Cold atom velocimetry with a matterwave interferometer

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We show that a Doppler-sensitive Ramsey interferometer can reveal the velocity distribution within a thermal cloud of ultracold atoms [1].

Varying the interferometer period τ and the phase of the second laser pulse allows a quadrature measurement, the Fourier transform of which reveals the 1-D atomic velocity distribution. However, in a Ramsey interferometer, τ is restricted to positive values and, combined with the finite duration of the pulses, this limits its usefulness in practice.

This is solved in an asymmetric Mach-Zehnder configuration, that we use to make a precision measurement of the velocity distribution [2]. We compare our measurement to Doppler Raman spectroscopy and see a signal-to-noise improvement, due in part to the entire ensemble contributing to the signal.

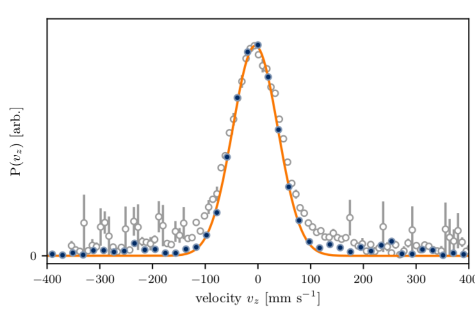

Figure 1: Interferometric measurement of a velocity distribution (filled circles) to which a Gaussian is fitted (solid line) corresponding to a temperature of 17μK. Doppler Raman spectroscopy data are also shown (empty circles), revealing differences in the wings.

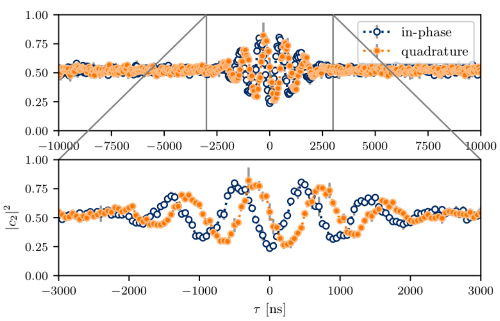

Figure 2: Quadrature interferometer signal measured as a function of τ, the temporal asymmetry introduced to the pulse sequence.

We also find small differences in the wings of the reconstructed distributions, with the interferometric measurement narrower – consistent with previous works [3]. The intensity dependence of the Doppler measurement suggests that it is this method that is inaccurate, perhaps as a result of off-resonant excitation [4].

Keywords: ATOM INTERFEROMETRY, VELOCIMETRY, MOMENTUM MEASUREMENT

References

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