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Theory of entanglement-enhanced phase estimation

Advancements in physics are often motivated/accompanied by advancements in our precision measurements abilities. The current generation of atomic and optical interferometers are limited by shot-noise, a fundamental limit when estimating a phase shift with classical light or uncorrelated atoms. In the last years, it has been clarified that the creation of special quantum correlations among the particles, which will be called here “useful entanglement”, can strongly enhance the interferometric sensitivity. Pioneer experiments have already demonstrated the basic principles. We are probably at the verge of a second quantum revolution where Quantum Mechanics of many-body systems is exploited to overcome the limitation of classical technologies. This course will illustrate the deep connection between entanglement and sub shot-noise sensitivity.