PHOTOIONIZATION OF ALKALI-DOPED HELIUM NANODROPLETS

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Superfluid helium droplets (He_N) provide a cold, weakly-interacting environment for the investigation of weakly bound molecules. Whereas the host-dopant interaction is weak for neutral molecules, ion impurities may be surrounded by frozen shells of polarized helium atoms. An extreme example of the different behavior is given by alkali metal impurities that stay at the surface of the droplet as neutrals but immerse into the droplet as cations releasing a considerable amount of binding energy. We report measurements of the photoionization efficiency for the rubidium-He_N and cesium-He_N systems [a] and find that the ionization threshold is lowered compared with the free atoms and is in good agreement with Rydberg state spectroscopy of these systems [b]. The corresponding energy shift increases when going from heavy to light alkali metals and from small to large helium droplets. Both effects can be explained by the difference in polarization energies associated with submerged alkali metal cations. The findings agree qualitatively well with recent calculations of helium snowball formation around alkali metal cations [c].

[a] M. Theisen, F. Lackner, G. Krois, and W. E. Ernst, J. Phys. Chem. Lett. 2, 2778 (2011).
[b] F. Lackner, G. Krois, M. Theisen, M. Koch, and W. E. Ernst, Phys. Chem. Chem. Phys. 13, 18781 (2011).
[c] D. E. Galli, D. M. Ceperley, and L. Reatto, J. Phys. Chem. A 115, 7300 (2011).