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Electron Spectroscopy of strontium in the vicinity of four-photon excitation of the $5p^2\ ^1S_0$ state

A. Dimitriou[† 1*], **S. Cohen**[† 2]

[†] Dept. of Physics, University of Ioannina, GR 45110 Ioannina, Greece

Synopsis We present experimental photoelectron energy spectra and angular distributions from multiphoton ionization of Sr by dye laser pulses of ~ns duration in the wavelength range of 715–737 nm and relatively low intensity (≈4×10^{11} W·cm^{-2}). The selected wavelength range comprises the highly correlated $5p^2\ ^1S_0$ autoionizing state, excited by four photons. Our results reveal the dominant (single and double) ionization pathways that were obscured in earlier experiments, based solely on the recording of ion and ionic-fluorescence yields.

We report on an electron energy analysis study conducted for elucidating the single and double ionization pathways when ground state strontium atoms interact with dye laser pulses of ≈5 ns duration and ≈4×10^{11} W·cm^{-2} maximum intensity. Within the examined 715–737 nm wavelength range there are three-photon resonant, four-photon ionized bound states ($4d5p\ ^1P_1$ and $5s5f\ ^1F_3$) and the four-photon excited $5p^2\ ^1S_0$ highly correlated autoionizing state, located above the first ionization threshold of strontium. Electron spectra as a function of laser wavelength probed the accumulation of population in the excited $4d_j$ and $5p_j$ Sr^+ states. This signifies the absorption of at least two photons above the first ionization threshold ot the atom. However, contrary to what was anticipated in earlier work (performed using the same excitation and ionization scheme but based solely on the detection of ion and ionic-fluorescence yields [1]) the former states are found to be much more heavily populated than the latter ones. Thus, the main pathway to double ionization within this wavelength range is multiphoton ionization out of the $4d_{3/2,5/2}$ levels of Sr^+ and within the same laser pulse. Finally, the recording of photoelectron angular distributions from four- and five- photon ionization for selected laser wavelengths, reveales the dominant contributing partial waves at each ionization step. These latter results are compared to those obtained from relevant earlier studies on other Alkaline Earth atoms [2],[3].

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[*] **Present address:** Dept. of Physics, University of Crete, GR 71003, Heraklion, Greece

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[1] E-mail: adimitr@physics.uoc.gr
[2] E-mail: scohen@uoi.gr