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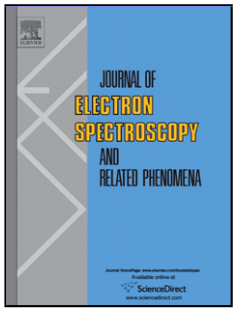

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Author: Béla Paripás Jozo Jureta Béla Palásthy Bratislav Marinković Gábor Pszota

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ACCEPTED MANUSCRIPT

High resolution study of the autoionizing states of He in their exchange interference energy region

Béla Paripás[a,*], Jozo Jureta[b], Béla Palásthy[a], Bratislav Marinković[b], Gábor Pszota[a]

[a] *Institute of Physics, University of Miskolc, H-3515 Miskolc-Egyetemváros, Hungary*
[b] *Laboratory for Atomic Collision Processes, Institute of Physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia*

Abstract

The electron impact excitation (and their decay into the same final ionic state) of the autoionizing states of helium ($2s^2(^1S)$, $2s2p(^3P)$, $2p^2(^1D)$ and $2s2p(^1P)$) have been studied. The interference of these states can occur when the energies of the autoionizing electrons match that of the scattered electrons. The observation of this exchange interference is disturbed by the Fano interference, which occurs at all primary energies. We intend to study it separately in the neighbourhood of the critical energy, and then to estimate its measure for the critical energy. The present measurements were made at 88eV and 97eV primary energies (where the groups of the ejected and the scattered electron peaks are well separated), at 130^o, 90^o and 50^o scattering angles. The measured spectra were evaluated by a computer code, using the Shore parametrization. We give the obtained peak parameter values in tabulated form. We found an anomaly of the fitted values of Lorentz width of $2s^2(^1S)$ peak.

Keywords: electron impact, Helium, autoionizing state, Fano interference, exchange interference

1. Introduction

Interference usually refers to the interaction of coherent waves that originate from the same source, but they travel to the common final state travel via different paths. In the two-step process of the formation and decay of autoionizing states, the interference may occur in several ways. In the most general case, this can happen by way of the interference with the direct process that leads to the same final state (Fano interference). If there is not just one, but two autoionizing states, and they have neighboring energies (they partially overlap), then these states can interfere with each other, because the electrons that arrive in the overlapping energy region can be associated with either one of the autoionizing states. However, the sates with non-overlapping energies may also interfere in a slightly more complex way [1, 2]. In our previous works we have already presented this case [3, 4]. In these papers we concentrated on the interference of the $2s^2(^1S)$ and $2p^2(^1D)$ resonances of helium, where some resonance-like phenomena have been observed in [1, 2]. The excitation energies (E_R) of these autoionizing states are 57.84 eV and 59.90 eV [5]. The energy of their common He^+1s^{-1} final state is E_F=24.59 eV, hence the energies of the ejected autoionizing electrons ($E_a = E_R - E_F$) are 33.25 eV and 35.31 eV, respectively. At E_0=93.15 eV primary energy (Fig.1), the energy of the scattering peaks ($E_s = E_0 - E_R$) associated with the generation of these autoionizing states are 35.31 eV and 33.25 eV. Thus the ejected-scattered (scattered-ejected) electron pairs going along the two paths have the same energies (33.25; 35.31 eV); these scattered-ejected electron pairs

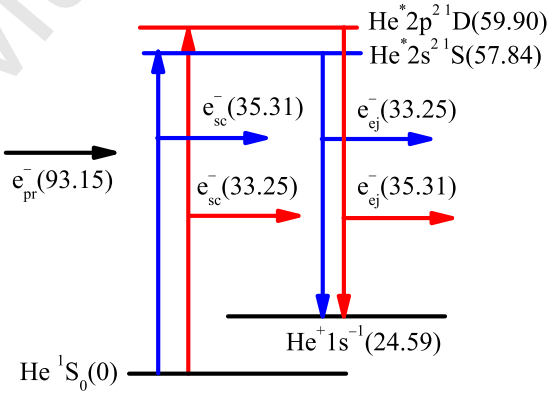

Figure 1: (Color online) The energy levels and transitions of the studied state-to-state interference

are indistinguishable. Therefore this state–to–state (exchange) interference can occur at this primary energy, so the **critical energy** for this pair is 93.15 eV. Including the other two autoionizing states of helium ($2s2p(^3P)$ at E_a=33.71 eV and $2s2p(^1P)$ at E_a=35.55 eV), too, the critical energies for the non-overlapping pairs fall into the 93.15–93.85 eV primary energy interval. The ± 5 eV surrounding of this interval, i.e. the 88–99 eV region considered as the **exchange interference energy region** in this paper.

The energy spectra measured at the critical energy are obviously complex, since the energies of at least two-two electron peaks coincide. In this example there is one coinciding scattered-ejected electron peak pair both at 33.25 eV and 35.31 eV, the other parameters of which, however, differ significantly.

*Corresponding author
Email address: fizpari@uni-miskolc.hu (Béla Paripás)

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