VIBRATIONAL COOLING OF LARGE MOLECULES IN SUPERSONIC EXPANSIONS: THE CASE OF C_{60} AND PYRENE

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Supersonic expansions are a useful tool for cooling molecules in the gas phase. While translational and rotational degrees of freedom can generally be cooled to low temperatures (<30 K) using this technique, there has been conflicting evidence concerning the cooling of vibrational degrees of freedom. This cooling is particularly important for gas-phase absorption spectroscopy of large molecules with many vibrational degrees of freedom, such as buckminsterfullerene (C_{60}). We have attempted gas-phase infrared spectroscopy of C_{60} by producing C_{60} vapor in a hot ($\sim$900 K) oven and seeding the vapor in an argon supersonic expansion, but have been unable to observe any absorption signal. We attribute this to insufficient cooling of vibrational degrees of freedom in the expansion. In contrast, we have performed a similar experiment with pyrene ($C_{16}H_{10}$) heated to $\sim$430 K, which yielded rotationally-resolved spectra and an estimated vibrational temperature of 25-90 K. We will discuss these results and possible methods to obtain gas-phase absorption spectra of C_{60}.

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