Simulation of charged-particle injection into a levitated dipole trap

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Abstract

Magnetically confined plasmas with a mass ratio of unity ("pair plasmas") are predicted to be fundamentally different from conventional fusion plasmas. Their experimental investigation will thus be a benchmark for the understanding of plasma physics.

The APEX collaboration pursues the creation of such plasmas consisting of electrons and positrons in the magnetic dipole field of a levitated, superconducting coil which is capable of containing both non-neutral as well as quasi-neutral plasmas. To obtain the number of positrons necessary to achieve the plasma state ($\gtrsim 10^{11}$ in a 10-l volume), they need to be accumulated in a tailored non-neutral plasma trap before they are injected into the dipole field, where they will mix with electrons. Injection requires charged-particle transport across closed magnetic field lines, for which an efficient scheme is being developed. In previous single-particle experiments with a permanent-magnet trap, it was demonstrated that lossless injection can be achieved when an $E \times B$ drift scheme is used in conjunction with localized electric fields.

In this contribution, we use single-particle simulations to investigate if a similar scheme can be employed in a levitated dipole trap with the envisaged parameters of the APEX project. We include effects due to the increased magnetic field strength (1 T) and modified field line geometry compared to the permanet magnet, boundary conditions dictated by the levitation physics, and source parameters set by the non-neutral positron trap.