

# Rotationally-Resolved Infrared Spectroscopy of the Polycyclic Aromatic Hydrocarbon Pyrene (C<sub>16</sub>H<sub>10</sub>)

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Large, symmetric molecules, such as linear carbon chains, polycyclic aromatic hydrocarbons (PAHs), and fullerenes are important to interstellar chemistry, but cannot be observed by rotational spectroscopy because they lack a permanent dipole moment. In particular, buckminsterfullerene (C<sub>60</sub>) has recently been detected by infrared emission spectroscopy in many environments.<sup>1</sup> To better understand the interstellar chemistry of C<sub>60</sub>, it will be necessary to observe it in environments which are not favorable for emission. To aid in astronomical searches for C<sub>60</sub> absorption signals, we are working on obtaining a cold, gas-phase spectrum of C<sub>60</sub>. To do so, we are using a hot oven for generating gas-phase sample and then cooling the molecules using a supersonic expansion. It is unknown whether this technique will be sufficient to cool a molecule as large as C<sub>60</sub> to the point where it can be observed by absorption spectroscopy.

As an intermediate step, we have acquired a rotationally-resolved infrared spectrum of the PAH pyrene (C<sub>16</sub>H<sub>10</sub>) to test cooling of large molecules by supersonic expansion. Our spectra were obtained using an infrared cavity ringdown spectrometer based on a quantum cascade laser near 8.5 μm. Though it is small compared to C<sub>60</sub>, pyrene is the largest molecule to be observed with rotational resolution by absorption spectroscopy. We have fit the spectrum to an effective asymmetric top Hamiltonian and have found that this molecule behaves like an almost ideal rigid rotor. We have also found that the pyrene molecules are cooled to a rotational temperature of ~25 K and estimate that the vibrational temperature is 25 - 90 K.

<sup>1</sup>See, for example, Cami et al., *Science*, **329**, 1180 (2010).