COOLING OF ELECTRONICALLY-EXCITED He_2 MOLECULES IN A MICROCAVITY PLASMA JET

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Helium dimers in the $d^3\Sigma_u^+$ excited electronic state with potential energy >24 eV and radiative lifetime of 25 ns have been generated in a microcavity plasma jet and rotationally cooled by supersonic expansion in vacuum. The dynamic process of cooling is recorded by imaging the axis of expansion onto the slit of Czerny-Turner spectrometer, yielding spatial-temporal spectrograms of $d^3\Sigma_u^+ \rightarrow b^3\Pi_g$ $(v', v'') = (0, 0)$ emission. Analysis of the data shows the spatial-temporal evolution of the rotational temperature to be a damped sinusoid that reaches a minimum value of 100K. This reproducible behavior is attributed to the reflection of electrons from a virtual cathode located downstream of the nozzle and indicates that the spatially-averaged electron density is 10^8 cm^{-3}. We present this observed rotational temperature oscillation during the supersonic cooling process as an example of the potential of our supersonic microplasma expansion as a tool to explore physical dynamics in diatomic molecules having high excitation energies and small lifetimes.