via particles (or waves), as well as the imposition of static or time-varying fields (electric and magnetic). For example, biased limiter experiments have improved tokamak confinement. Is confinement better for a combination of direct current limiter bias, alternating current field component(s), and removal (or injection) of substantial current? By analogy to example 2 above, can incoherent wave injection (v = frequency, $k_\parallel$ = parallel wave number) quell turbulence (V = frequency, $K_\parallel$ = parallel wave number) with $v \gg V$ and $k_\parallel \gg K_\parallel$? If turbulent transport can be controlled with such techniques, smaller and less expensive ITER-class experiments may be possible.

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February 8, 1993

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ION DEFOCUSING IN MULTICUSP PLASMA CONFINEMENT SYSTEMS

The proposed Polywell® polyhedral multicusp plasma confinement systems are designed to achieve strong ion focusing to a radius $r_c \ll R$ (Refs. 1 and 2). In this letter, a phenomenon is indicated that may tend to limit the attainable degree of focusing.

The plasma is produced by electron beam injection radially inward through the point cusps. As the electron density increases, electron diamagnetic currents push the magnetic surfaces outward, producing a relatively sharp boundary, as illustrated in Fig. 1. Ions are confined mostly by the electrostatic potential well, with only weak magnetic effects at the edge.

Since electrons can flow comparatively easily along magnetic field lines, the variation of electrostatic potential along magnetic field lines is relatively gradual. The contours of electrostatic potential tend to have shapes similar to those of the magnetic surfaces, as illustrated by the hypothetical contours of Fig. 2.

Consider the trajectories of ions that are initially well focused to within a small radius r_c at the center of the device. As these ions leave the central region, they are reflected

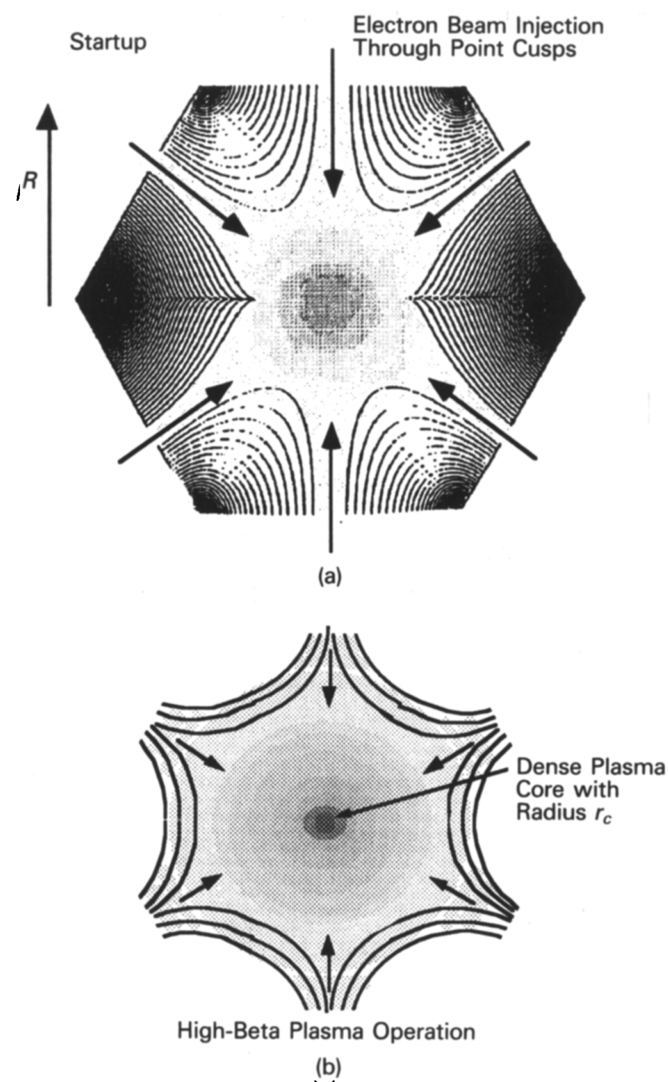

Fig. 1. (a) Startup by electron beam injection and (b) high-beta operation.

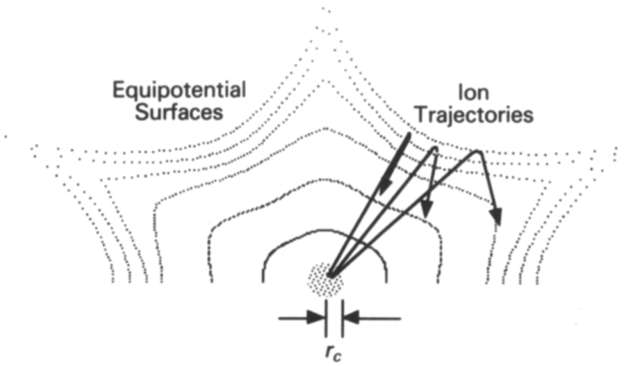

Fig. 2. Hypothetical electrostatic potential surfaces (dotted curves) and trajectories of ions initially focused within the core region r_c.

by the electrostatic potential boundary layer. After reflection, many of the ions are no longer focused to the small central region r_c from which they emerged. This defocusing by reflection from the convex boundary tends to increase the focus region radius r_c. Similar effects are expected in the three-dimensional case.

This defocusing effect should be taken into account when estimating the feasible regimes of operation. Although it may not preclude successful operation of polyhedral multicusp devices, it may limit the attainable convergence to $r_c/R \geq 0.2$.

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January 5, 1993

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