Quantum Physics

Application of Abel-Plana formula for collapse and revival of Rabi oscillations in Jaynes-Cummings model

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In this paper, we give an analytical treatment to study the behaviour of the collapse and the revival of the Rabi oscillations in the Jaynes-Cummings model (JCM). The JCM is an exactly soluble quantum mechanical model, which describes the interaction between a two-level atom and a single cavity mode of the electromagnetic field. If we prepare the atom in the ground state and the cavity mode in a coherent state initially, the JCM causes the collapse and the revival of the Rabi oscillations many times in a complicated pattern in its time-evolution. In this phenomenon, the atomic population inversion is described with an intractable infinite series. (When the electromagnetic field is resonant with the atom, the nth term of this infinite series is given by a trigonometric function for $\sqrt{n}t$, where t is a variable of the time.) According to Klimov and Chumakov's method, using the Abel-Plana formula, we rewrite this infinite series as a sum of two integrals. We examine the physical meanings of these two integrals and find that the first one represents the initial collapse (the semi-classical limit) and the second one represents the revival (the quantum correction) in the JCM.

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