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Continuous cold atom inertial sensor with 1 nrad/s rotation stability

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Over the past two decades, important progress in cold atom physics has established atom interferometry as a key technique for precision measurements of gravito-inertial effects. Atom interferometry addresses various applications ranging from fundamental physics, to inertial navigation to geophysics and geodesy. Several techniques are being developed to improve the performances of atom interferometers (AIs). However, benefiting from these new techniques to fully exploit the potential of AIs requires to handle the problem of dead times between successive measurements occuring in cold atom sensors.

Here, we report the first continuous operation (i.e. without dead times) of a cold atom inertial sensor. We show that such continuous operation improves the short term sensitivity of AIs, by demonstrating a record rotation sensitivity of 100 nrad/s/sqrt(Hz) in a cold atom gyroscope of 11 cm^2 Sagnac area. We also demonstrate a rotation stability of 1 nrad/s at 10 000 s of integration time, which establishes the record for atomic gyroscopes. We expect that the continuous operation of cold atom inertial sensors will allow to benefit from the full sensitivity potential of AIs, determined by the quantum noise limit.

The sensitivity reached by our instrument allows us to forsee applications in geodesy and geophysics. We will present perspectives of sensitivity improvements of our setup at the 10^-11 rad/s level for such applications.