Development of an onboard cold atom inertial measurement unit

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Abstract

Since 1990s, a new generation of inertial sensor based on wave-matter interferometry has appeared : accelerometers [1], gradiometers [2] and gyroscope [3] have been developed and shown high sensitivity and accuracy. Major applications for atom interferometers are today geophysics, inertial navigation and fundamental physics.
However, for measurements in a dynamic environment, people use for now classical (non quantum) sensors which require calibration and a correction to their inherent drift. Most of the atom interferometry based sensors are laboratories experiments and cannot perform onboard measurements, except for some notable exceptions such as ONERA's marine and air-born gravimeter [4]. Thanks to the success of the onboard cold atom gravimeter, a project towards the development of a cold atom inertial measurement unit (three accelerometers and three gyroscopes) has been started.

In this paper, we present the recent work about the cold atom inertial measurement unit. Instead of having six independent sensors, we aim to build a single multi-axis atomic sensor that measures sequentially each inertial component (3 accelerations, 3 rotations).

The atomic sensor is in fact hybridised with classical accelerometers and gyroscopes. After each inertial measurement of the cold atom sensor, the bias of the corresponding classic sensors is corrected thanks to the high accuracy of the atom measurement. The cold atom

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inertial measurement unit then consists in reading the measure of the classical devices corrected by the multi-axis inertial atom sensor.

Until now, the vertical gravimeter [5] and horizontal accelerometer [6] have been studied. The next step of the project will be first the development of a cold atom gyroscope. As our device shall be compact, we will be limited by the short interrogation time of the atoms. We will then aim to use large momentum transfer to compensate low interrogation times. Then, we will want to extend the operation range as, for now, the contrast of the interference fringes decrease drastically when the unit rotates. The next and final step will be to combine each atomic accelerometers and gyroscopes developed previously in a single sensor which will be hybridised with classical accelerometers and gyroscopes.

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