On the submersion of alkali metals in prestine and doped helium-nano droplets

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Superfluid helium nanodroplets (HND) have proven to be an interesting environment for studying ion-molecule reactions and that is especially true for alkali metal compounds. The electronic structure of alkali metals is the reason for this special interest, because it is introducing a repulsive potential – the Pauli repulsion – into the interaction. Therefore all alkali metals atoms are classical heliophobes and do not stay submerged inside a HND but do reside in a small dimple on the surface of the droplet, even small cluster of alkali metals are not solvated in the helium. Theoretical prediction by Stark and Kresin suggested that there should be an upper limit of atoms, after this limit is met the cluster is gaining an energy advantage if it submerges into the HND [1]. In order to test this theory we doped a beam of HND with different alkali metals and subsequently ionized them via electron bombardment. Then a mass to charge distribution is measured with a high-resolution time of flight mass spectrometer. By scanning through the ionization energies – because there are two different main channels for surfaced and submerged atoms or cluster – one can obtain information about the position of the cluster via their respective ion yield. To optain infomation about the impact of a second species inside the HND C_{60} was added to he helium droplets after it was doped with the alkali meatal atoms. For the submersion of the alkali metal into prestine HND the theory and the experiment are in good agreement to each other and for sodium and photasium there is evidence that suggests a lower limit for the critical cluster size of 21 respectively 80 [2, 3]. The experimental data for the doped HND seem to establish the picture that every alkali cluster or atom with the sole exception of cesium can be submerged into the droplet in presence of a Buckminster fullerene [4].

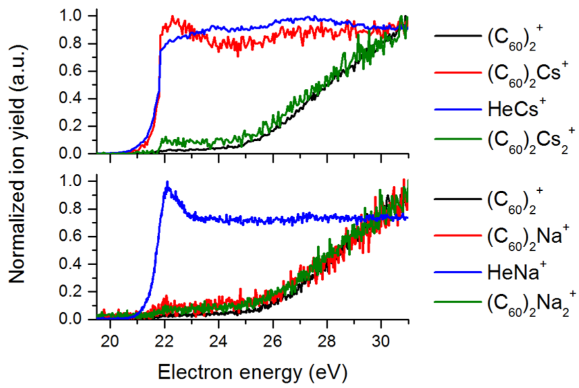

Figure 1. Normalized ion yield versus the electron energy for different alkali C_{60} compounds [4].

References

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