

Resonance Charge Transfer in Dipole Bound Anions
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Any molecule with a dipole moment above ~ 2.5 Debye can form a stable negative ion (dipole-bound anion).^{1,2} These anions are best produced by “resonance” charge exchange from atoms in high Rydberg states (Rydberg electron transfer, RET). RET to form dipole-bound anions occurs over a narrow range of effective principle quantum number, n^* . We have studied dipole-bound anions for over 25 molecules with dipole moments between 2.5 and 5.5 Debye. The excess electron in such an anion is very diffuse and weakly bound. Binding energies (electron affinities, EAs) are estimated from the narrow range of n^* at which charge exchange occurs and also from measurements of the electric field E_{critical} required to detach the electron. Electron affinities range from less than ~ 1 milli electron volt (meV) to ~ 55 meV. Reactions of chiral Rydberg atoms (oriented atoms with selected M_J) with chiral molecules have been studied to examine enantiomeric selective charge exchange reactions.³ Charge-exchange reactions between dipole-bound anions and polar molecules are also under investigation. These reactions can be thought of as electron exchange (i.e. “hopping”) between polar molecules. The long-range nature of the electron-dipole interaction provides a mechanism for electron transport involving polar molecules. These studies have important biochemical implications such as in the electron transport chains found in biology.

We will also discuss our progress toward studies of photodetachment of dipole-bound anions. Intense beams of dipole-bound anions are produced by rubidium Rydberg atoms produced by resonantly enhanced two-photon excitation ($5s \ ^2S_0 \rightarrow 6p \ ^2P_{1/2} \rightarrow n^2S, n^2D$). A third laser is used to photodetach the weakly bound electron. Photoelectron spectroscopy is used to determine the electron affinity.

¹C. Desfrancois, H. Abdoul-Carime, and J. P. Schermann, *International Journal of Modern Physics B* **10**, 1339 (1996).

²R. N. Compton and N. I. Hammer, “Multipole-Bound Molecular Anions” in *Advances in Gas-Phase Ion Chemistry Volume 4*, edited by N. Adams and L. Babcock, Elsevier Science, 2001, pp. 257-291.

³N. I. Hammer, F. Gao, R. M. Pagni, and R. N. Compton, *Journal of Chemical Physics* **117**, 4299 (2002).