



HAL
open science

Two- and many-body effects in cation emission from H₂O molecules by O⁺ impact at keV energies: Similarities between ionization of atoms and proton emission from molecules

B. Sulik, Z. Juhasz, Elie Lattouf, J. A. Tanis, Bernd A. Huber, E. Bene, S. Kovács, P. Herczku, A Méry, Jean-Christophe Pouilly, et al.

► To cite this version:

B. Sulik, Z. Juhasz, Elie Lattouf, J. A. Tanis, Bernd A. Huber, et al.. Two- and many-body effects in cation emission from H₂O molecules by O⁺ impact at keV energies: Similarities between ionization of atoms and proton emission from molecules. *Journal of Physics: Conference Series*, 2015, XXIX International Conference on Photonic, Electronic, and Atomic Collisions (ICPEAC2015) 22–28 July 2015, Toledo, Spain, 635 (3), pp.032118. 10.1088/1742-6596/635/3/032118 . hal-02894124

HAL Id: hal-02894124

<https://hal.science/hal-02894124>

Submitted on 27 May 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

PAPER • OPEN ACCESS

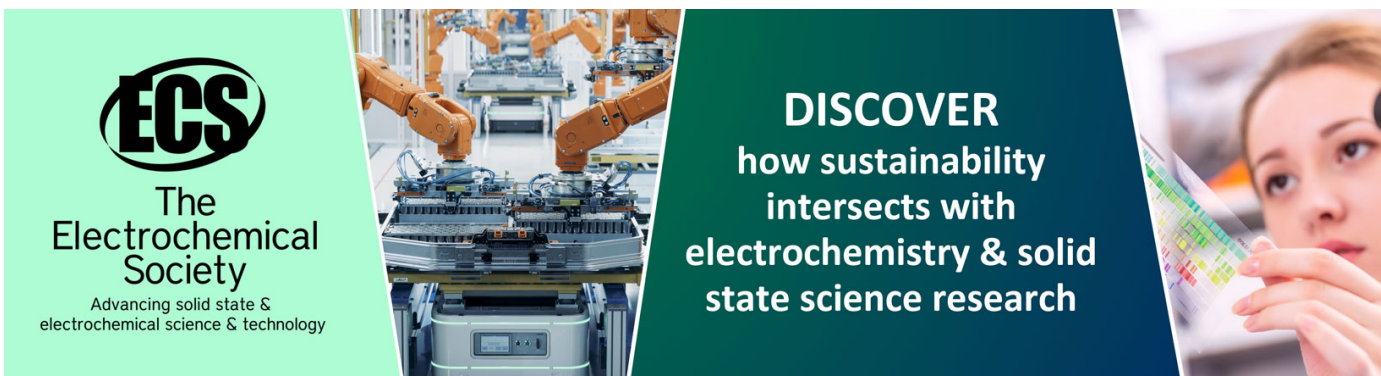
Two- and many-body effects in cation emission from H₂O molecules by O⁺ impact at keV energies: Similarities between ionization of atoms and proton emission from molecules

To cite this article: B Sulik *et al* 2015 *J. Phys.: Conf. Ser.* **635** 032118

View the [article online](#) for updates and enhancements.

You may also like

- [Research on Optimization of independent microgrid based on flexible interconnection technology](#)
Qun Wang, Hai Yu, Yingzhe Huo et al.
- [The Construction of Air Energy Hot Water System in Colleges and Universities Students' Dormitories](#)
Kun Huang, Bing Wang, Qing Zeng et al.
- [Vehicle tracking based on Adaboost cascade classifier](#)
Xu Long, Hu Ming and Tao Tao



ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Two- and many-body effects in cation emission from H₂O molecules by O⁺ impact at keV energies: Similarities between ionization of atoms and proton emission from molecules

B. Sulik^{*1}, Z. Juhász^{*}, E. Lattouf[†], J. A. Tanis^{†,§}, B. A. Huber[†], E. Bene^{*}, S. T. S. Kovács^{*}, P. Herczku^{*}, A. Méry[†], J.-C. Pouilly[†], J. Rangama[†], and J.-Y. Chesnel[†]

^{*} Institute for Nuclear Research, Hungarian Academy of Sciences (MTA Atomki), H-4001 Debrecen, Hungary

[†] Centre de Recherche sur les Ions, les Matériaux et la Photonique (CIMAP), 6 Bd Mar. Juin, F-14000 Caen, France

[§] Department of Physics, Western Michigan University, Kalamazoo, Michigan 49008 USA

Synopsis We demonstrate that energy and angle differential emission yields of fragment ions provide valuable information about the collisions of keV energy ions and molecules. For proton fragments, originating from larger molecules, there are striking similarities to the spectra of electrons emitted in fast ion-atom collisions.

The rich structure of the spectra of ejected electrons in fast ion-atom collision experiments provides deep insight into the details of the ionization process [1]. The key for clarity there is the large proton/electron mass ratio. Electrons move in the fields of much heavier centers.

Here we demonstrate that double differential emission yields of fragment ions provide similarly valuable information in ion-molecule collisions at keV energies. For protons emitted from heavier molecules, due to the large mass ratio, there are close similarities to ionization.

Figure 1 shows experimental double-differential cross sections (DDCS) for cation emission in 6.6-keV ¹⁶O⁺ + H₂O collisions. The experimental arrangement was identical with that of ref. [5]. The main component of each spectrum is a broad, slowly decreasing structure. There the relative contributions of H⁺ and heavier fragments were derived from complementary time-of-flight measurements. The low energy part is mostly due to many-body processes with small momentum transfer, in analogy with the dipole-ionization dominated low energy electron emission in fast ion-atom collisions [1]. At forward angles (< 90°) pronounced peaks are observed at higher energies. These peaks are due to the different cations formed in hard binary collisions [2-5], similarly to electron emission. We note that the heavier oxygen ions are mostly recoils, appearing in the binary ridge, while proton emission is dominated by many-body effects, and it is almost isotropic at low energies. One should keep in mind that highly charged ion impact is somewhat different. There multiple charge-exchange processes, followed by Coulomb explosion, dominate the fragment ion spectra at low energies.

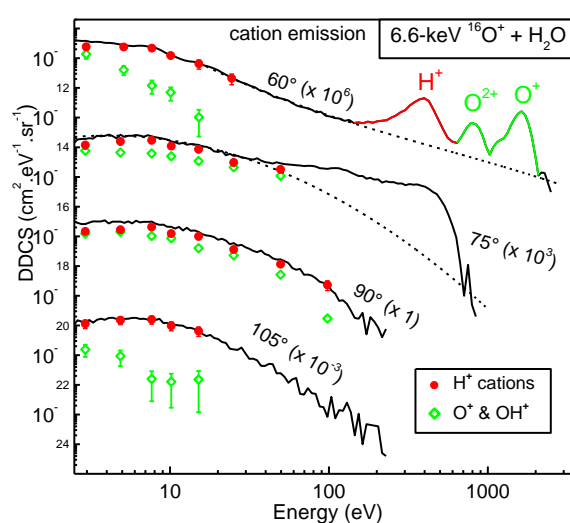


Figure 1. Full curves: Experimental DDCS for cation emission at various angles in 6.6-keV ¹⁶O⁺ + H₂O collisions; Full circles: H⁺ contribution from TOF measurements. Open diamonds: O⁺ and OH⁺ contributions from TOF; Each spectrum is multiplied by the indicated factor.

This work was supported by the Hungarian National Science Foundation OTKA (Grant No. K109440), the French-Hungarian Cooperation Program PHC Balaton (No. 27860ZL/TéT_11-2-2012-0028), and the French-Hungarian CNRS-MTA Cooperation (ANION project).

References

- [1] N. Stolterfoht, R.D. DuBois and R. D. Rivarola, *Electron emission in heavy Ion Collisions* (Springer, Berlin, 1997, pp 1-16)
- [2] Z. Juhász *et al* 2012 *J. Phys. Conf. Ser.* **388** 102051
- [3] Z. Juhász *et al* 2013 *Phys. Rev. A* **87** 032718
- [4] Z. Juhász *et al* 2014 *J. Phys. Conf. Ser.* **488** 102024
- [5] E. Lattouf *et al* 2014 *Phys. Rev. A* **89** 062721

¹ E-mail: sulik@atomki.mta.hu

