RECENT ADVANCES IN STUDIES OF POSITRON SWARMS IN ELECTRIC AND MAGNETIC FIELDS IN GASES

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Abstract. A Monte Carlo simulation technique has been used for the calculation of positron transport properties in neutral gases under the influence of electric and magnetic fields. The motivation for this work was twofold. First, positrons have applications in many research areas ranging from gamma-ray astronomy to biomedicine. Second motivating factor is associated with the recent development of positron traps, designed for the determination of low-energy cross sections for positron-matter interactions. Further improvements and optimization of these devices require a detailed knowledge of both collision and transport processes of positrons in gases in various configuration of electric and magnetic fields. The high magnitude of the cross section for positronium (Ps) formation process comparing to other collisional processes and its strong energy dependence are two major factors for the development of many interesting kinetic phenomena observed in the positron transport. One of the most striking phenomena is the existence of negative differential conductivity (NDC) in the bulk drift speed component and the absence of any sign of this phenomenon in the profile of the flux component. Along similar lines we have observed that the differences between the flux and bulk components of various transport coefficients, originating from the non-conservative nature of Ps formation, are much higher than those that have been ever observed for electrons. The influence of magnetic field in a crossed field configuration (**E**×**B**) is also investigated. Due to the presence of magnetic field the number of transport coefficients is increased. Since the longitudinal and transverse components of the drift velocity exhibit different sensitivities with respect to the magnetic field strength, it is found that the NDC effect in a crossed field configuration can be controlled by the magnetic field. The magnetic cooling effect has also been observed – the mean energy of the swarm is a decreasing function of the magnetic field for all electric field strengths considered in this work. In that sense, positrons behave in exactly the same way as electrons. The results of the Monte Carlo simulations are compared with those obtained by the multi-term theory for solving the Boltzmann equation. The excellent agreement between these two entirely independent techniques supports the numerical integrity of our Monte Carlo code.

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