PHOTOASSOCIATION OF ULTRACOLD ATOMS: A NEW TOOL FOR MOLECULAR SPECTROSCOPY

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The field of laser cooling and trapping of atoms has had a profound impact on many areas of atomic, molecular and optical science. In particular, ultracold atoms colliding in magneto-optical traps typically have relative kinetic energies of 300μK ($\sim$7 MHz), so free-bound absorption lines are as sharp as bound-bound lines. Moreover, because of very long range centrifugal barriers, only a few collisional partial waves are important (J'' = 0, 1 and 2 in our work on ^{39}K). Such photoassociative free-bound absorption allows observation of "pure long-range molecule" states (R_e = 28 and 39 Å in $^{39}K_2$) as well as long-range levels of known short range states with outer classical turning points of $\sim$20 - 250 Å. Such spectra have been observed by "trap loss" (decrease in atomic fluorescence), molecular ionization, and fragment ionization. Optical-optical double resonance (OODR), e.g. through the "Franck-Condon windows" of the "pure long-range" states, produces readily assignable spectra at higher asymptotes as well. Further extensions of ultracold photoassociative spectroscopy and applications to determination of long range potentials, atomic properties, and Bose-Einstein condensate stability will be presented.