From many-body oscillations to thermalization in an isolated spinor gas

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The dynamics of a many-body system can take many forms, from a purely reversible evolution to fast thermalization. We will present experimental and numerical results, showing that an assembly of spin-1 atoms all in the same spatial mode allows one to explore this wide variety of behaviors. When the system can be described by a Bogoliubov analysis, the relevant energy spectrum is linear and leads to undamped oscillations of many-body observables. Outside this regime, the nonlinearity of the spectrum leads to irreversibility, characterized by a universal behavior, as shown in the Figure 1 below. When the integrability of the Hamiltonian is broken, a chaotic dynamics emerges and leads to thermalization, in agreement with the eigenstate thermalization hypothesis paradigm.

[1] B. Evrard et al, Phys. Rev. Lett. **126**, 063401 (2021)
[2] B. Evrard et al, Phys. Rev. A **103**, L031302 (2021)
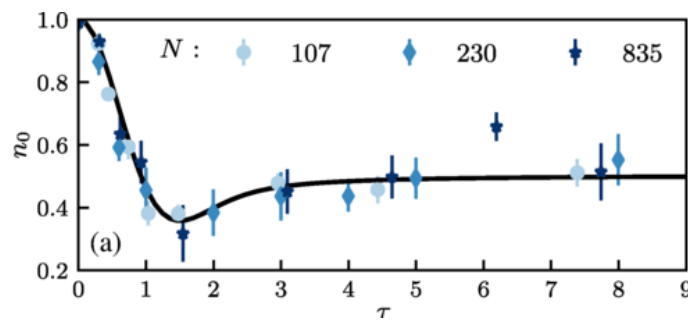
Figure 1 : Universal relaxation dynamics of mesoscopic spin-1 Bose-Einstein condensates. The relative population of atoms in the Zeeman state $m = 0$ relaxes to a stationary value of $n_0 = 1/2$, consistent with the prediction of a Generalized Gibbs Ensemble.