Generation of Schrödinger cat states in a NMR quadrupolar system

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One of the most intriguing theoretical concepts between classical and quantum mechanics is the Schrödinger cat state [1,2], which plays a distinguished role in quantum computation as a resource for universal computation and a good control for quantum systems. Therefore, a challenging task is the development of efficient strategies for achieving an experimental implementation of a Cat state. On this behalf, experimental demonstrations of the efficiency of quantum protocols using trapped ions [3], and also a pair of photons [4], allowed the recognition of their quantum advantages. Thus, the effort of extending those systems for more qubits became a major issue for many experimentalists. Later, this kind of state was implemented using six-atoms in a cavity at ultra cold temperatures [5], also, in the light scenario, in which up to several dozens of photons were used [6,7], and also in superconducting devices with the number equivalence of five photons [8].

The main strategy in those implementations was exploring the atom-field interaction [6,7] (except in [8]), but that is not the only possible strategy. In the context of atomic physics there is a theoretical proposal which explores the atom-atom interaction [9]. This strategy was developed using the total angular momentum description $\hat{\mathbf{J}} = \left(\hat{J}_x, \hat{J}_y, \hat{J}_z\right)$, the SU(2) algebra and the appropriate coupling strength between particles of a two mode Bose-Einstein Condensate. From the point of view of algebraic structures, the spin angular momentum description, $\hat{\mathbf{I}} = \left(\hat{I}_x, \hat{I}_y, \hat{I}_z\right)$, belongs and obeys the SU(2) algebra, and this special characteristic allows us to transfer the knowledge developed for a many body system into a spin system [10]. In this work, we will show how a nuclear spin system, $I = 7/2$, achieves an analogous behaviour of a few ultra-cold atoms particles, $N = 7$, in a trap to generate a Schrödinger cat state.

References

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