Controlling autoionization in strontium two-electron-excited states

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One challenge in engineering long-lived two-electron-excited states, i.e., so-called planetary atoms, is autoionization. Autoionization, however, can be suppressed if the outermost electron is placed in a high-$n$, $n \sim 300 - 600$, high-$L$ state because such states have only a very small overlap with the inner electron, even when this is also excited to a state of relatively high $n$ and hence of relatively long lifetime. Here the $L$-dependence of the autoionization rate for high-$n$ strontium Rydberg atoms is examined during excitation of the core ion $5s \, ^2S_{1/2}-5p \, ^2P_{3/2}$ transition. Measurements in which the angular momentum of the Rydberg electron is controlled using a pulsed electric field show that the autoionization rate decreases rapidly with increasing $L$ and becomes very small for values larger than $\sim 20$. The data are analyzed with the aid of calculations undertaken using complex scaling.

Research supported by the NSF and Robert A. Welch Foundation

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Date submitted: 25 Jan 2016