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Milestones on the way to matter/antimatter plasmas: Efficient injection and extended confinement of positrons in a dipole trap[1]

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Plasmas that consist of negatively and positively charged particles of equal mass ("pair plasmas") have been a topic of theoretical and computational studies for more than forty years and are predicted to exhibit many significant differences from electron/ion plasmas. Electron/positron plasmas, which can be magnetized easily, are of particular interest, and there have recently been major advancements in experimental methods to study them in the laboratory. This talk will report on achievements of the APEX (A Positron Electron eXperiment) collaboration that are key steps toward its goal of magnetically confined e+/e- pair plasmas. APEX uses an intense source of cold positrons (the NEPOMUC beam line at the neutron source FRM-II), which will ultimately be accumulated in a series of non-neutral plasma traps, then injected with electrons into the confining magnetic field of a levitated dipole trap. First, a prototype trap based on a supported permanent magnet has been used to demonstrate injection and trapping of the externally produced positrons in a dipole field. Lossless transport of the positrons into the trap has been achieved with ExB drifts, induced by strategically applying voltages to electrodes at the edge of the confinement region[2]. Switching off these voltages results in injected positrons being trapped for more than a second, corresponding to hundreds of thousands of toroidal transits[3]. Simulations have guided and reproduced injection experiments and tentatively identified elastic scattering off residual background gas (causing diffusion in position and velocity space) as the main limit on confinement, suggesting that longer trapping will be readily achievable.

[1]on behalf of the APEX Collaboration

[2]E. V. Stenson et al., PRL 121, 235005 (2018)

[3]J. Horn-Stanja et al., PRL 121, 235003 (2018)