From matter waves to quantum sensors

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Inertial sensors based on cold atoms and light-pulse interferometry exhibit state-of-the-art sensitivity and ultra-low measurement bias that could revolutionize a variety of fields including geophysics and seismology, gravitational wave detection and fundamental tests of gravity, and inertial navigation [1].

In the latter case, cold-atom interferometers are widely considered as breakthrough technology for future autonomous navigation. Nowadays, absolute quantum inertial sensors are available as commercial [2] and field-deployable devices [3].

New concepts of matter-wave interferometry can also be used to study the low frequency variations of the strain tensor of space-time and gravitation. They can be used for the most precise monitoring of gravity or for precise tests of the weak equivalence principle (WEP) [4].

For instance, the MIGA instrument, which is currently built in the underground laboratory in Rustrel, France will allow the monitoring of the evolution of the gravitational field at unprecedented sensitivity, which will be exploited both for geophysical studies and for Gravitational Waves (GWs) observations [5].

I present here some of the most recent advances in these fields.

References

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[4] B. Barret et al, "Testing the Universality of Free Fall using correlated 39K -- 87Rb interferometers", AVS Quantum Sci. 4, 014401 (2022)

[5] A. Bertoldi et al, "Quantum sensors with matter waves for GW observation", Handbook of Gravitational Wave Astronomy (Eds. C. Bambi, S. Katsanevas and K. Kokkotas; Springer Singapore, 2021)

Figure

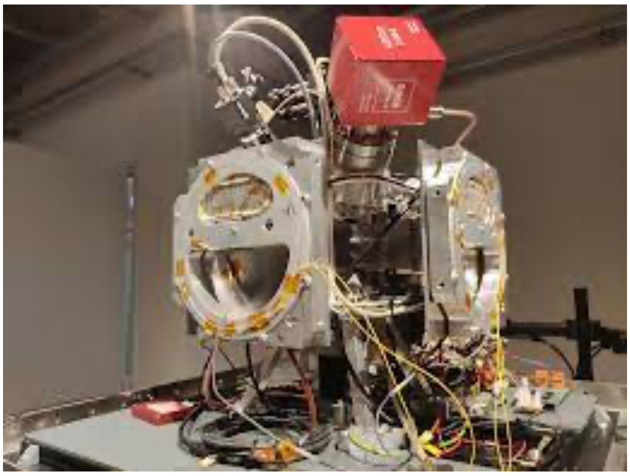

Figure 1: Prototype of a full 3D quantum corrected accelerometer for navigation [CNRS/IOGS/EXAIL]