CENTRIFUGAL CONFINEMENT FOR FUSION: THE MARYLAND CENTRIFUGAL TORUS (MCT)

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The basic idea of centrifugal confinement is to use centrifugal forces from supersonic rotation to augment the usual magnetic confinement. Using this extra "knob" optimally results in a device that features four advantages over tokamaks: steady state, no disruptions, superior crossfield confinement, and a simpler coil configuration. One geometry, to be used in the proposed MCT expt at the University of Maryland, is a simple mirror with a central column. The central column is biased with respect to the outer wall resulting in a radial electric field that drives toroidal rotation. The radial centrifugal force keeps the ions completely confined against parallel effusion, bead-on-wire fashion. The electrons are held in electrostatically but the potential well is much deeper than in a mirror machine, scaling as the square of the Mach number.

A second prong of the centrifugal idea is that the large velocity shear will stabilize even the flute interchanges. Thus, extra magnetic fields may not be necessary, although numerical simulations of flute interchanges indicate a residual wobble. If necessary, the latter could be suppressed by a weak toroidal magnetic field. The velocity shear will also quell microturbulence, leading to fully classical confinement as there are no neoclassical effects. The parallel electron transport is minimized by a large Pastukav factor resulting from the deep potential well. At Mach 4-5, the Lawson Criterion should be accessible.

The central goal of the MCT experiment will be to obtain MHD stability from velocity shear. Specifically, it will be determined how much if any toroidal field is necessary to suppress residual wobbles and convection from the interchange. Previous experiments were probably MHD convection limited and did not have a toroidal field. In addition, the MCT experiment will feature a plasma of elongation 6-8, which should reduce the interchange growth rate and so reduce Mach number requirements. The experiment will be small-scale (plasma width ~ 10 cm), possibly neutral dominated, but sufficiently in the MHD regime to test the above. An elongated mirror geometry using existing coils and power supplies cost-effectively is planned. A toroidal field capability will be included. Mirror ratios of 4-10 are planned with a maximum field of 2T. Voltage drops of 10-20 keV will be used. Zero-D transport code estimates suggest an operating regime where the various MHD issues above could be adequately tested. In addition, the experiment will study and optimize plasma formation and insulator design.

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