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Effect of Interatomic Separation and Wavepacket Spreading on the Behavior of a High Compton Frequency Collective State Interferometer RESHAM SARKAR, MAY KIM, YANFEI TU, SELIM SHAHRIAR, Northwestern University — Recently, we proposed an N-atom collective state interferometer (CSI), for which the Compton frequency is N times higher than that of a single atom, producing an N-fold enhancement of sensitivity. Collective excitation occurs when the inter-atomic distance, D, is much less than the transition wavelength. For realizing a CSI, it is important to establish the precise role of D in determining the fidelity of collective excitation. For semi-classical atoms, the excitation is found to consist of a collective state and individual excitations. This yields a condition for the purity of the collective excitation as a function of D, taking into account the statistical distribution of D. We then take into account the center of mass motion of the atoms, and find that if the atoms are each a plane wave, then the only parameter that governs the extent of collective behavior is D. When each atom is assumed to be a wavepacket, we find that this conclusion remains unchanged. Furthermore, we find that the free-spread spreading of the wavepacket does not affect the degree of collective excitation. In this talk, we describe the details of this analysis, and establish conditions necessary for realizing the CSI.

Resham Sarkar
Northwestern University

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