Recent status of the PAX and APEX projects toward the formation of electron-positron plasma

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Electron-positron plasmas are predicted to exhibit unique properties as a result of the equal masses of the two particle species [1]. Motivated by recent successful confinement of pure electron non-neutral plasmas in toroidal geometries [2,3], we aim to create the first magnetically-confined electron-positron plasma in stellarator and dipole traps [4] operated at the NEPOMUC facility [5], the world's strongest positron source (~10^9 moderated positrons per second). In order to realize confinement of positrons and electrons as plasma, we have started two experimental projects in parallel. One is the PAX (Positron Accumulation eXperiment), which aims to accumulate on the order of 10^{11} positrons using a buffer-gas trap and a multicell type linear trap [6]. On the way of constructing such a trap system, electron confinement experiments have been conducted with a Penning-Malmberg trap in a high-field (5 T) magnet. More than 1 hour of confinement and observation of collective mode for ~10^9 electrons have been realized. Based on these results, we will design a new accumulator with large electrostatic potential wells and rotating wall fields.

The second project is APEX (A Positron Electron eXperiment), focusing on efficient injection and confinement of positrons and electrons in toroidal geometries. In APEX, we started positron injection experiments using a prototype dipole field trap generated by a permanent neodymium magnet. In the first experimental campaign at NEPOMUC in 2015, we achieved efficient (40%) injection of the remoderated 5 eV positron beam into the dipole field. Injection was realized using static electric fields applied by ExB plates located outside the confinement region. We also measured the parallel and perpendicular positron beam energies, which are important parameters for further optimization of the injection efficiency. In the near future, we will construct a levitated dipole trap which can simultaneously confine positrons and electrons in closed field lines. Design studies on the trap configurations and the levitation system are ongoing.

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