Interleaved atom interferometry for high sensitivity inertial measurements

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Cold-atom inertial sensors target several applications in navigation, geoscience and tests of fundamental physics. Reaching high sampling rates and high inertial sensitivities, obtained with long interrogation times, represents a challenge for these applications.

Here we report on the interleaved operation of a cold-atom gyroscope, where 3 atomic clouds are simultaneously interrogated in an atom interferometer featuring a 3.75 Hz sampling rate and an interrogation time of 801 ms. Interleaving improves the inertial sensitivity by efficiently averaging vibration noise, and allows us to perform dynamic rotation measurements in a so-far unexplored range. We demonstrate a stability of 3×10^{-10} rad.s^{-1}, which competes with the best stability levels obtained with fiber-optics gyroscopes.

Our work validates interleaving as a key concept for future atom-interferometry sensors probing time-varying signals, as in on-board navigation and gravity gradiometry, searches for dark matter, or gravitational wave detection.

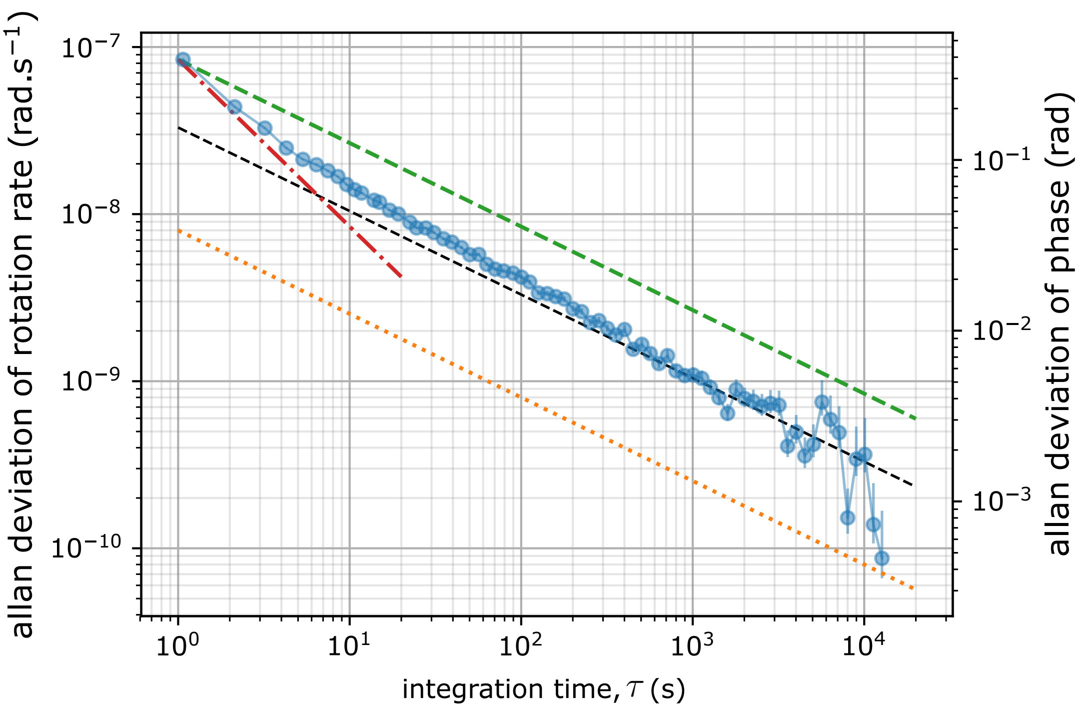

Figure 1: Gyroscope sensitivity. Stability analysis of a 11.3 hour portion of the rotation rate measurements. The error bars represent the 68 % confidence intervals on the estimation of the Allan deviation (adev). 3×10^{-8} rad.s^{1} $\times$ $\tau^{-1/2}$. Green dashed line: $\tau^{-1/2}$ scaling from the one shot adev. Red dotted-dashed line: $\tau^{-1/2}$ scaling from the one shot adev. Orange dotted line: detection noise limit corresponding to 8×10^{-9} rad.s^{1} $\times$ $\tau^{-1/2}$.