Positron annihilation on molecules using a trapped based beam with enhanced energy-resolution.

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Experiments have shown that the low-energy (sub eV) annihilation spectra of positrons on molecules is dominated by relatively sharp features that have been identified as vibrational Feshbach resonances involving fundamental modes [1]. Further, in most molecules there is a broad spectrum of enhanced annihilation between the fundamentals, in the region of combination and overtone vibrational modes. Unfortunately, the mode density is typically too high to identify discrete multimodes, since the ability to resolve these features is limited by difficulties encountered in creating beams with sufficiently narrow energy spreads.

Over the last several years, we have made a number of advancements in understanding the factors limiting the energy resolution of trapped based positron beams [2,3]. From this work, we developed a new cryogenic, buffer-gas trap based beam, with total beam energy spreads as small as 7 meV FWHM and temporal spreads of sub-microsecond duration [4].

In this progress report, the new cryogenic beam will be described as will experiments using the narrow energy spread beam to measure positron annihilation energy spectra with enhanced resolution. New features are observed, including new resonances identified as IR-inactive vibrational modes [5]. Attempts to directly measure the effect of overtone and combination modes, will also be reported [6], as will a discussion of the current limits to the measurements and prospects for the future.

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