Interferometry with independently prepared Bose-Einstein condensates

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Whenever the value of an unknown parameter is extracted from a series of experiments, the result is inevitably burdened by some uncertainty. If the system, which is the subject of measurement consists of unentangled particles, this uncertainty is bounded by the shot-noise limit. To overcome this limitation, it is necessary to use a properly entangled state, which is usually prepared in a dedicated procedure. We show that quantum correlations arising from the indistinguishability of bosons are a sufficient resource for the sub-shot-noise interferometry. To this end, we consider an interferometer, which operates on two independently prepared Bose-Einstein condensates with fluctuating numbers of particles. We calculate the sensitivity obtained from the measurement of the number of atoms and compare it with the ultimate achievable bound. Our main conclusion is that even in presence of major atom number fluctuations, an interferometer operating on two independent condensates can give very high precision. These observations indicate a new possibility for an interferometer operating below the shot-noise limit.