

# Enhanced Resonant Positron Annihilation due to Nonfundamental Modes in Molecules

S. Ghosh<sup>1,\*</sup>, J. R. Danielson<sup>1</sup> and C. Surko<sup>1</sup>

<sup>1</sup>Department of Physics, University of California, San Diego, La Jolla, CA 92093-0319, USA

\*email: soumen@physics.ucsd.edu

Evidence is presented here that in positron-molecule interactions, vibrational Feshbach resonances can occur by excitation of vibrational modes due to multimode vibrations (e.g., combinations and overtones). Positrons bind to most molecules through Feshbach resonant excitation of dipole- and quadrupole-active fundamental vibrational modes, and this leads to greatly enhanced annihilation rates [1]. In this presentation, evidence for new resonances (Fig.1) beyond these fundamental modes will be presented for several n-alkane and cycloalkane molecules [2]. The resonance positions will be compared to infrared absorption spectra. A room-temperature (FWHM  $\sim 36$  meV), as well as a cryogenically cooled (FWHM  $\sim 20$  meV) [3] positron beam was used for these studies. Implications of the energy distributions of these beams in determining the shapes of the observed resonances will be discussed. While the most likely possibility is that these resonances are due to combinations and/or overtones of the fundamental vibrations, this has yet to be established with certainty. Outstanding questions and alternative possibilities regarding the origin of this effect will be discussed.

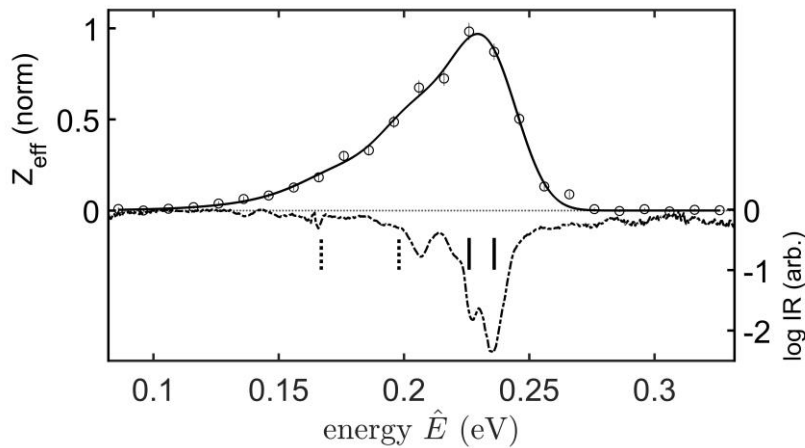


Fig.1. Normalized, background-subtracted annihilation rate  $Z_{\text{eff}}$  for cyclooctane as a function of peak total energy using the room-temperature beam (circles). Solid curve represents the fundamental (solid bars) as well as newly identified multimode (dotted bars) convoluted beam distribution fitted with the data. These modes and the IR spectrum (dash-dot curve) have been downshifted by the 128 meV binding energy.

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