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Squeezed state metrology with Bragg interferometers operating in a cavity

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Bragg interferometers, operating using pseudospin-1/2 systems composed of two momentum states, have become a mature technology for precision measurements. State-of-the-art Bragg interferometers are rapidly surpassing technical limitations and are soon expected to operate near the projection noise limit set by uncorrelated atoms. Despite the use of large numbers of atoms, their operation is governed by single-atom physics. Motivated by recent proposals and demonstrations of Raman gravimeters in cavities, we propose a scheme to squeeze directly on momentum states that is capable of surpassing the projection noise limit in Bragg interferometers. We consider unique issues that arise when a spin squeezing protocol is applied to momentum pseudospins, such as the effects of the momentum width of the atomic cloud and the coupling to momentum states outside the pseudospin manifold. Our scheme promises to be feasible using current technology and is experimentally attractive because it requires no additional setup beyond what is required to operate Bragg interferometers in cavity geometries. We anticipate that our scheme will be an effective protocol for demonstrating appreciable levels of spin squeezing on momentum pseudospins.

Summary

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