Long Baseline Universal Matter-Wave Interferometry (LUMI)

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We report on the realization of a novel Long Baseline Universal Matter-wave Interferometer (LUMI) in Vienna. LUMI is a near-field, Talbot-Lau type interferometer with a baseline of two meters. This increase in length by one order of magnitude over previous molecule interferometers [1-3] boosts its sensitivity to electromagnetic and collisional interactions by a factor of one hundred and makes it possible to operate with a wide range of de Broglie wavelengths down to 70 fm, opening the way to high-mass interferometry with particles well beyond 100,000 amu.
The modular design of the experiment permits the in-vacuum exchange between optical and nanomechanical diffraction gratings as well as the introduction of electric and magnetic deflection fields, collision cells and spectroscopy laser beams, making LUMI a versatile new tool to analyze a large class of particles in high vacuum and with high precision. First experiments document already the excellent performance of the vibration insulation system and the Coriolis compensation. The observed phase stability and the high interference contrast are compatible with the requirements for new tests of macroscopicity and spontaneous collapse models and may even allow us to set new bounds in the search for dark matter [4].

References:

[1] Brezger, B., et al., Phys. Rev. Lett. 2002, 88, 100404.
[2] Gerlich, S., et al., Nat. Phys. 2007, 3, 711.
[3] Haslinger, P., et al., Nat. Phys. 2013, 9, 144.
[4] Riedel, C.J. and Yavin, I., Physical Review D 2017, 96.