Relativistic effects on the radial equilibrium of nonneutral plasmas

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Relativistic effects on the radial equilibrium of nonneutral plasmas confined in cylindrical traps are analyzed for rigid and sheared modes of plasma rotation, both with and without the presence of a coaxial inner charged conductor [1,2]. The changes with respect to the non-relativistic results are especially pronounced for the fast rotational equilibrium solutions (when the frequency of the plasma azimuthal rotation is close to the cyclotron frequency).

In the case of a solid plasma column the density profile turns out to be nearly parabolic rather than stepwise as predicted by the non-relativistic theory. This modification of the equilibrium density profile should be observable in experiments similar to those performed by Theiss et al. [3].

In the case of an annular plasma column it is found that relativistic effects can limit its outer radius. Analytical estimates of this maximum radius are found both for a rigid plasma rotation and for the case of a uniform plasma density.

It is also observed that the Brillouin density limit is modified when the shielding of the external magnetic field by the current associated with the plasma rotation becomes significant and a class of sheared equilibria is found where the limit valid for the case of rigid rotation can be overcome.