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Object-Observer Entanglement and Back-Action Evasion in Continuous Positions Measurements

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At a fundamental level Quantum mechanics dictates that a measurement corresponds to a physical process generating entanglement among the measured object and the measurement apparatus (and possibly the rest of the world). This entanglement inevitably results in a disturbance of the measured system - the famous Measurement Back Action in Quantum Mechanics. Measurement Back Action may become the main factor limiting the sensitivity in repeated or continuous measurements, as is the case in laser-interferometric postion sensors such as e.g. in LIGO. I will show how Object-Observer Entanglement and Measurement Back Action - as well as Back Action Evasion - can be demonstrated and tested in table-top optomechanical position sensors. Back Action Evasion can be achieved by measuring position with respect to an engineered reference frame corresponding to a negative mass harmonic oscillator, as demonstrated by C.B. Møller, et al.

Ref: C.B. Møller, R.A. Thomas, G. Vasilakis, E. Zeuthen, Y. Tsaturyan, K. Jensen, A. Schliesser, K. Hammerer, E.S. Polzik: Quantum back-action-evading measurement of motion in a negative mass reference frame, Nature 547, 191–195 (2017)

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