Sausage, Kink and Spheromak Formation

SETTHIVOINE YOU, PAUL M. BELLAN, Caltech — Observations from the Caltech spheromak experiment motivate a revisiting of the sausage and kink instabilities. A collimated, current-carrying magnetic flux tube (center column) is observed to “detach” from the gun at high \( \lambda \) (ratio of gun current to imposed magnetic flux). This detachment appears to be initiated by a sausage instability. Previous measurements [1] indicated the kink instability of this center column is a precursor to spheromak formation. A flux-amplifying kink of the column occurs first, quickly followed by a detachment and spheromak formation. Furthermore, recent results [2] have shown that before kinking, dynamic and stagnating plasma flow is responsible for flux tube collimation—as predicted by the gobble/collimation theory [3]. Ideal MHD linear stability analysis of a diffuse current pinch (using the energy principle and including a skin current and magnetic field relationships from [3]) maps out a \( k \) vs \( \lambda \) operating space, where \( k \) is the inverse length. The space includes \( m = 0 \) and \( m = 1 \) instability regions that are modified from classical thresholds. Measurements of \( k \) and \( \lambda \) throughout the duration of the plasma discharge then trace a path in the operating space. Hence, the observed evolution of the plasma column may suggest an answer to a novel question: is sausage instability another necessary condition for spheromak formation? [1] S.C.Hsu, P.M.Bellan, PRL, 90, 215002 (2003) [2] S.You, G.S.Yun, P.M.Bellan, PRL, (2005) in press [3] P.M.Bellan, Phys.Plasmas, 10, 5 (2003) 1999.

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