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Pure electron plasmas in a stellarator: Theory and experiment[1]

THOMAS SUNN PEDERSEN, Columbia University

The confinement of non-neutral plasmas by magnetic surfaces, such as those of a tokamak or a stellarator, is a new area of plasma research. The theory of such plasmas, which range from single component to quasi-neutral, has had a rapid development in recent years. The primary focus has been on pure electron plasmas, in particular the properties of low density electron plasma equilibria. The equilibrium equation is a Poisson-Boltzmann equation for the electrostatic potential which has been solved numerically in realistic three-dimensional geometries. Pure electron plasmas confined on magnetic surfaces are now being studied in several experiments, including the recently operational Columbia Non-neutral Torus (CNT). CNT is an ultralow aspect ratio stellarator at Columbia University, which is devoted to the study of plasma confinement on magnetic surfaces over the full range of plasma neutrality: single component to quasi-neutral. These experiments have already confirmed one theoretical prediction: The existence of macroscopically stable equilibria. We will report on theoretical predictions and experimental measurements of equilibrium, stability, and confinement, and will discuss work in progress on the inclusion of a finite ion fraction and the effects of high electron densities.

In collaboration with Allen H. Boozer, Remi G. Lefrancois, Jason P. Kremer, Quinn R. Marksteiner, and John Berkery, Columbia University.

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