Photoassociation spectroscopy of cold calcium atoms

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Photoassociation spectroscopy can yield information about many atomic properties such as excited states lifetimes, ground state scattering lengths and long range potentials.

The most abundant isotopes of the alkaline earth metals show a non-degenerate ground state with no hyperfine splitting. This makes the comparison between experiment and theory more feasible than in the case of alkali metals where atomic fine and hyperfine structure has to be taken into account.

Here we present photoassociation spectroscopy measurements on ⁴⁰Ca atoms. The atoms were confined in a magneto-optical trap at a temperature of 2 mK and a density of 10¹⁰ cm⁻³. A photoassociation laser red detuned to the atomic ¹S₀⁻¹P₁ transition at 423 nm was used to excite the atoms. The photoassociation spectra were determined by measuring the additional trap loss with the photoassociation laser turned on. The rovibrational spectra of Ca₂ up to 67 GHz from the atomic resonance were measured. The rotational structure of the vibrational lines at large detunings from resonance could be fully resolved. The relative intensities of the vibrational lines could give a hint to the still unknown ground state scattering length of calcium.