KERR-TYPE NONLINEAR QUANTUM OSCILLATOR - QUANTUM CORRELATIONS, CHAOTIC AND REGULAR DYNAMICS

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We consider a model of an anharmonic Kerr-like oscillator characterized by the nonlinearity constant χ, and excited by a series of ultra-short coherent pulses. The model can be described by the following Hamiltonian [1-3]

$$\hat{H} = \frac{\chi}{2}(\hat{a}^\dagger)^2\hat{a}^2 + \varepsilon(\hat{a}^\dagger + \hat{a})\sum_{k=1}^{\infty}\delta(t-kT),$$

where the sequence of the pulses is modelled by the sum of the Dirac-delta functions *δ(t-kT)* (*T* denotes the time between two subsequent pulses, *k* labels individual pulses, whereas ε is a coupling constant characterizing the strength of the interaction with external field).
For such a model we discuss intra-mode correlations described by the second-order correlation function $g^{(2)}$

$$g^{(2)} = \frac{\langle \hat{a}^\dagger\hat{a}^\dagger\hat{a}\hat{a}\rangle}{\langle \hat{a}^\dagger\hat{a}\rangle^2} = \frac{\langle \hat{n}(\hat{n}-1)\rangle}{\langle \hat{n}\rangle^2},$$

and analyze the behavior of the deviation of $g^{(2)}$ which is defined as the difference of two functions:

$$g_p^{(2)} - g_u^{(2)} = \frac{\langle \Psi_p|\hat{n}(\hat{n}-1)|\Psi_p\rangle}{\langle \Psi_p|\hat{n}|\Psi_p\rangle^2} - \frac{\langle \Psi_u|\hat{n}(\hat{n}-1)|\Psi_u\rangle}{\langle \Psi_u|\hat{n}|\Psi_u\rangle^2}.$$

The function $g_u^{(2)}$ is calculated for the "unperturbed" quantum state represented by the wave-function $|\Psi_u\rangle$ and is related to the situation when coupling parameter is equal to ε. From other side, $g_p^{(2)}$ corresponds to the "perturbed" system described by quantum state $|\Psi_p\rangle$, when external coupling is slightly perturbed ($\varepsilon \to \varepsilon + \delta, \delta \ll \varepsilon$).
For our model the both: $g^{(2)}$ and its deviation are discussed in a context of the detection of quantum chaotic behavior. We show how those parameters could be applied as the witnesses of quantum chaos.

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