On the properties of quantum packets in the model of interaction of a single two-level atom with a mode of the quantized electromagnetic field

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22.09.2015

A new mathematical method to study the function of atomic inversion in the Jaynes-Cummings model (JCM) is discussed.

If the optical field is almost monochromatic and its frequency is close to one from the frequencies of atomic transitions, then it's possible not to take into account the transitions between other energy levels and to consider this atom as a two-level atom. Jaynes and Cummings [1] demonstrated that the equations of motion in the problem on the interaction of a single two-level atom with a single mode of the quantized field of radiation are analytically solvable ones. After creation of one-atom maser and microlaser, and also one-mode resonator of high quality the JCM obtained an experimental confirmation with certain phenomena theoretically predicted in the JCM, such as the collapses and revivals of the oscillations of atomic inversion.

We study [2], [3], [4], [5] the function of atomic inversion in the JCM with the electromagnetic field in the coherent state. Applying certain number theoretic tools we get new asymptotic formulas for this function. These asymptotics give the possibility to predetermine the details of the behavior of the inversion on various time intervals and to establish the characteristics of the packets of quantum oscillations depending on the parameters of the system.

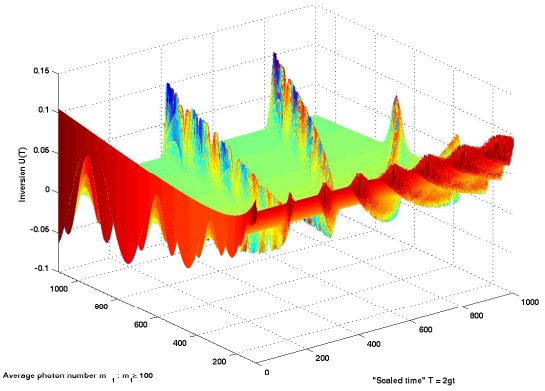

Figure 1: Atomic inversion depending on time and average photon number for "quadratic scaled detuning parameter" $a = (\Delta/(2g))^2 = 10$.

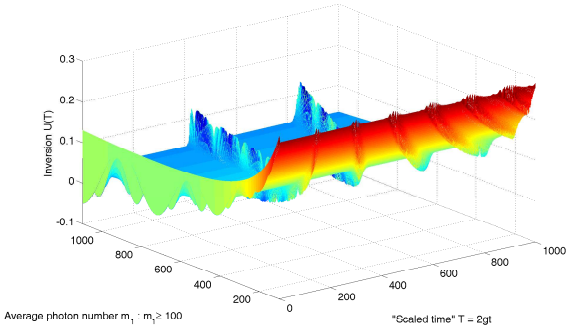

Figure 2: Atomic inversion depending on time and average photon number for $a = 40$.

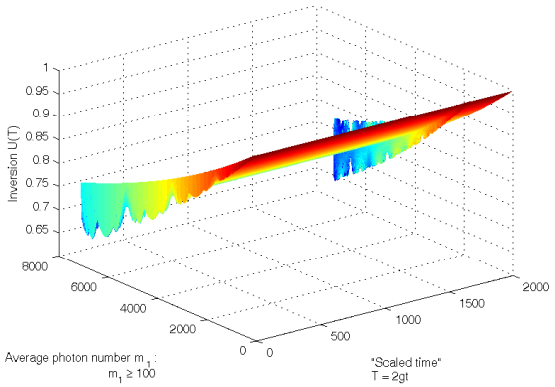

Figure 3: Atomic inversion depending on time and average photon number for $a = 17424$.

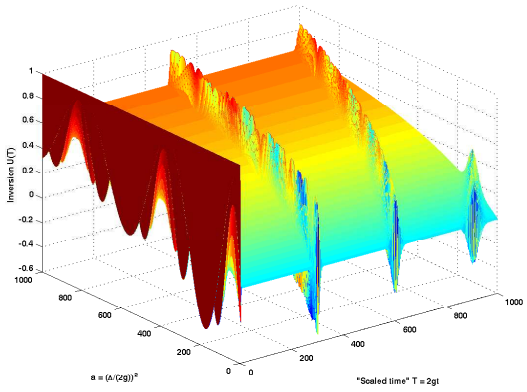

Figure 4: Atomic inversion depending on time and "quadratic scaled detuning parameter" for average photon number $m_1 = 576$.

References

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