Resonances in Positron Annihilation on Molecules – Which Bells Ring?\textsuperscript{1}

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Positron collisions with molecules can result in the excitation of high-Q vibrational Feshbach resonances – temporary positron-molecule bound states that exhibit greatly enhanced annihilation rates.\textsuperscript{3} A simple theory agrees well with data for annihilation spectra as a function of incident positron energy for selected molecules, such as methyl halides, in which infrared-active vibrations dipole-couple the incident positron to the bound state.\textsuperscript{4} However additional effects appear to be prominent in most molecules, including the excitation of combination and overtone modes.\textsuperscript{5} Until now, limited energy resolution has inhibited the study of these effects. A recently developed, high-energy-resolution, cryogenic trap-based beam is used to investigate two other ways to “ring the molecule’s bells”: positron coupling to infrared-inactive modes and the excitation of combination modes. The operation of the new beam system will be briefly described,\textsuperscript{6} followed by a discussion of high-resolution data for molecules that provide evidence of resonant annihilation due to infrared inactive modes. Data exploring the possible excitation of combination modes will also be discussed and related to broad and featureless regions of the annihilation spectra observed in many molecules.\textsuperscript{3,5}

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\textsuperscript{3}G. F. Gribakin, J. A. Young, and C. M. Surko, Rev. Mod. Phys. 82, 2557 (2010).