

ESR3: Quantum logic spectroscopy with a state selected simple molecular ion

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Host Institution: CNRS/LKB

Duration: 36 months

Planned secondment: Heinrich Heine University of Düsseldorf



Description:

The hydrogen molecular ion H_2^+ is a quasi ideal quantum system allowing for direct optical determination of an important fundamental constant: the proton to electron mass ratio m_p/m_e . Indeed, recent theoretical progress in relativistic, QED and hyperfine corrections for the three body Coulomb problem show that two-photon vibrational spectroscopy at the 6×10^{-11} relative accuracy level is possible [1], and will lead to a significant improvement with respect to the 2012-CODATA recommended value.

The group is setting-up an experiment aiming at observing the first Doppler free two-photon vibrational transition at $9.17 \mu\text{m}$ in state selected H_2^+ ions by REMPD and at measuring its frequency to determine m_p/m_e .

The tasks will consist in

- implementing a state selected H_2^+ REMPI ion source
- cooling the H_2^+ ions by sympathetic cooling with a laser cooled Be^+ ion crystal in a linear trap
- performing H_2^+ two-photon spectroscopy using our frequency controlled $9.17 \mu\text{m}$ laser source [2]

to prepare quantum logic spectroscopy by

- designing and implementing a “precision trap” for H_2^+/Be^+ ion pair sympathetic side band cooling
- implementing femto-second comb stabilization of the $9.17 \mu\text{m}$ laser source to reach unprecedented accuracies

The team comprises 3 permanent researchers, PhD and Master's degree students and closely interact with other Kastler Brossel laboratory teams. It is supported by electronics, mechanics and optics workshops.

References:

[1] V.I. Korobov, L. Hilico, J.-Ph., calculation of the relativistic Bethe logarithm in the two-center problem, Phys. Rev. A 87, 062506 (2013).

[2] F. Bielsa, A. Douillet, T. Valenzuela, J.-Ph. Karr and L. Hilico, Narrow-line phase-locked quantum cascade laser in the 9.2 micron range, Opt. Lett. 32, 1641 (2007).

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Links: <http://www.lkb.ens.fr/-Metrologie-de-l-ion-H-2-?lang=en>