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Quantum Frequency Interferometry: with applications ranging from gravitational wave detection to dark matter searches

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We introduce a quantum interferometric scheme that uses states that are sharp in frequency and delocalized in position. The states are frequency modes of a quantum field that is trapped at all times in a finite volume potential, such as a small box potential. This allows for significant miniaturization of interferometric devices. We consider a concrete implementation using the ground state and two phononic modes of a trapped Bose-Einstein condensate. We apply this to show that frequency interferometry can improve the sensitivity of phononic gravitational waves detectors by several orders of magnitude, even in the case that squeezing is much smaller than assumed previously and that the system suffers from short phononic lifetimes. Other applications range from magnetometry, gravimetry and gradiometry to dark matter/energy searches.

Author: Prof. FUENTES, Ivette (University of Southampton)

Presenter: Prof. FUENTES, Ivette (University of Southampton)

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