INERTIAL ELECTROSTATIC CONFINEMENT: THEORETICAL AND EXPERIMENTAL STUDIES OF SPHERICAL DEVICES

Ryan Meyer

Dr. Mark Prelas, Dissertation Supervisor
Dr. Sudarshan Loyalka, Dissertation Supervisor

ABSTRACT

Inertial Electrostatic Confinement (IEC) is a means to confine ions for fusion purposes with electrostatic fields in a converging geometry. Its engineering simplicity makes it appealing when compared to magnetic confinement devices. It is hoped that such a device may one day be a net energy producer, but it has near term applications as a neutron generator. We study spherical IECs (SIECs), both theoretically and experimentally. Theoretically, we compute solutions in the free molecular limit and map out regions in control parameter space conducive to the formation of double potential wells. In addition, several other observables are mapped in the control parameter space. Such studies predict the threshold for the phenomena of "core splitting" to occur when the fractional well depth (FWD) is ~70%-80%. With respect to double potential wells, it is shown that an optimal population of electrons exists for double well formation. In addition, double well depth is relatively insensitive to space charge spreading of ion beams.

Glow discharge devices are studied experimentally with double and single Langmuir probes. The postulated micro-channeling phenomenon is verified with density measurements along a micro-channel and along the radius where micro-channels are absent. In addition, the measurements allow an evaluation of the neutrality of micro-channels and the heterogeneous structure of "Star Mode". It is shown that, despite visual evidence, micro-channeling persists well into "Jet" mode. In addition, the threshold for the "Star" mode to "Jet" mode transition is obtained experimentally. The studies have revealed new techniques for estimating tangential electric field components and studying the focusing of ion flow.