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Ionization of Simple Molecules by Ion or Electron Impact in a Reaction Microscope¹

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We have studied single ionization of simple molecules by fast charged particle impact in a reaction microscope. By measuring the momenta of the emitted electron and the recoil ionic fragment in coincidence, channel-selective low-energy electron spectra have been recorded. For non-dissociative ionization of H₂ by 6 MeV protons, the electron energy distribution agrees well with a CDW-EIS prediction [1] except for $E_e < 1$ eV where an significant enhancement is observed. It is due to the autoionization of rovibrational levels of Rydberg states of H₂, which occurs by converting vibrational energy into kinetic energy of the emitted electron. First fully differential cross sections have been obtained bearing the “signature” of this molecular mechanism, which lies beyond the Born-Oppenheimer approximation [2].

Recently, considerable interest has been raised by the observation of two-center interference effects in the electron emission from H₂, in analogy to Young’s double-slit experiment [3]. They are predicted to be more pronounced if one could fix the orientation of the molecular axis at the instant of the collision [4]. For dissociative ionization of H₂ by 6 MeV protons we had access to this information. Molecular-frame angular distributions of the emitted electrons have been compared to the CDW-EIS calculation [5].

Argon dimers as well as atomic Ar, both present in the same gas-jet, are ionized by 1keV electron impact in a kinematically complete experiment carried out in an upgraded reaction microscope. The obtained electron spectra for Ar₂ and Ar are compared directly in order to identify interference structures, which are expected to be much more visible than for H₂ since the interatomic distance of Ar₂ is comparable to the de Broglie wavelength of the emitted electron.

[1] M.E. Galassi *et al.*, Phys. Rev. A **66**, 052705 (2002)

[2] C. Dimopoulou *et al.*, Phys. Rev. Lett. **93**, 123203 (2004)

[3] N. Stoltherfoht *et al.*, Phys. Rev. Lett. **87**, 023201 (2001)

[4] G. Laurent *et al.*, J. Phys. B **35**, L495 (2002)

[5] C. Dimopoulou *et al.*, J. Phys. B **38**, 593 (2005)

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