INFRARED SPECTRA OF OCS-HELIUM AND OCS-HYDROGEN CLUSTERS

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Spectra of the weakly-bound van der Waals complex OCS-He were first observed by Higgins and Klemperer [1] in the microwave region. Their results were of special interest since OCS has proven to be an ideal probe of ultracold helium nanodroplets, a topic of intense recent interest in chemical physics [2]. We have obtained the corresponding infrared spectrum of OCS-^{4}He [3] (and, more recently, OCS-^{3}He), with results that are in good agreement with the microwave data. Interestingly, OCS-He shows a small blue shift (+0.11 cm^{-1}) of the the O-C vibration, even though a red shift of about -0.56 cm^{-1} is observed for helium nanodroplets with ($n = 60$ to 10,000 He atoms). By cooling our pulsed supersonic jet and increasing the backing pressure, we have now detected IR spectra of clusters containing one OCS molecule and many helium atoms, OCS-He$_n$. For clusters with n = 2 to 8, we resolve and assign discrete rotational transitions, and the results have been confirmed by complementary observations in the microwave region by Xu and Jäger [4]. These may be the largest van der Waals complexes for which rotationally- and size-resolved spectra have been assigned. For even larger values of n ($\approx$ 10 to 20), we also observe strong, discrete spectral lines, but the size assignments are not yet clear. Similar observations have been made for OCS-hydrogen clusters. Our data for these 'small' clusters complement those for the larger helium nanodroplets, together bringing us closer to the ultimate goal of experimentally connecting the microscopic world of isolated molecules and the macroscopic world of bulk matter.

References

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