Rydberg states of alkali atoms on helium nanodroplets: Screening effects of a nanosized helium dielectric

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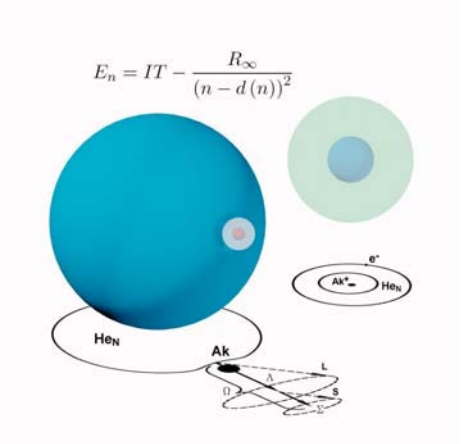
Rydberg series of Rb and Cs atoms on the surface of helium nanodroplets (He_N) [1] have been studied by resonance enhanced multiphoton ionization and laser induced fluorescence spectroscopy. The recorded excitation spectra [2,3] are analyzed by using a Rydberg-Ritz approach [4]. The dependence of the quantum defects on the principal quantum number within a Rydberg series gives insight into the interaction between the alkali atom's valence electron and the superfluid helium droplet. For higher excited states, a screening of the valence electron from the alkali atom core by the helium droplet is observed. For lower states, the screening effect decreases and the quantum defects are found to lie closer to free atom values. In addition, the large spin-orbit (SO) constant of the Cs-He_N P($^2\Pi$) states allows a detailed study of the influence of the helium droplet on the SO splitting as function of the principal quantum number.



Within a pseudo-diatomic picture, the alkali-He_N system represents a diatomic molecule. The coupling of the alkali valence electron's spin and orbital angular momentum with the intermolecular axis, which is defined by the connection between the droplet center and the alkali nucleus, depends on the strength of the atomic SO interaction.
For low *n* states with the alkali atom in a dimple near the helium droplet surface (left part of the picture), the electron is repelled towards the alkali ion core resulting in stronger core penetration than in the case of the alkali ion core surrounded by helium as it is the case for high *n* (right part). There the helium reduces the probability to find the high-*n* electron nearby the core [5].

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