

INTERPLAY OF ELECTRONIC CORRELATIONS AND ELECTRIC-QUADRUPOLE TRANSITIONS IN THE ISOLATED-CORE EXCITATION OF Sr BELOW THE Sr⁺(5g) THRESHOLD

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Atoms and molecules in a Rydberg state with a large principal or orbital-angular-momentum quantum number ($n \geq 100$ or $l \geq 10$) have an ion core that, to a good approximation, is isolated from the Rydberg electron and behaves as the bare ion. Properties of cations, such as their rovibronic structure, can thus be spectroscopically determined by studying the ion core within the orbit of a Rydberg electron. This led to the development of the isolated-core-excitation (ICE) technique [1] and isolated-core multiphoton Rydberg dissociation spectroscopy [2]. Until now, the photoexcitation of the ion core relied on electric-dipole transitions. We report the first observation of an electric-*quadrupole* ICE transition observed in the Sr atom and attributed to the one-photon excitation of the ion core from the Sr⁺(5d_{5/2}) state to the Sr⁺(5g_{7/2,9/2}) states.

Photoexcitation spectra from Sr(5d_{5/2}nl) states ($n = 16 - 21$, $l = 12$), located high in energy in the Sr⁺ continuum, to an energy region between the Sr⁺(5f) and Sr⁺(5g) ionization thresholds were studied in a joint experimental and theoretical investigation. They show series of lines attributed to Sr(5gn''l'') states, which cannot be reached by electric-dipole ICE from Sr(5d_{5/2}nl) states. We have identified two mechanisms responsible for these lines: (i) the direct electric-quadrupole excitation from Sr(5d_{5/2}nl) to Sr(5gn'l) states, and (ii) the electric-dipole excitation to the weak Sr(5fnl) component of the Sr(5gn'l') states, this mixing being caused by the Coulomb interaction between the two excited electrons. The two excitation mechanisms can be unambiguously identified because they lead to spectra with different line-intensity distributions. A detailed analysis of the spectra is under way.

[1] W. E. Cooke, T. F. Gallagher, S. A. Edelstein and R. M. Hill, *Phys. Rev. Lett.* **40**, 178 (1978)

[2] M. Génévriez, D. Wehrli and F. Merkt, *Mol. Phys.* **118**, e1703051 (2020)