

# Determination of scattering lengths of cesium through photoassociative spectroscopy of cold atoms

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Photoassociative spectroscopy of cold atoms is a particularly well adapted tool for the determination of scattering lengths, which are the key parameters of ultracold collisions, especially in Bose-Einstein condensates. The interpretation of the experiments can be performed using only the asymptotic part of the involved molecular potentials. Such an analysis of an ensemble of experiments on cold cesium atoms has allowed us to determine two scattering lengths, without even relying upon *ab initio* calculations of the  $C_6$  coefficient of the  $6s + 6s$  multipole expansion.

The first part of the experiments consists of photoassociative spectroscopy of the  $0_g^-$  molecular state below the  $6s + 6p_{3/2}$  asymptote, using cold atoms polarized in the  $f = 4$ ,  $m_f = 4$  Zeeman state. The line intensities display a modulation which reflects the node structure of the  $s$ -wave ground state wave function of two free colliding atoms. The determination of the scattering length from experimental data is almost completely self-sufficient. First, it requires knowledge of the  $0_g^-$  potential, which we deduce from previous spectroscopic study of the  $0_g^-$  progression of the PA spectrum [1]. It also requires knowledge of the asymptotic part of the ground state potential; the most important parameter,  $C_6$ , is determined through self-consistency requirements of the analysis [2].

The second part of the experiments concerns a two-color excitation of the ro-vibrational levels close to the ground state dissociation limits. Using the extension of the method of ref. [3] to the multi-channel problem, one can deduce the scattering length associated to the corresponding dissociation limit. Preliminary single channel results will be presented.

- [1] A. Fioretti, D. Comparat, C. Drag, C. Amiot, O. Dulieu, F. Masnou-Seeuws, P. Pillet, *Eur. Phys. J.* **5** 389-403 (1999).
- [2] C. Drag, B. Laburthe Tolra, B. T'Jampens, D. Comparat, M. Allegrini, A. Crubellier, P. Pillet, to be published.
- [3] A. Crubellier, O. Dulieu, F. Masnou-Seeuws, M. Elbs, H. Knöckel, E. Tiemann, *Eur. Phys. J. D* **6**, 211-220 (1999).