MILLIMETER-WAVE SPECTRA OF CARBON MONOXIDE SOLVATED WITH HELIUM ATOMS

L. A. SURIN, T. F. GIESEN, S. SCHLEMMER, *I. Physikalisches Institut, University of Cologne, 50937 Cologne, Germany*; A. V. POTAPOV, B. S. DUMESH, *Institute of Spectroscopy of Russian Academy of Sciences, 142190 Troitsk, Moscow region, Russia*.

Millimeter-wave spectra of He_N-CO ($^{12}C^{16}O$, $^{13}C^{16}O$, $^{12}C^{18}O$, $^{13}C^{18}O$) clusters with N up to 10, produced in a molecular expansion, were observed using intracavity OROTRON jet spectrometer in the frequency range of 110-150 GHz. The $R(0)$ transitions were detected, which correspond to the known b-type ($K = 1-0$) $R(0)$ lines of the binary system, He_1-CO. Further, the a-type ($K = 0-0$) rotational transitions of He_N-CO (N = 7, 8) in the frequency range of 20-40 GHz were measured combining OROTRON spectrometer with a double resonance technique. The isotopic shifts of the cluster transitions show remarkably smooth behavior with N from 1 to 6 and become rather scattering for $N \geq 7$. The dependence of the rotational constant (cluster moment of inertia) and of the shift of the CO fundamental vibration on the number of He atoms in cluster were obtained for He_N-CO isotopologues from the analysis of their infrared spectra [a] and very recent microwave data for the normal $He_N-^{12}C^{16}O$ isotopologue [b]. This study explores the microscopic evolution of superfluidity, which becomes apparent even in such small clusters as He_4-CO. The obtained results are compared with those from recent quantum Monte-Carlo calculations [c] and used to further interpret recent infrared measurements of CO in helium nanodroplets [d].

[a] J. Tang, A. R. W. McKellar, J. Chem. Phys. 119, 763 (2003); A. R. W. McKellar, J. Chem. Phys. 121, 6868 (2004); A. R. W. McKellar, J. Chem. Phys. 125, 164328 (2006).

[b] L. A. Surin, A. V. Potapov, B. S. Dumesh, S. Schlemmer, Y. Xu, P. L. Raston, and W. Jäger, Phys. Rev. Lett. 101, 233401 (2008).

[c] T. Škrbić, S. Moroni, and S. Baroni, J. Phys. Chem. A 111, 7640 (2007).

[d] K. von Haeften, S. Rudolph, I. Simanovski, M. Havenith, R. E. Zillich, and K. B. Whaley, Phys. Rev. B 73, 054502 (2006).