Atom interferometry using clock transitions for fundamental physics

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Precision atom interferometry is poised to become a powerful tool for discovery in fundamental physics. I will discuss work to develop a 10 meter baseline clock atom interferometer based on atomic strontium that takes advantage of features used by the best atomic clocks in the world and combines them with established techniques for building advanced inertial sensors [1, 2]. We anticipate single-photon atom interferometry with alkaline-earth atoms to be a decisive step in matter-wave sensors, offering a definite reduction in sensitivity to laser phase noise and substantially increasing the allowed interferometer pulse area through highly efficient pulses. I will show our progress towards realizing atom interferometry with strontium-87 in our test chamber.

The potential of single-photon atom interferometry is only beginning to be realized, and the ongoing improvements in sensitivity can enable a diverse science impact, including laboratory tests of general relativity and the equivalence principle, searches for dark matter [3], and detection of gravitational waves [4]. I will show how this technology contributes to gravitational wave detection in the deci-Hertz band through improved angular localization of gravitational wave sources [5], measurement of black hole spin and mass ratios, and measurement of the Hubble constant through the standard siren program [6].

Bibliography

[1] P.W. Graham, J.M. Hogan, M.A. Kasevich, and S. Rajendran, Phys. Rev. Lett. 110, 171102 (2013)

[2] L. Hu, N. Poli, L. Salvi, and G. M. Tino, Phys. Rev. Lett. 119, 263601 (2017)

[3] P. W. Graham, D. E. Kaplan, J. Mardon, S. Rajendran, W. A. Terrano, L. Trahms, and T. Wilkason, Phys. Rev. D 97, 055006 (2018)

[4] A. Arvanitaki, P. W. Graham, J. M. Hogan, S. Rajendran and K. Van Tilburg, arXiv:1606.04541, (2016)

[5] P. W. Graham and S. Jung Phys. Rev. D 97, 024052 (2018)

[6] D. E. Holz and S. A. Hughes Astrophys.J.629:15-22,2005

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