### **PAPER • OPEN ACCESS**

# Signatures of Light-Induced Potential Energy Surfaces in ${}^{\rm H_2^+}$

To cite this article: M Kübel et al 2020 J. Phys.: Conf. Ser. 1412 092017

View the article online for updates and enhancements.

## You may also like

- <u>Sum rules and asymptotic behaviors of</u> <u>neutrino mixing and oscillations in matter</u> Zhi-zhong Xing and Jing-yu Zhu
- <u>The commutator of raising and lowering</u> operators for angular momentum to the free particle's hamiltonian A F Sugihartin, B Supriadi, Subiki et al.
- <u>Hyperon and antihyperon physics</u> Andrzej Kupsc

The Electrochemical Society

## 241st ECS Meeting

May 29 – June 2, 2022 Vancouver • BC • Canada Abstract submission deadline: **Dec 3, 2021** 

Connect. Engage. Champion. Empower. Acclerate. We move science forward



This content was downloaded from IP address 94.134.197.189 on 18/11/2021 at 08:04

Journal of Physics: Conference Series

## Signatures of Light-Induced Potential Energy Surfaces in H<sup>+</sup><sub>2</sub>

M Kübel<sup>1,2,3\*</sup>, M Spanner<sup>4</sup>, Z Dube<sup>1</sup>, A Yu Naumov<sup>1</sup>, M J J Vrakking<sup>5</sup>, P B Corkum<sup>1</sup>, D M Villeneuve<sup>1</sup> and A Staudte<sup>1†</sup>

<sup>1</sup>Joint Attosecond Laboratory, National Research Council and University of Ottawa, Ottawa, Ontario, Canada

<sup>2</sup>Ludwig-Maximilians-Universitt Munich, Am Coulombwall 1, D-85748 Garching, Germany

<sup>3</sup>Friedrich-Schiller Universitt Jena, Max-Wien-Platz 1, D-07743 Jena, Germany

<sup>4</sup>National Research Council, 100 Sussex Drive, Ottawa, Ontario K1A 0R6, Canada

<sup>5</sup>Max-Born-Institut, Max-Born-Strae 2A, D-12489 Berlin, Germany

Synopsis Using theory and Cold Target Recoil Ion Momentum Spectroscopy we find signatures of light-induced molecular potential energy surfaces in the 3-dimensional proton momentum distributions of dissociating  $H_2^+$ .

H<sub>2</sub> continues to provide fundamental insights into the mechanisms of intense light-matter interactions [1]. Recently, there has been significant interest in so-called light-induced conical intersections (LICI) that arise from the angle dependence of the single-photon coupling of electronic states. Analogously to regular conical intersections, electronic and nuclear motions are strongly coupled in the vicinity of LICIs. As a signature of such rovibronic dynamics, weak modulations in the angular distribution of protons emitted from  $H_2^+$  have been reported [2]. More generally speaking, infrared (IR) laser pulses couple the  $\sigma_q$  and  $\sigma_u$  electronic states of H<sub>2</sub><sup>+</sup> typically through several pathways involving an odd number of photons [1], which can produce complex light-induced potential energy landscapes, and consequently even richer dynamics.

Here, we report the observation of strongly structured proton angular distributions obtained from the dissociative ionization of H<sub>2</sub>. Our experiment relies on the STIER (Sub-cycle Tracing of Ionization Enabled by infraRed) technique [3], where an intense few-cycle visible pulse ionizes  $H_2$  to  $H_2^+$ . The cation subsequently dissociates under the influence of a moderately intense mid-IR (2300 nm) pulse, which is polarized perpendicularly to the visible pulse and does not cause ionization of  $H_2$  on its own. The 3dimensional momentum of the ejected protons were recorded using COLTRIMS (cold target recoil ion momentum spectroscopy). Figure 1 a) shows the proton distribution produced in a

\*E-mail: matthias.kuebel@uni-jena.de <sup>†</sup>E-mail: andre.staudte@nrc.ca

few-cycle, 800 nm laser pulse. In Figure 1b) a cross-polarized, multi-cycle, 2300 nm pulse is superimposed. Strikingly, the weak mid-IR field does not only add a contribution along its polarization axis, but also produces angular features closer to the polarization of the visible laser pulse. Using numerical solutions of the timedependent Schrdinger equation, we explain the features of the measured momentum distribution as an angle-dependent competition of different dissociation pathways in a complex light-induced potential energy landscape [4].

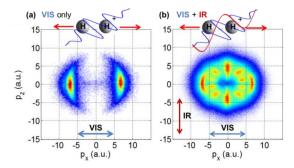


Figure 1. Measured proton momentum distributions produced by (a) a visible (730 nm) few-cycle pulse only and (b) and an additional mid-IR (2300 nm) dressing field. The arrows indicate the laser polarization.

#### References

- Ibrahim H et al 2018 J. Phys. B 51 42002 [1]
- [2]Natan A et al 2016 Phys. Rev. Lett. 116 1
- [3]Kbel M, et al 2017 Phys. Rev. Lett. 119 183201
- [4]Kbel M et al in preparation



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI. Published under licence by IOP Publishing Ltd