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Controlled vibrational quenching of nuclear wave packets in D_2^+[1]
THOMAS NIEDERHAUSEN, UWE THUMM, James R. Macdonald Laboratory, Kansas State University — The sudden ionization of neutral D_2 molecules by a short and intense pump laser pulse may create a wave packet as a coherent superposition of vibrational states on the lowest ($1s\sigma_g^+$) adiabatic potential curve of the D_2^+ molecular ion. We investigate the possibility of manipulating the bound motion, dissociation, and vibrational-state composition of such nuclear wave packets with one (or several) ultra-short (6 fs) intense (1 x 10^{14} W/cm^2) near infrared (800 nm) control laser pulses. We show numerically that a single control pulse with an appropriately tuned time delay can significantly quench the vibrational state distribution of the nuclear wave packet by increasing the contribution of a selected stationary vibrational state of the molecular ion to more than 50%. We also show that a second control pulse with a carefully adjusted delay can further squeeze the vibrational state distribution and suggest a scheme for a multi control pulse "Raman shaping". Since the resulting nuclear wave function is almost stationary, fragmentation of the molecular ion with a final intense probe pulse can be used to project its nodal structure onto the measurable kinetic energy release, thereby suggesting a tool for assessing the degree at which the nuclear motion in a small molecule can be controlled.

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Thomas Niederhausen
James R. Macdonald Laboratory, Kansas State University

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