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Improving the accuracy of cold atom gravimeters using ultracold atoms

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Cold atom gravimeters constitute today one of the most mature inertial sensors based on atom interferometry. They reach performances better than their classical counterparts, both in terms of short term sensitivity and long term stability, and in contrast with the latter, offer the possibility to perform high repetition rate continuous measurements over extended periods of time. Best accuracies in the 30-40 nm/s^2 range have been reported for these instruments and validated through the participation of these instruments to international comparisons of absolute gravimeters. The limit in their accuracy is linked to the wavefront distortions of the lasers beamsplitting pulses, arising from reflection and transmission through imperfectly flat optics, which lead to parasitic phase shifts sampled by the atoms during their ballistic expansion and to a bias in the gravity measurement. To tackle this problem, we have implemented ultracold atoms as a source in our high accuracy atom gravimeter and performed gravity measurements in a so-far largely unexplored temperature range for such a high accuracy sensor, down to about 50 nK. This allowed to precisely evaluate the bias due to wavefront aberrations for the first time in our instrument, and to improve our accuracy by a factor of two in a first series of experiments, down to 2 μGal. This results clears the way towards sub-μGal accuracy with absolute atomic gravimeters.