CONTAINMENT OF SINGLE-SPECIES PLASMAS
AT LOW ENERGIES

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For some purposes, it may be convenient to store or transport antiprotons in cylindrical traps rather than in storage rings. This talk will describe some of the theoretical perspectives and experimental results developed in the UCSD program on containment of pure electron plasmas. My remarks will fall into 5 general areas:

(1) Practical limits on magnetic fields and containment voltages limit the number of charges stored, with \(10^{15}\) being moderately difficult.

(2) Long-term containment of the particles depends on cylindrical symmetry and conservation of the total angular momentum of the plasma, so small asymmetries can cause significant losses.

(3) The Newton-Maxwell equations almost scale with respect to charge and mass, so much of the physics of pure electron plasmas applies to pure ion plasmas.

(4) The detection and transmission of azimuthally asymmetric plasma waves may be important for diagnostics and for dynamical stabilization of the plasma.

(5) Confined thermal equilibrium states exist for unneutralized plasmas at high or low temperatures, even for more than one charge species.

Cylindrical Containment.

A simplified diagram of a cylindrical electron plasma containment apparatus is shown in Figure 1a. The entire apparatus is in a uniform magnetic field \(B_z\), and evacuated to below \(10^{-10}\) Torr. The system is repetitively pulsed in the following sequence. Initially cylinders A and B are grounded, and cylinder C is biased strongly negative. Electrons emitted from a negatively biased thermionic source\(^{(1,2)}\) then form a column from the source through cylinder B. When cylinder A is biased negative, the electrons are axially trapped by the electrostatic fields. The unneutralized space charge generates a strong radial electric field, and some radial transport may occur with time.\(^{(3,4)}\)