

## **Studies of a Parallel Force Balance Breaking Instability in a Stellarator**

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An instability has been observed in non-neutral plasmas confined on magnetic surfaces in the presence of a finite ion fraction [Phys. Rev. Letters **100**, 065002 (2008)]. In the Columbia Non-neutral Torus (CNT) the instability has a poloidal mode number of  $m = 1$ . This does not correspond to a rational surface, implying that the parallel force balance of the electron fluid is broken. In CNT, there is a large variation in the magnetic field, and a large fraction ( $\sim 65\%$ ) of the electrons are on trapped orbits. We present a summary of key experimental observations of the instability, including the dependence on neutral pressure, magnetic field strength, and ion species. A simple analytical theory which describes the above mentioned instability in terms of these trapped electrons is also presented. The bulk of the trapped and untrapped electrons obey parallel force balance and hence are in a Boltzmann distribution. However, there is a perturbed component of the trapped electrons which depart from this equilibrium. These electrons exhibit orbits which  $E \times B$  drift in the perturbed electric field, and interact with the finite fraction of ions to cause the plasma to go unstable. Results from this theory will be presented and compared with experimental results.