The photodetachment cross section of H^-: an animated-crossed-beam measurement

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The photodetachment of the negative hydrogen ion H^- has attracted numerous studies due to the ion's prototypical character and the importance of electron correlations in that weakly bound system. It has become a commonly used benchmark from atomic theories and numerical methods, which have, over the decades, reached an overall good agreement. On the experimental side fewer studies exist, and only one [1] provides absolute cross sections at various photon energies. Recently, Vandrevraye *et al.* [2] have carried out an absolute measurement at 1064 nm (1.1653 eV), presented in Fig. 1.

In order to measure an absolute photodetachment cross section, it is necessary to disentangle the so-called volume effect. In our crossed beam setup, the finite size of the ion beam and of the laser beam defines an effective interaction volume, within which both the ion and the photon flux vary. The measured photodetachment signal is therefore an *average* over these local variations and the cross section is, in general, retrieved by assuming a certain distribution for both beams.

The animated-crossed-beam method, originally developed for electron-ion collisions [3], eliminates the need for the knowledge of the beams distributions. Instead of fully characterizing the interaction volume, it aims at *removing* its influence on the measured signal by repeatedly sweeping the laser beam across the ion beam, as realized by tilting a fused silica plate. After integration of the signal along the laser's vertical displacement, the cross section is expressed only in terms of easily measurable quantities, e.g., the laser power and the ion beam current.

The photodetachment cross section obtained in the range from 700 nm to 1064 nm [4] is in excellent agreement with previous experiments and compelling theoretical works, in particular the state-of-the-art calculation of Venuti and Decleva [5] shown in Fig. 1. We also confirm the commonly admitted value of 3.5×10^{-21} m^2 at 1064 nm (1.1653 eV).

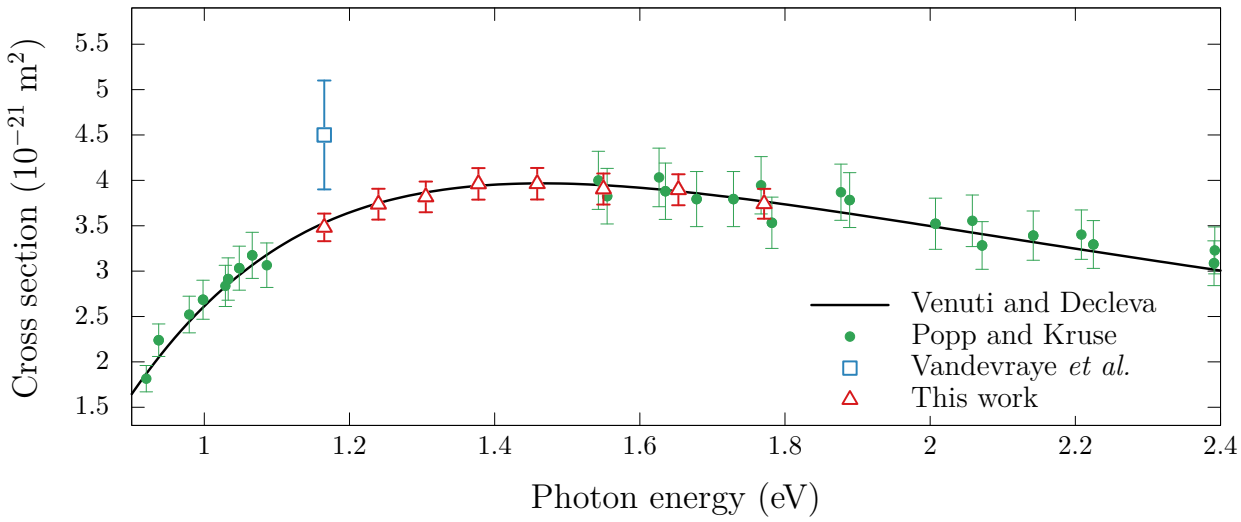

Figure 1: *Photodetachment cross section of H^- versus photon energy.*

References

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