of angular momentum will then lead to a compression of the cloud to the maximum density [43].

This system allows a detailed study of the dynamics of non-neutral plasmas and helps to understand instabilities in different confinement scenarios, to minimize loss mechanism, and to investigate specific fusion processes. But for all practical purposes aiming at power production, the total reactivity per unit volume is severly limited and the question was posed, how to extend this technique beyond the brillouin density limit.

5.2.1. Ion Traps vs. Fusion Machines

Considering the enormous amounts of money being put into the development of tokamak reactors for fusion energy despite the fact that the cost per incremental progress is growing exponentially, one may argue that alternate fusion approaches should be pursued if (a) they do not require magnetic confinement superior to tokamaks, (b) their physics basis may be experimentally tested, (c) they offer near-term applications to important technical problems, and (d) their cost to proof-of-principle is low enough to be consistent with nowadays budget constraints. Lead by these principles D. C. Barnes and collaborators [44] have asked the natural question whether the excellent confinement observed in non-neutral (single species) plasmas stored in Penning traps might be applied to the controlled release of nuclear fusion energy. Equally naturally one may arrive at the conclusion that the reactivity per unit volume one can obtain from such systems is very much too low to be of practical importance. This low reactivity is associated with the Brillouin limit which constrains the plasma mass energy density (nMc^2 , where n is the number density, M is the mass, and c is the velocity of light) relative to the magnetic field energy density ($B_o^2/2\mu_0$, B_0 is the magnetic induction and μ_0 is the permeability of free space). On the other hand, it is an important observation that the Brillouin density limit only applies in a volume average sense, and local densities far beyond the Brillouin density could be achievable if a steep spatial density gradient could be imposed to the cloud. To realize this density gradient it is proposed to inject low energy, low P_Θ (canonical angular momentum) electrons into a spherical Penning trap. These electrons are accelerated radially inward to approximately 100 keV by the effective spherical well (comprising the applied potential, the space charge potential, and the magnetic field). Convergence of these particles near r = 0 produces a dense, inertially confined core. This core represents a virtual cathode, and if neutral gas atoms are admitted to the system, they will be inonized, attain thermonuclear energies, and are electromagnetically confined in the