

Excitation of $3^{1,3}P$ and $3^{1,3}D$ states of helium from the ground 1^1S state by electrons and positrons

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Abstract. A systematic theoretical study is carried out for the electron and positron impact excitation of the $3^{1,3}P$ and $3^{1,3}D$ states of helium from the ground 1^1S state. The results are reported for the differential cross sections, Stokes parameters and alignment and orientation parameters. To calculate the scattering amplitude which relate these parameters, a distorted wave approximation theory with different choices of distortion potential has been used. The results are compared with available theoretical and experimental data in the energy range of 40–100 eV.

Keywords. Excitation; electrons; positrons; helium.

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1. Introduction

Most of the pioneering experimental studies of the fundamental processes in electron-atom scattering such as elastic, excitation and ionization have been carried out with helium as target. Theoretically also any approximate method for a particular type of collision process before being recommended for the general use/application (i.e. for heavier atoms) is first tested for hydrogen and helium. The studies on helium are more challenging due to the presence of two electrons in it which permits inter-electron repulsion to be introduced in a realistic manner. Further, helium being an inert gas is much easier to handle experimentally and because of this reason measurements with helium are more readily available than for hydrogen. In addition, the study of electron-helium scattering processes have wide ranging practical applications in the field of plasmas and lasers for their understanding. Also, helium is an abundant element and, therefore, helium emissions are widely observed in a variety of stellar and interstellar media, and are in turn used for determining abundances of this element. It is, therefore, important to provide quantitative electron collision cross sections for this target as well as to measure/calculate those scattering parameters which provide best test of a scattering theory.

In this paper we focus our attention and deal with the electron (positron)-impact excitation of the $n = 3$ states of helium from its ground state with the point of view of differential cross sections and electron-photon coincidence results. Though electron impact excitation of the $n = 2$ states of helium from the ground state have been studied in considerable detail, similar studies for the excitation of the $n = 3$ states are few. This can