First results from the Columbia Non-neutral Torus

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The Columbia Non-neutral Torus started operation in November 2004. CNT is an ultralow aspect ratio stellarator designed to study the physics of non-neutral plasmas confined on magnetic surfaces. It is created from a unique and simple coil set consisting of two pairs of planar circular coils. Hence, its coil set is simpler than that of any other stellarator, or any tokamak. The first results from CNT include detailed magnetic surface mappings, and initial pure electron plasma experiments.

The magnetic surface mapping experiments confirm the existence of large high quality magnetic surfaces with last closed flux surface aspect ratios as low as <1.9. These experiments were performed at magnetic field strengths up to 0.1 Tesla, and are in very good agreement with the numerical calculations (Figure 1). This makes CNT by far the lowest aspect ratio stellarator ever built. A significant, but smaller, volume of good magnetic surfaces is found even at very low magnetic fields, B=3 milliTesla. Detailed field line mapping results will be presented.

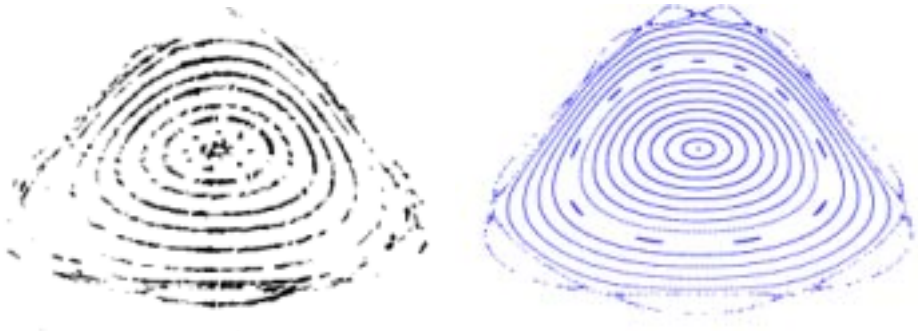

Figure 1. Experimentally obtained drift surfaces for a beam energy of 100 eV and a magnetic field of 0.1 Tesla (left) and numerically calculated magnetic surfaces (right).

A stationary electron emitter has been inserted into the confinement region to create pure electron plasmas. Measurements show that up to 10^{11} electrons fill the volume of the magnetic surfaces, and that the electron confinement time can be more than 10 milliseconds, despite the modest magnetic field strength (B<0.1 T), the lack of quasi-symmetry, and the presence of a macroscopic material object in the plasma (the emitter rod). Since the estimated drift escape time is less than 1 msec, the much longer confinement time is experimental evidence that an equilibrium exists for a pure electron plasma in a stellarator, as predicted from theory[1]. The confinement time is observed to decrease with increasing neutral pressure, and decreasing magnetic field strength. We will report on these first experiments, and discuss the results of upcoming experiments that will provide more detailed information.

1. T. Sunn Pedersen and A. H. Boozer, PRL **88**, 205002, 2002.