Status of A Positron-Electron Experiment (APEX) towards the formation of pair plasmas

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Laboratory experiments on electron-positron plasmas enable the understanding of unique characteristics of pair plasmas consisting of perfectly equal-mass charged particles. Although their stability and wave propagation properties have been intensively studied theoretically, no electron-positron plasmas have been created so far. We plan to achieve simultaneous confinement of electrons and positrons as plasmas by using toroidal geometries (A Positron-Electron Experiment, APEX) in combination with a multicell-type Penning trap based accumulator (a Positron Accumulation Experiment, PAX) [1], to be operated at the neutron-induced positron source NEPOMUC at FRM II [2].

The APEX project is under way to design and construct a stellarator and a levitated dipole device on the basis of recent experiments at CNT [3] and RT-1 [4], which demonstrated stable confinement of toroidal pure electron plasmas. While long confinement of both positrons and electrons is expected in these toroidal geometries, development of efficient particle injection methods into the closed field lines is needed. We are considering three injection methods; (1) drift injection by using local electric fields or the rotating wall technique, (2) formation, excitation, and photo-ionization of neutral positronium by lasers [1, 5], and (3) direct injection of high energy positrons and remoderation in confinement regions. In order to enhance the trap efficiency of positron beams in a buffer gas trap of the accumulator, optimization of beam energy spread is also important. Prior to the construction and operation of the superconducting APEX experiment, we are conducting numerical considerations and proof-of-principle experiments on these topics by using electron beams and a prototype dipole field trap generated by a permanent neodymium magnet. The status of development and initial results of APEX are reported.

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[1] T. Sunn Pedersen *et al.*, New J. Phys. **14**, 035010 (2012).
[2] C. Hugenschmidt *et al.*, New J. Phys **14**, 055027 (2012).
[3] P. W. Brenner and T. Sunn Pedersen, Phys. Plasmas **19**, 050701 (2012).
[4] Z. Yoshida *et al.*, Plasma Phys. Ctrl. Fusion **55**, 014018 (2013).
[5] D. B. Cassidy *et al.*, Phys. Rev. Lett. **107,** 033401 (2011).