DPP17-2017-001656

Abstract for an Invited Paper
for the DPP17 Meeting of
the American Physical Society

Progress toward magnetic confinement of a positron-electron plasma: nearly 100% positron injection efficiency into a dipole trap[1]

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The hydrogen atom provides the simplest system and in some cases the most precise one for comparing theory and experiment in atomics physics. The field of plasma physics lacks an experimental counterpart, but there are efforts underway to produce a magnetically confined positron-electron plasma that promises to represent the simplest plasma system. The mass symmetry of positron-electron plasma makes it particularly tractable from a theoretical standpoint and many theory papers have been published predicting modified wave and stability properties in these systems. Our approach[3] is to utilize techniques from the non-neutral plasma community to trap and accumulate electrons and positrons prior to mixing in a magnetic trap with good confinement properties. Ultimately we aim to use a levitated superconducting dipole configuration fueled by positrons from a reactor-based positron source and buffer-gas trap. To date we have conducted experiments to characterize and optimize the positron beam[4] and test strategies for injecting positrons into the field of a supported permanent magnet by use of ExB drifts and tailored static and dynamic potentials applied to boundary electrodes and to the magnet itself. Nearly 100% injection efficiency has been achieved under certain conditions and some fraction of the injected positrons are confined for as long as 400 ms. These results are promising for the next step in the project which is to use an inductively energized high Tc superconducting coil to produce the dipole field, initially in a supported configuration, but ultimately levitated using feedback stabilization.

[1]Work performed with the support of the German Research Foundation (DFG), JSPS KAKENHI, NIFS Collaboration Research Program, and the UCSD Foundation.

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