Journal of Physics: Conference Series

PAPER • OPEN ACCESS

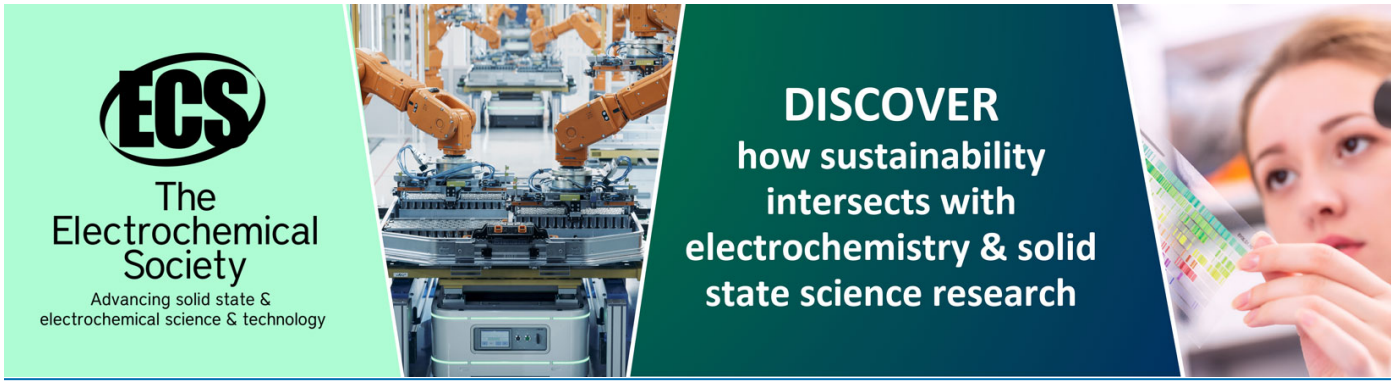
The generalized two-photon excitation cross-section of Xe revisited

To cite this article: C Blondel *et al* 2020 *J. Phys.: Conf. Ser.* **1412** 142012

View the article online for updates and enhancements.

You may also like

- Electron-impact excitation of forbidden and allowed transitions in Cr II
S S Tayal and O Zatsarinny
- Nonlocal treatment of resonant vibrational excitation in electron-dioxygen collision
V Alt and K Houfek
- Role of methylation in electron scattering on $X(CH_3)_4$ (X = C, Si, Ge) molecules
S Stefanowska-Tur, Cz Szmytkowski, E Ptasika-Denga et al.



This content was downloaded from IP address 18.222.22.244 on 11/05/2024 at 08:11

The generalized two-photon excitation cross-section of Xe revisited

C Blondel*, J Alkhoury, T Jannaud and C Drag†

Laboratoire de Physique des plasmas, École polytechnique, Centre national de la recherche scientifique, université Paris-sud, Sorbonne Université, Observatoire de Paris, route de Saclay, F-91128 Palaiseau, France

Synopsis Two-photon absorption laser-induced fluorescence (TALIF) is a technique commonly used for density and/or temperature diagnostics, mainly of oxygen atoms, in flames and plasmas. Usually, density measurements are based on the comparison with the signal obtained, at a similar wavelength, in pure xenon. The cross-section of xenon thus appears a key parameter, the measure of which has not been consolidated by independent measurements. The present experiment is a direct measurement of this two-photon cross-section.

Laser diagnostics in plasmas or flames frequently resorts to the so-called TALIF technique, which consists in recording the fluorescence that follows two-photon excitation of an atomic species. The density of oxygen atoms in plasmas can for instance be monitored via the $3p\ ^3P \rightarrow 3s\ ^3S^o$ 844 nm fluorescence that follows two-photon excitation of the $3p\ ^3P$ level from the $2p^4\ ^3P$ ground term, at the wavelength λ=226 nm. A widespread protocol is to compare the fluorescence yield to that measured in pressure-controlled Xe vapor, when illuminated by the same optical system. Xe atoms can be excited at the nearby wavelength of 224 nm to a $6p'[3/2]_2$ state, then de-excited by spontaneous emission to the $6s'[1/2]_1$ level at the wavelength λ=835 nm, in an atomic scheme quite similar to the one implemented in oxygen, which makes dealing with calibration issues easier, both for the exciting light and for fluorescence detection.

Quantitative analysis, however, relies on an assumed ratio of the two two-photon cross-sections $\sigma^{(2)}$ involved, namely $\sigma^{(2)}(Xe)/\sigma^{(2)}(O)$. Yet this ratio was measured only once [1] and only the cross-section of oxygen $\sigma^{(2)}(O)$ has been measured [2] or calculated [3] directly.

A direct measurement of the cross-section $\sigma^{(2)}(Xe)$ of Xenon has thus appeared desirable. We made it using an injected single-mode Ti:Sapphire laser [4], which gives perfect control of the photon statistics and assures a good reproducibility of the results. An example of a spectrum obtained in the vicinity of the $6p'[3/2]_2$ resonance is given by figure 1. The corresponding two-photon excitation cross-section of the $6p'[3/2]_2$ level has been found roughly twice smaller than what had been admitted previously. Results on other resonances will be shown at the conference.

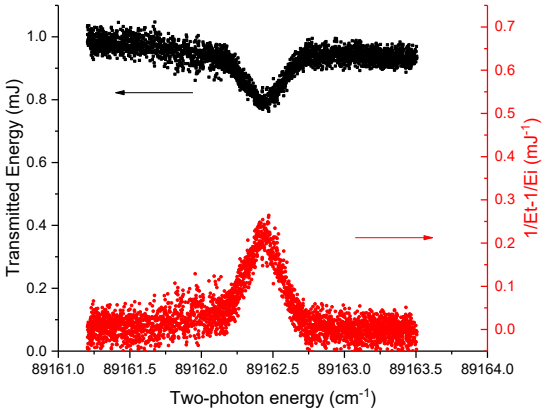


Figure 1. Two-photon absorption spectrum around the $6p'[3/2]_2$ resonance of Xe. The cell length is 51 cm and the pressure 8.61 kPa. The laser pulse duration is about 6 ns and the beam waist about 350 µm. Left axis: transmitted energy. Right axis: 1/(transmitted energy) - 1/(incident energy).

References

[1] Niemi K, Schulz-von der Gathen V and Döbele H F 2005 *Plasma Sources Sci. Technol.* **14** 375
[2] Bamford D J, Jusinski L E and Bischel W K 1986 *Phys. Rev. A* **34** 185
[3] Saxon R P and Eichler J 1986 *Phys. Rev. A* **34** 199
[4] Lottigier P, Jucha A, Cabaret L, Blondel C and Drag C 2019 *Appl. Phys. B* **125** 14

* E-mail: christophe.blondel@lpp.polytechnique.fr
† E-mail: cyril.drag@lpp.polytechnique.fr

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