Atom interferometry with ultra-cold atoms onboard a Zero G plane for space applications

Métayer Clément[1,*]

[1] *LP2N UMR 5298*

Rue François Mitterrand, 33400 Talence, France

The ICE project (Interférométrie à source Cohérente pour l'Espace) aims to be a proof of concept for a space mission using quantum particles, i.e., atomic clouds of potassium and rubidium in a matter-wave interferometer to test the Weak Equivalence Principle in microgravity [2]. The whole experiment is adapted to the Novespace Zero G aircraft that provides 22 s of microgravity per parabolic trajectory. In parallel with the onboard experiments, a microgravity simulator installed in the laboratory allows the sensor head (200 kg) to be in weightlessness for 500 ms, with a high repetition rate. To increase the interrogation time and the sensitivity of the measurement, the production of ultra-cold sources in microgravity with all-optical methods is studied both on the simulator and onboard the Zero G plane. In microgravity with ultra-cold sources, a particular regime of atomic interferometry called double diffraction takes place [1], which we study theoretically and experimentally on the simulator. We report on the production of Bose-Einstein Condensates (BEC) in microgravity both on the simulator and onboard the aircraft, and on our first results of interferometry in the double diffraction regime .

[1] Lévèque, T *et al.*, Enhancing the Area of a Raman Atom Interferometer Using a Versatile Double-Diffraction Technique, *Phys. Rev. Lett.* 103, 080405 (2009)

[2] Barrett,B *et al.*, Testing the universality of free fall using correlated 39K–87Rb atom interferometers, *AVS Quantum Science* (2022)

* clement.metayer@institutoptique.fr; https://www.coldatomsbordeaux.org/ice