

HIGH-RESOLUTION SPECTROSCOPY OF CATION-HELIUM COMPLEXES AT LOW TEMPERATURE

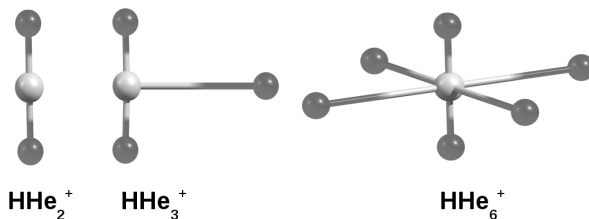
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Abstract. To date, one of the most successful approaches for the elucidation of molecular ions is action spectroscopy, in which typically infrared radiation is applied to a mass selected ensemble of trapped (or guided) ions. Its very high sensitivity derives from counting ions as the spectroscopic signal, and not detecting light as in conventional methods. For weakly bound ionic complexes such as $\text{H}^+(\text{H}_2\text{O})_n$, $\text{CH}_5^+(\text{H}_2)_n$ or $\text{H}_3^+(\text{H}_2)_n$, the action spectroscopic method called vibrational predissociation has been the standard technology for decades (Okumura et al. 1985, Bieske and Dopfer 2000). More recently, there is also increasing interest in weakly bound cation-helium complexes which can be conveniently investigated in modern cryogenic ion trap environments.

The research group in Köln set out to investigate the complexes HHe_n^+ , H_2He_n^+ and H_3^+-He_n , being very fundamental ions and consisting of the two most abundant elements in the universe. HHe^+ has been detected in space recently by Güsten et al. 2019. On this conference, new vibrational work on the fundamental complexes HHe_n^+ , $n = 2 - 6$, is presented. As seen in the Figure below, these complexes consist of the strongly bound chromophore $\text{He-H}^+-\text{He}$ ($n = 2$), surrounded by more loosely bound He atoms. With a $^1\Sigma$ ground state, this chromophore has a simple vibrational spectrum consisting of the IR active asymmetric stretching mode and the degenerate bending mode. The weakly bound He atoms in the complexes with $n = 3 - 6$ allow to probe the chromophore by predissociation spectroscopy. Using various IR sources, we have localized these vibrational features for the first time (Asvany et al. 2019). Very recently, also high-resolution information for the fundamental three-nucleus-four-electron molecule $\text{He-H}^+-\text{He}$ has been obtained.

The final aim of this research project will be high-resolution rotational spectroscopy for those species which possess a permanent dipole moment, as e.g. HHe_3^+ , H_2He^+ and potentially H_3^+-He . This can be achieved via a double resonance, consisting of a rotational excitation followed by a predissociating transition. The feasibility of such a double-resonance scheme has already been demonstrated for CH_3^+-He (Töpfer et al. 2018).



References

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