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To cite this article: D A Horner et al 2009 J. Phys.: Conf. Ser. 194 022068

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Classical two-slit interference effects in double photoionization of molecular hydrogen at high energies

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Synopsis We report a thorough theoretical study of one photon double ionization of H₂. We suggest that interference effects reported in one photon ionization will be reproducible in the case of double ionization when one of the photons carries most of the available energy and the other electron is not observed. These calculations reproduce recent double photoionization experiments of H₂.

Recent theoretical calculations have shown that interference effects, such as electron confinement and double slit diffraction, can be seen in one-photon single ionization of H₂ when the ejected electron is fast enough for its wavelength to be comparable to the equilibrium internuclear distance. A recent experiment suggests that such effects are also visible in double ionization of H₂ if one looks at the angular distribution of one electron irrespective of the other for very asymmetric energy sharing. This interpretation was supported by comparison with simple one electron models in which correlation between the two ejected electrons is ignored. Our theoretical results reproduce the experiments, while the simple models do not work at the energies used in the experiment. At higher energies we have evaluated triply differential cross sections (TDCS) and the doubly differential cross sections (DDCS) that result from integration of the former over the angular coordinates of one of the electrons. Although the simple diffraction models did not work at the energies used in the experiment, they do reproduce the calculated DDCS for higher energies. Figure 1 shows a comparison between our results and the simple model used in [3] for circularly, parallel and perpendicularly polarized light at 375 eV in which the plotted electron takes 99% of the available energy. In the lower left panel, the appearance of six lobes reveals typical double-slit interferences similar to those predicted by the simple diffraction model. For triply differential cross sections, the interpretation is not so simple: many angular nodes are observed with no apparent connection to those observed in the doubly differential cross sections. The physical origin of these complex structures will be discussed at the conference.

Fig. 1. DDCS for photon energy of 375 eV and 99% energy sharing. Left: Parallel (upper panel) and perpendicular (lower panel) polarization. Right: Circular polarization. Dashed curves: Simple diffraction model.

References

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