# Two modes – N particles: entanglement, chaos, and applications

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**Abstract**

Quantum dynamics of interacting many-particle systems with mesoscopic particle number is often well captured via a classical meanfield description. Nevertheless quantum mechanical features can be revealed in the experiments analyzing fluctuations. This limit is analogous to the continuous variable limit in quantum optics where one of the paradigm examples of quantum states are squeezed states of light.
With the atomic system we can go beyond mere squeezing by generating non-gaussian many particle states. For their characterization we developed a new method which allows the extraction of a lower bound on the quantum Fisher information [1]. Its application to atom interferometry and a pathway for upscaling to large atom numbers will be presented [2].

The experimental system is perfectly suited for the study of the quantum and classical i.e. infinite many particles, limit. As paradigm example I will present the detection of the Poincare-Birkhoff-theorem [3] for driven many particle systems. Building on careful noise/fluctuation analysis we experimentally confirm that elliptic and hyperbolic fixed points are generated according to the theorem.

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