Ultra-precise measurement of the fine-structure constant by the means of atom interferometry and implementation of large-momentum-transfer beam-splitters

MANUEL ANDIA, RAPHAEL JANNIN, CLEMENT COURVOISIER, PIERRE CLADE, SAIDA GUPELLI-KHELIFA, FRANCOIS BIRABEN, Laboratoire Kastler Brossel — In our experiment in Paris, we use a Ramsey-Bordé atom interferometer with cold $^{87}$Rb atoms, in combination with the technique of Bloch oscillations in an accelerated optical lattice, to measure the recoil velocity $v_r$ in $^{87}$Rb. We can then deduce the value of the fine-structure constant $\alpha$. Such an experimental scheme allows for many kinds of measurements, and in particular has led in 2013 to the proof-of-principle realization of a compact gravimeter based on Bloch oscillations, which can be used for on-board compact gravimeters or gradiometry applications. More recently, attention has been paid to the implementation of a new laser system, motivated by the need of greater laser power in order to reduce some systematic effects and to perform more Bloch oscillations, to further reduce uncertainty on $\alpha$. Upcoming projects revolve around increasing the sensitivity of the interferometer, which will be done through the Large-Momentum-Transfer Beam-Splitter technique (LMTBS). The first step towards LMTBS will be the implementation of double-diffraction, which makes the interferometer symmetrical by splitting the initial wavepacket into two opposite velocity classes.

Manuel Andia
Laboratoire Kastler Brossel

Date submitted: 30 Jan 2015
Electronic form version 1.4