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Positron Annihilation as a Probe of Intramolecular Vibrational Energy Redistribution (IVR)[1]

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Experiments at incident energies in the range of the molecular vibrations show that positrons can attach to molecules via vibrational Feshbach resonances.[3] While attached, the positron has an increased probability of annihilation, leading to an enhancement of the measured annihilation rate. This enhancement is limited because the vibrational auto-detachment rate is typically much faster than the annihilation time, meaning that most positrons escape before annihilating. However, in many molecules, intramolecular vibrational energy redistribution (IVR) couples the entrance mode energy into nearly isoenergetic multimode states. This process leads to either suppression or enhancement of the annihilation depending on whether the auto-detachment rate of the coupled vibrations is faster or slower than that of the entrance mode. These effects have recently been combined into a simplified rate-equation model which describes the effect of IVR on the measured annihilation rates.[4] With certain approximations, the primary unknown in the model is the IVR coupling rate. This model will be described and used to show how observations of annihilation enhancement or suppression can be used to extract an estimate of the IVR coupling rate for selected modes in several small molecules.

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[2]In collaboration with M. R. Natisin, A. C. L. Jones, and C. M. Surko.

[3]G. F. Gribakin, et al., *Rev. Mod. Phys.* **82**, 2557 (2010).

[4]J. R. Danielson, et. al., *Phys. Rev. A* **88**, 062702 (2013).