 3-D MHD simulations including a resistive edge region. Preliminary results indicate that helicity dissipation in this edge region is small compared to dissipation in the plasma interior. The loop voltage required to reach a particular current level is essentially unaffected; the principle effect being that the amount of toroidal field reversal achieved is reduced.

The simulations were done with a 3-D nonlinear, $0 < \beta$ resistive MHD code. The Lundquist number for the simulations was $S = 10^4$. Resistivity was increased by a factor of 100 in the edge region. Figures 1 a, b, and c show the final evolved $B_{z,m,n}(r)$, $B_{\theta,m,n}(r)$, $\Lambda(r)$, and $q(r)$ profiles respectively for a typical case with a 10% resistive edge region. Note that the current diffuses from the high resistance region, as is illustrated by the $\Lambda(r)$ profile. Figures 2a and b compare the rate of helicity dissipation in the plasma core with the dissipation in the edge. Note that the dissipation in the edge starts at a large value (due to the initial conditions) but rapidly decreases to a low level.

These results are not particularly surprising since it is well documented that the MHD drivers for the RFP dynamo are internal $m = 1$ kinks.[2-8] These modes

stability characteristics (and hence their relative nonlinear amplitudes) are largely affected by $d\lambda/dr$ in the plasma interior. Consequently, increasing the resistivity in the edge has little effect on their behavior and hence does not entice the dynamo to "work harder" in the edge region.

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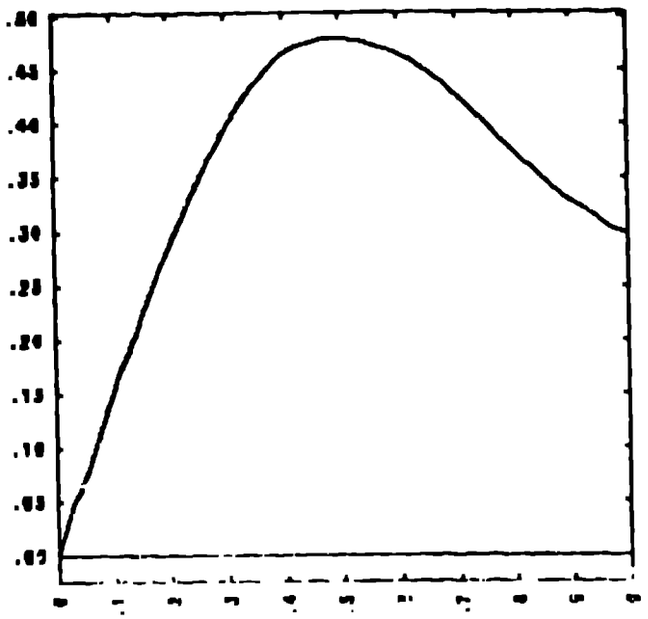
Fig. 1. Final evolved profiles for **a)** $B_{\theta_{0,0}}(r)$, **b)** $B_{z_{0,0}}(r)$, **c)** $\lambda(r)$ and **d)** $q(r)$.

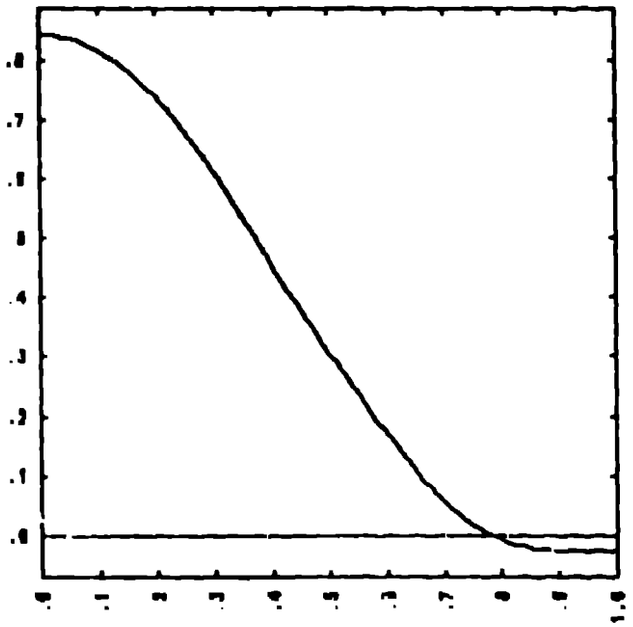
Fig. 2. Helicity consumption rate **a)** in the plasma core and **b)** in the plasma edge.

TA MAGNETIC FIELD



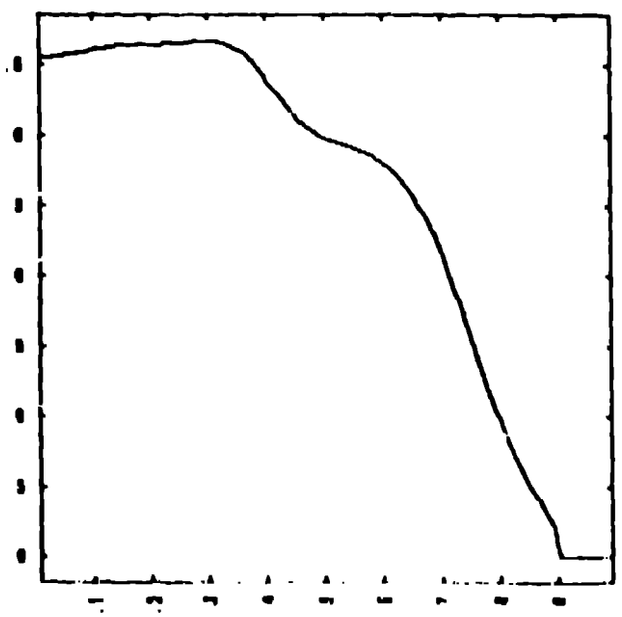
(a)

AXIAL MAGNETIC FIELD



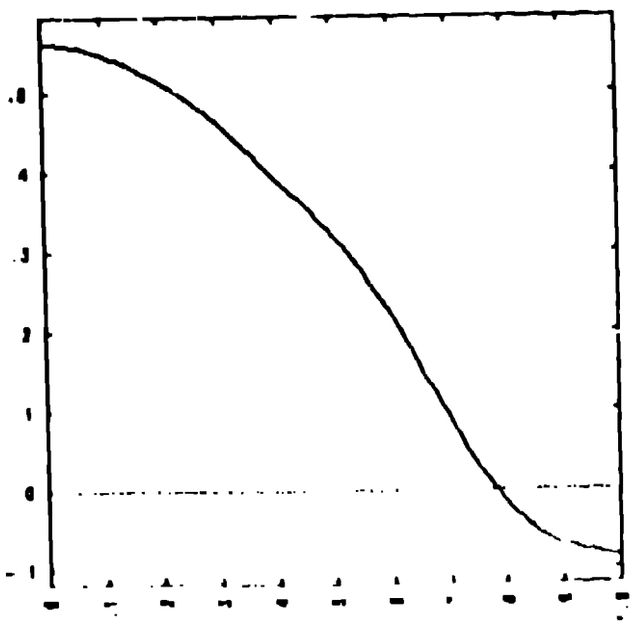
(b)

RADIUS



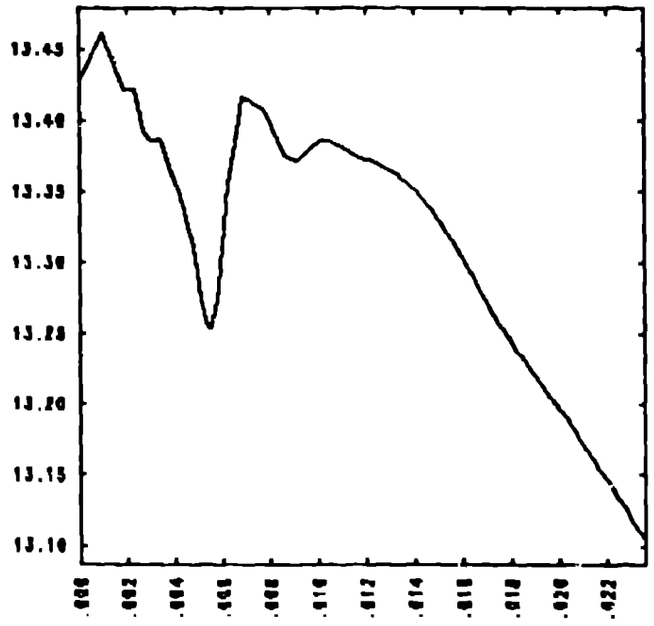
(c)

SAFETY FACTOR



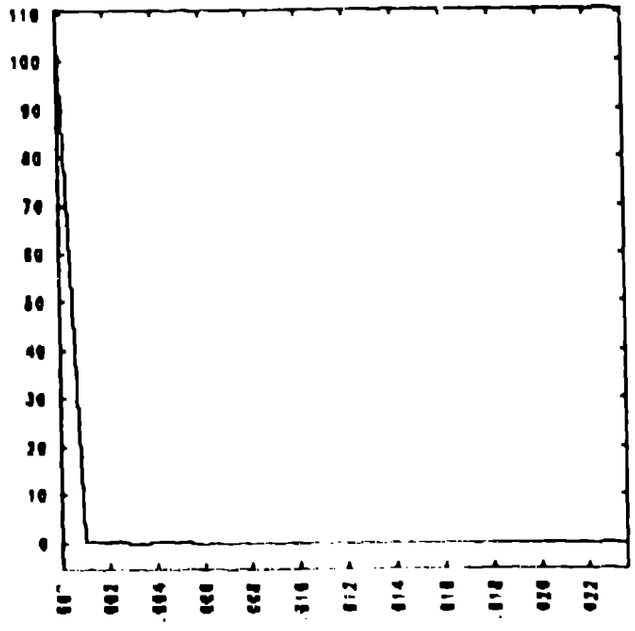
(d)

DHELI/DT CORE VS. TIME



(a)

DHELI/DT EDGE VS. TIME



(b)

Fig. 2