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Comment on Measuring Photoionization Cross Sections of Excited Atomic States

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Abstract. The results of the measured absolute photoionization cross section from the 7^2P excited states of cesium are reported. The following values have been obtained: $(6.2\pm0.5)\times10^{-18}$ cm^2 and $(8.8\pm1.6)\times10^{-18}$ cm^2 for the levels $7^2P_{1/2}$ and $7^2P_{3/2}$, respectively.

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Recently a new method of photoionization cross section measurement based on the observation of saturation in the ion yield as a function of radiation intensity has been proposed [1]. These authors have measured the photoionization cross sections for the $6^2P_{1/2}$ and $6^2P_{3/2}$ excited levels of Rb. It is the purpose of this comment to report on the results of the absolute photoionization cross section from the $7^2P_{1/2}$ and $7^2P_{3/2}$ excited states of cesium, which have been measured in 1974 [2, 3] by nearly the same method as reported in [1].

Light (4593 Å or 4555 Å) from a flashtube pumped coumarin dye laser was brought to a focus of 1 mm diameter on a Cs atomic vapor beam. The photoelectrons emitted from the Cs were extracted by an electric field of 3500 V·cm^{-1}, were collected in a Faraday cup and integrated in a vibrating reed electrometer. We could ensure that the ground state $(6^2S_{1/2})$ and the intermediate state had identical populations throughout the laser pulse. Then the number of photoelectrons detected per pulse is given by

$$I_E = f N_A [1-\exp(-\sigma_{PI} I_L/2)],$$

where N_A is the number of atoms in the laser beam, I_L is the number of photons per unit area in the laser pulse, σ_{PI} is the photoionization cross section, and f is the fraction of the emitted photoelectrons that reach the collector. If the light intensity I_L is so high that I_E is not proportional to I_L, i.e. essentially all atoms in the laser beam (90%) are photoionized during a single laser pulse, it is possible to calculate σ_{PI} from the I_E vs I_L curve, even if the density of the atomic beam is unknown. The laser pulse energy was measured with a calibrated thermopile. The laser beam cross sectional area was determined by two independent procedures [2, 3]. Namely either a photographic method or using the thermopile in combination with a movable knife edge intersecting the laser beam. The following cross sections have been obtained: at 4593 Å $\sigma_{PI} = (6.2\pm0.5)\times10^{-18}$ cm^2 for the $7^2P_{1/2}$ state, and at 4555 Å $\sigma_{PI}=(8.8\pm1.6)\times18^{-18}$ cm^2 for the $7^2P_{3/2}$ state. The value at 4593 Å agrees [3] with an extrapolation of photoionization cross sections calculated from theoretical recombination cross sections [4].

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References

1. R. V. Ambartzumian, N. P. Furzikov, V. S. Letokhov, A. A. Puretsky: Appl. Phys. **9**, 335 (1976)
2. H. D. Zeman, U. Heinzmann, D. Schinkowski: Proc. 4th Intern. Conf. on Atomic Physics, Heidelberg, Germany (1974). Abstracts of Contributed Papers, edited by J. Kowalski and H. G. Weber (Heidelberg Univ. Press, Heidelberg, 1974) p. 394
3. H. D. Zeman: In Proc. Intern. Symposion on Electron and Photon Interactions with Atoms, Stirling, Great Britain (1974), ed. by P. G. Burke, H. Kleinpoppen and M. R. C. McDowell (Plenum Press, New York 1976) p. 581
4. D. W. Norcross, P. M. Stone: J. Quant. Spec. Rad. Transf. **6**, 277 (1966)