1C54

Effect of conserved angular momentum on minimum energy states*

Preston Geren
Geren Consulting Services, Shoreline, Washington

Loren Steinhauer
University of Washington, Redmond Plasma Physics Laboratory

Minimum-energy theory has proved useful in predicting the structural properties of some magnetically-confined plasmas. The most widely-known theory of this type is based on the principle of conserved magnetic helicity, K_m, and leads to what are commonly called Taylor States. More recently, a more general theory has been developed based on the two-fluid model. It has *two* helicity constraints, one for each species (K_e for electrons and K_i for ions). In general, adding another constraint raises the minimum energy and modifies the structure of the minimum-energy state. For example, adding the ion helicity allows finite beta, which is not allowed in a Taylor state. Another constraint that may apply in many cases is the angular momentum, L_z, a constraint that has largely been ignored in minimum-energy studies to date. Likewise in general, including it as a constraint raises the minimum energy and modifies the plasma structure.

The minimum-energy theory with constraints on the two helicities and the angular momentum is presented. Assuming an incompressible plasma and using a Fourier-Beltrami (FB) expansion, a FB spectrum of solutions is determined. These full-spectrum solutions differ markedly from the one-point (Taylor-like states) or two-point (double-Beltrami) solutions that appear when angular momentum conservation is ignored.

An important property of the full-spectrum solutions is that they are axisymmetric. This implies that no member of this class of solutions can be kinked, “sausaged”, tilted, ”ballooned”, fluted or otherwise manifesting the persistence of an instability. On the other hand, the one-point or two-point spectrum solutions *can* be non-axisymmetric, and thus can represent the nonlinear end-state of a fully-developed instability. The question then is which solution type applies for a given set of constraints $\{K_e, K_i, L_z\}$.

The full-spectrum solutions are presented and compared with the one- and two-point solutions developed previously. The issue of which specific combinations of the invariants (two helicities, angular momentum) is also investigated. For this purpose the two-dimensional helicity map K_e-K_i is used to classify the states and identify the regions of stability and instability.

*This work is supported by USDOE Grant DE-FG03-98ER54480.