Nonclassical behaviour of a bidimensionally trapped ion in presence of nondissipative decoherence

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Quite recently it has been shown [1, 2] that the quantum dynamics of a properly laser driven ion, isotropically confined in a 2D Paul trap, exhibits peculiar nonclassical features arising from the granularity of the energy of the harmonic oscillator. In more details, it has been demonstrated that a difference of an excitation only in the initial vibrational state, determines the occurrence of very different behaviours in the time evolution of the system . In particular it has been analytically demonstrated that there exists a time instant t at which the probability $P_{-}(t)$ of finding the ion in its ground state is crucially dependent on the parity of the total vibrational quanta N initially present in the system. It turns out, in fact, that if N is even (odd) the electronic and vibrational degrees of freedom are maximally entangled (disentangled) in accordance with the fact that $P_{-}(t) = 0.5$ ($P_{-}(t)$=1). This nonclassical effect on the measurable quantity $P_{-}(t)$ has been deduced neglecting any source of decoherence. The aim of this paper is to reanalyse the quantum dynamics of the system taking into account the unavoidable presence of an intrinsic non-dissipative decoherence. To this end we discuss the problem in the context of the recent theory of Bonifacio et al. [3], showing that the effect previously predicted is compatible with the experimentally observed decoherence time.

[1] S. Maniscalco, A. Messina and A. Napoli *Phys. Rev. A* in press (May 2000).
[2] S. Maniscalco, A. Messina and A. Napoli, *J. Mod. Opt.* in press.
[3] R. Bonifacio, S. Olivares, P. Tombesi and D. Vitali *Phys. Rev. A* in press (May 2000)