Abstract Submitted
for the DAMOP06 Meeting of
The American Physical Society

Photoassociation Spectroscopy of Ultracold Atoms and the Study of "Physicist's Molecules" EITE TIESINGA, NIST, KEVIN JONES, Williams College, PAUL LETT, PAUL JULIENNE, NIST — Photoassociation is the process where two colliding atoms absorb a photon to form an excited molecule. The development of laser cooling techniques for producing gasses at ultracold (< 1 mK) temperatures has allowed photoassociation spectroscopy to be performed with very high spectral resolution. In particular, it has allowed the probing of "purely long range" molecular states and the investigation of such "physicist's molecules," - molecules whose properties can be derived with high precision from the properties of their constituent atoms. This presentation describes what is special about photoassociation spectroscopy at ultracold temperatures, how it is performed, and how it is used to investigate cold atomic collisions and extract atomic and molecular properties. We discuss the extraction of scattering lengths, their control via optical Feshbach resonances, precision determinations of atomic lifetimes, rate limits in a Bose-Einstein condensate, and briefly, production of cold molecules. Discussions are illustrated with examples on alkali-metal atoms as well as other species. This work has recently been accepted by the Review of Modern Physics.

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Date submitted: 27 Jan 2006 Electronic form version 1.4