ATOMIC REALIZATION OF THE YOUNG SINGLE ELECTRON INTERFERENCE PROCESS IN INDIVIDUAL AUTOIONIZATION COLLISIONS

R. O. Barrachina* and M Žitnik†

*Centro Atómico Bariloche and Instituto Balseiro, 8400 S. C. de Bariloche, Río Negro, Argentina.
†J. Stefan Institute, Jamova 39, P. O. Box 3000, SI 1000 Ljubljana, Slovenia.

Young's double-slit demonstration, applied to the interference of single electrons, is considered to be one of the most beautiful experiments in Physics [1]. A few years ago, a controversy arose between Merli *et al.* [2] and Tonomura *et al.* [3] regarding the the first complete realization of this experiment. Of course, the diffraction of electrons by atomic arrays had already been studied many decades before, but the novelty in the experiments by Merli and Tonomura was that one electron at a time collides with a single two-slit arrangement. We recently proposed [4] a direct atomic realization of a Young interference experiment, where a single electron source and a two-center scatterer are prepared in each collision event.

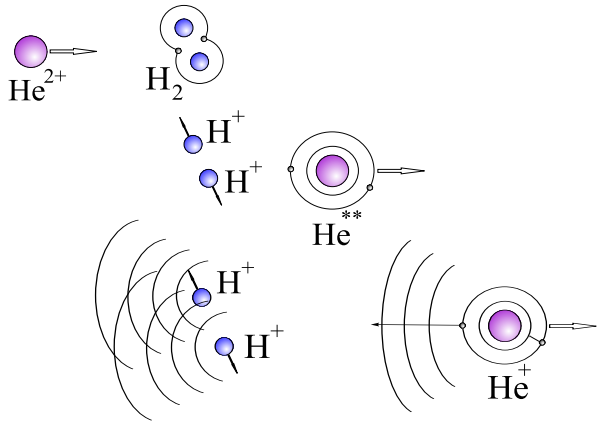

Fig. 1. $(2s^2)^1S$ autoionization of He^{**} induced by a $He^{2+} + H_2$ double electron capture collision.

The proposed mechanism is exemplified in Figure 1. An atom – molecule collision leads to a configuration where an autoionizing atom emits an electron with a sharply defined energy. The scattering of this electron with a diatomic molecule builds up an interference pattern. The autoionizing atom and the receding molecule play the role of the electron source and the two-slit arrangement, respectively, in this *atomic-size* laboratory setup. Note that this arrangement can be built-up by many different collision processes, ranging from the one depicted in Figure 1, to the double excitation of an atom.

By means of a generalization of the Continuum Distorted Wave (CDW) model previously employed in simplest cases [5] we demonstrate that a Young-type oscillatory pattern does actually occur, as shown in Figure 2. The conditions for the appearance of this structure and the distortions produced by multiple scattering processes are also discussed.

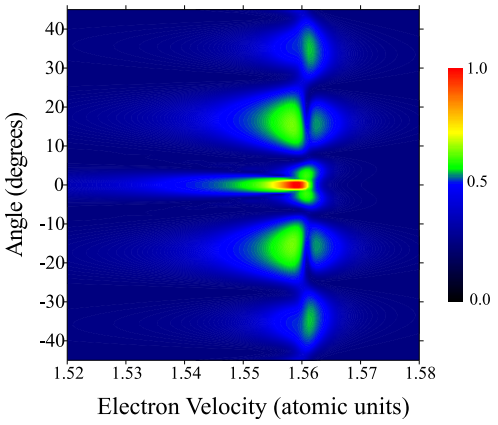

Fig. 2. Normalized DDCS for the process depicted in Fig. 1 in the coordinate frame of the He atom. The relative velocity is 1 au. The dissociation of the H_2 molecule is supposed to occur in a direction perpendicular to the projectile's trajectory.

References

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