

Ultra-cold Magnesium atoms

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High-resolution atom interferometry is crucial for the implementation of atomic clocks and inertial sensors of high accuracy and stability.

In ^{24}Mg , the narrow $3^1\text{S}_0 \rightarrow 3^3\text{P}_1$ intercombination line at 457 nm has already been employed to implement atom interferometers with resolutions as low as 491 Hz FWHM in spectroscopy of this line [1]. These Ramsey-Bordé type interferometers are based on Mg ensembles that are captured within a magneto-optical trap and Doppler cooled on the $3^1\text{S}_0 \rightarrow 3^1\text{P}_1$ transition at 285 nm.

The broad transition linewidth of 80 MHz restricts cooling to a Doppler temperature in the 2 mK regime. However, in this regime, the motion of the atoms with $v_{rms} \approx 1 \frac{m}{s}$ is still a severely limiting factor for interferometric performance.

Since the non-magnetic ground states in ^{24}Mg prevent the application of sub-Doppler cooling mechanisms, our strategy is to extend Doppler cooling to the $3^1\text{S}_0 \rightarrow 3^3\text{P}_1$ intercombination line, where the limiting factor is given solely by the recoil limit of about 10 μK . Artificially broadening the linewidth of the $3^1\text{S}_0 \rightarrow 3^3\text{P}_1$ transition will enhance the scattering rate of about 200 Hz by two orders of magnitude and allow for rapid cooling. Level broadening is achieved by irradiating 462 nm laser light, thus driving the $3^3\text{P}_1 \rightarrow 4^1\text{S}_0$ transition, which in turn leads to an effective depopulation of the 3^3P_1 level.

We will implement this novel technique as part of a multi-stage cooling scheme, where cooling down to the micro-Kelvin regime will significantly enhance the capabilities of atom interferometry in ^{24}Mg and also facilitate sub-Doppler cooling techniques as eg. Raman sideband cooling within a dipole trap.

The quench cooling process has been investigated by numerical Monte-Carlo simulations. Applying these to ^{40}Ca and comparing with experimental results from a recent demonstration of quench cooling in ^{40}Ca at PTB[2] backup our predictions.

[1] F. Ruschewitz *et al.*, *PRL* **80** 3173 (1998).

[2] T. Binnewies *et al.*, *PRL* **87** 123002 (2001).