Quantum-Enhanced Multiparameter Estimation and Compressed Sensing of a Field

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We show that a significant quantum gain corresponding to squeezed or over-squeezed spin states can be obtained in multiparameter estimation by measuring the Hadamard coefficients of a 1D or 2D signal. The physical platform we consider consists of two-level atoms in an optical lattice in a squeezed-Mott configuration, or more generally by correlated spins distributed in spatially separated modes. Our protocol requires the possibility to locally flip the spins, but relies on collective measurements. We give examples of applications to scalar or vector field mapping and compressed sensing.

Figure 1: A discretized image on a 512x512 grid (left panel) is imprinted in an ensemble of regularly spaced atoms, and subsequently reconstructed from collective measurements on the atoms. The middle panel corresponds to the use of uncorrelated atoms, while the right panel corresponds to the use of correlated atoms (in a spin-squeezed state) for the same number of measurements