Positron and Positronium Physics Around GBAR

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In order to make a direct observation of the effect of gravitation on antimatter, the GBAR [1] experiment aims at measuring the influence of Earth's gravity in the trajectory of antihydrogen atoms. The first step of the experiment is the production of antihydrogen ions and involves two consecutive three- and four-body charge exchange reactions involving positronium atoms and low energy antiprotons. One of the biggest challenges faced by GBAR is to find the best experimental and physical conditions (positronium state, antiproton energy etc...) for enhancing the antihydrogen ion production rate. In this context we present two recent works devoted to the cross-sections computation for the two reactions.

In [2] a new *ab-initio* method is developed to solve Faddeev-Merkuriev equations using Lagrange-mesh techniques to describe collisions of the Coulombic three-body systems. This method has been applied to study $(\bar{p}, e^+, e^-)$ system in the energy range between $e^- + \bar{H}(n = 2)$ and $e^- + \bar{H}(n = 3)$ thresholds. A special focus is made on the role played by Feshbach resonances and Gailitis-Damburg oscillations appearing in the vicinity of the different reaction thresholds. Our results are in very good agreement with previous works while giving more detailed cross sections [3, 4].

In a second work [5] we explore the possibility to increase the antihydrogen positive ion production rate by assisting the capture processes involved in the two reactions using a laser field having standard specifications (e.g. ion or excimer lasers). By using a formalism adapted from [6-8], we present an extensive study of the influence of the laser parameters (laser field strength and photon energy) on the charge exchange cross sections in the energy range of interest for the GBAR's experiment. Under special irradiation conditions antihydrogen' atom and ion formation cross sections may be significantly increased by the presence of the laser field.

References

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