An Electrostatic Confinement Experiment to Explore the Periodically Oscillating Plasma Sphere

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Theoretical work[1,2] has suggested that a tiny oscillating ion cloud (Periodically Oscillating Plasma Sphere or POPS) may undergo a self-similar collapse that can result in the periodic and simultaneous attainment ultra-high densities and temperatures. Theoretical projections[1] indicate that such a system may have net fusion gain even for an advanced fuel such as Deuterium-Deuterium. Schemes have also been suggested where a massively modular system consisting of tens of thousands of these spheres can lead to a very high mass power density device (similar to a fission light water reactor)[1] while still having conventional wall loads (~ 1 MW/m^2).

POPS also has the feature that the total fusion power scales inversely with the device radius.[1] This favorable surface to volume scaling leads to high mass power density and thus a device which will be competitive with fission, coal, gas and renewable energy sources. The lightweight, modular design is also an excellent fit for the space propulsion systems which will be required for interplanetary space travel.

The fusion energy development path for the POPS system is also very different from conventional fusion systems. Conventional systems tend to get larger and more expensive with each generation. (For instance, the next generation magnetic confinement device (ITER) is projected to cost twelve billion dollars.) For POPS, we will demonstrate the physics on a single cell so each generation device should be smaller than the previous generation. The costs of any successive device should be similar to our present device that was less than $100k.

Thus, this device combines the following three attributes: a high mass power density device with favorable economics, a low cost development path where no device costs more than $100k, and a system which can operate with advanced fuels. However, a number of issues need to be addressed to determine the efficacy of the POPS scheme. Some of these issues are: phase locking and control of the ion oscillations, space charge neutralization during the ion collapse phase, electron cloud uniformity and control, stability of the electron cloud, and maintenance of the virtual cathode. These issues are being addressed both theoretically and experimentally.

References

1. R. A. Nebel, D. C. Barnes, ***Fusion Technology*** **38**, 28 (1998).
2. D. C. Barnes, R. A. Nebel, ***Physics of Plasmas*** **5**, 2498 (1998).