DAMOP11-2011-000286

Abstract for an Invited Paper
for the DAMOP11 Meeting of
the American Physical Society

Positron binding to molecules[1]

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While there is theoretical evidence that positrons can bind to atoms,[2] calculations for molecules are much less precise.[3] Unfortunately, there have been no measurements of positron-atom binding, due primarily to the difficulty in forming positron-atom bound states in two-body collisions. In contrast, positrons attach to molecules via Feshbach resonances (VFR) in which a vibrational mode absorbs the excess energy. Using a high-resolution positron beam, this VFR process has been studied to measure binding energies for more than 40 molecules. New measurements will be described in two areas: positron binding to relatively simple molecules, for which theoretical calculations appear to be possible;[4] and positron binding to molecules with large permanent dipole moments, which can be compared to analogous, weakly bound electron-molecule (negative-ion) states. Binding energies range from 75 meV for CS_2 (no dipole moment) to 180 meV for acetonitrile (CH_3CN). Other species studied include aldehydes and ketones, which have permanent dipole moments in the range 2.5 - 3.0 debye. The measured binding energies are surprisingly large (by a factor of 10 to 100) compared to those for the analogous negative ions,[5] and these differences will be discussed. New theoretical calculations for positron-molecule binding are in progress, and a recent result for acetonitrile will be discussed.[6] This ability to compare theory and experiment represents a significant step in attempts to understand positron binding to matter.

[1]In collaboration with A. C. L. Jones, J. J. Gosselin, and C. M. Surko, and supported by NSF grant PHY 07-55809.

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[4]Danielson, *et. al.*, Phys. Rev. Lett., **104**, 233201 (2010).
[5]Hammer, *et. al.*, J. Chem. Phys. 119, 3650 (2003).
[6]Tachikawa, *et. al.*, Phys. Chem. Chem. Phys. **13**, 2701 (2011).