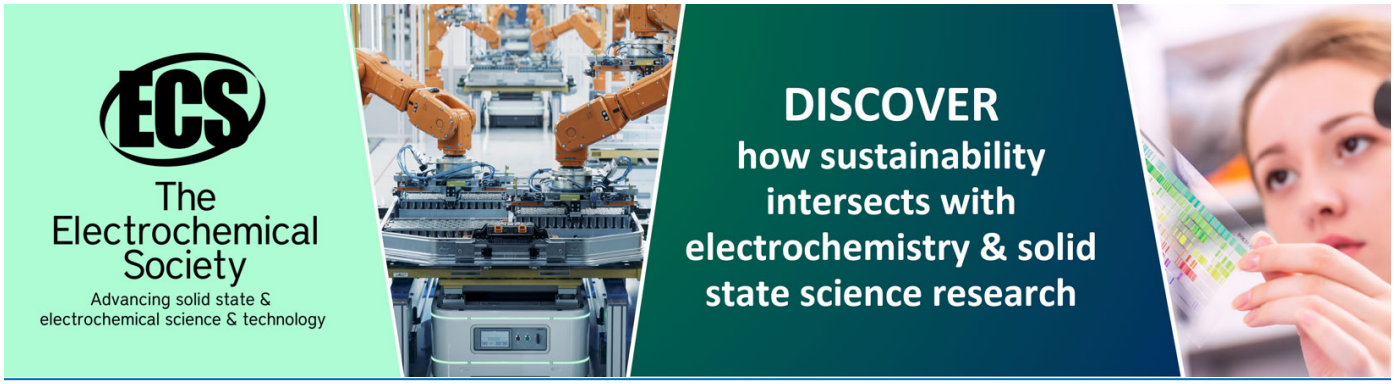
# Asymmetric electron emission in laser-assisted photoionization of diatomic molecules





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# Asymmetric electron emission in laser-assisted photoionization of diatomic molecules

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**Synopsis** We study theoretically the different kinds of asymmetries that may arise in the laser-assisted photoionization of diatomic molecules.

The study of the electron dynamics now available within its natural time scale gave place to the birth of the so called attosecond physics [1]. Extreme ultraviolet (XUV) light pulses with durations in the range of hundreds of attoseconds (as, 1 as $= 1 \times 10^{-18}$ s) in combination with a weak or moderately strong near-infrared laser field (NIR), allow to monitor and/or control the electron dynamics.

The asymmetric electron emission is closely related to the control of dynamical properties in laser-assisted reactions. The electron localization in dissociating molecular states [2] and the orbital parity mix [3] have been proved to be valid tools to control the reactions.

In this work, we study theoretically the laser-assisted photoionization of diatomic molecules by means of an analytical model [4, 5], with emphasis in the asymmetric electron emission. In this model, the initial molecular wavefunctions are described as linear combination of Slater type orbitals variationally optimized, whereas the final states are represented by separable Coulomb-Volkov type wavefunctions. Multiple differential cross sections (MDCS) obtained by means of our analytical model [4] are in qualitative agreement with ab-initio calculations [6].

When the reaction is assisted by a NIR, strong asymmetries in the MDCS are obtained compared to the completely symmetric MDCS produced by the XUV solely. Our model provides an interpretation of this effect based on interferences of the different channels opened by the NIR presence. For heteronuclear diatomic molecules, the aforementioned effects, are superimposed to the corresponding asymmetric emission patterns for the one-photon ionization processes.

Finally, the effect of the XUV and NIR pulses durations are analyzed. In Fig. 1, we show the angle-energy photoelectron spectra for $H_2^+$ molecules ionized with XUV pulses of different duration in the presence of a NIR. As can be seen, asymmetric electron emission is obtained for XUV pulses with smaller durations (Fig. 1, first row), corresponding to the streaking regime. On the contrary, almost symmetric electron emission distributions are obtained when the XUV pulse duration is comparable to the period of the NIR (Fig. 1, second row).

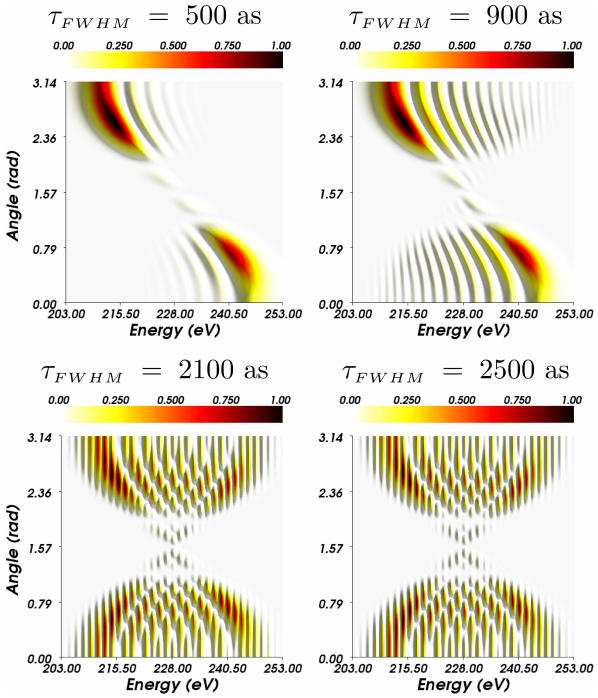


**Figure 1**. Angle-energy photoelectron spectra for $H_2^+$ ionized with XUV pulses of different durations, in the presence of a moderately intense NIR.

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