IMPLEMENTATION OF A PHASE-TRACING INTERFEROMETER FOR THE ALIGNEMENT OF ANTIPARALLEL LASER BEAMS

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High-resolution laser spectroscopy of electronic transitions in atomic-beam experiments often suffers from the Doppler effect. Next to the broadening of spectral lines resulting from the velocity spread of atoms moving in the direction of the laser beam, the 1st-order Doppler shift provides an obstacle in the determination of Doppler-free transition frequencies. Experimental methods have been designed for the compensation of the 1st-order Doppler shift,[1] which rely on recording two Doppler components resulting from the absorption induced by two antiparallel laser beams of the same frequency, which intersect the atomic beam at near-right angles. Their respective Doppler shifts are equal in magnitude but of opposite sign. The Doppler-free frequency lies in the center of the two peaks in the spectrum. The deviation from an exact antiparallel overlapping arrangement of the two beams, typically achieved by retroreflection, is the main limiting factor of the precision of this technique. Different methods have been developed to minimize the tilt angle between the propagation axes of the initial and retro-reflected beams.[2,3] We present the implementation of a phase-tracing Michelson interferometer to measure and minimize the tilt angle between the incoming and reflected beams. This angle is encoded in the interference pattern of both beams. A spatial gradient of the phase is introduced by modulating the phase of the initial beam. The resulting phase gradient is read out using a quadrant photodiode enabling correction of the alignment along two axes using a feedback loop. The tilt angle is proportional to the phase and can therefore be calculated. The poster will demonstrate the sensitivity of this method.

[1] doi:10.1103/PhysRevA.97.012501 Maximilian Beyer et al., **Physical Review A 97 no. 1**, (January 3, 2018): 012501.
[2] doi:10.1364/OE.417455 Vitaly Wirthl et al., **Optics Express 29, no. 5** (March 1, 2021): 7024.
[3] doi:10.1364/OL.30.003323 Holger Müller et al., **Optics Letters 30, no. 24** (December 15, 2005): 3323.

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