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Practical quantum metrology with Bose-Einstein condensates ALEXANDRE TACLA, University of New Mexico, SERGIO BOIXO, Caltech, ANIMESH DATTA, Imperial College, MATTHEW DAVIS, University of Queensland, ANIL SHAJI, Indian Institute of Science Education and Research, CARLTON CAVES, University of New Mexico — We analyze in detail the recently proposed experiment [Boixo et al., Phys. Rev. Lett. **101**, 040403 (2008)] for achieving better than $1/N$ scaling in a quantum metrology protocol using a two mode Bose-Einstein condensate of N atoms. There were several simplifying assumptions in the original proposal that made it easy to see how a scaling approaching $1/N^{3/2}$ may be obtained. We look at these assumptions in detail to see when they may be justified. We present numerical results that confirm our theoretical predictions for the effect of the spreading of the BEC wave function with increasing N on the scaling. Numerical integration of the coupled Gross-Pitaevskii equations for the two mode BEC also shows that the assumption that the two modes share the same spatial wave function is justified for a length of time that is sufficient to run the metrology scheme.

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