The dynamical Casimir effect of a metastable excited atom driven by a time periodic external field

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We have studied the dynamical Casimir effect of a metastable excited atom whose energy is driven by a periodic external field in terms of the complex spectral representation of the Floquet Hamiltonian. The non-Hermitian effective Hamiltonian for the impurity state is constructed from the original Hermitian Hamiltonian in terms of the Brillouin-Wigner-Feshbach projection method. We have revealed characteristically different types of a photon emission from the atom. We have found that a virtual photon initially localized at the atom is emitted as a Zeno photon in a short time scale due to the branch point contribution associated with the initial dressed field. In addition, a new virtual cloud emerges around the atom due to the induced branch point effects by the external field. Since the periodic external field yields many Floquet bands, this new virtual cloud is formed as a superposition of many branch point contributions, resulting in a unique space-time evolution of the photon emission in the dynamical Casimir effect.

Besides the branch point effect, Floquet resonance states gives a delocalized photon emission with an exponential intensity growth in space. As a result of the interference between many Floquet resonance states, we have found out a pulsed photon emission in space.

We also show that the spectral profiles of the photon emission due to the branch point effect and the resonance state effect are characteristically different and that the latter effect is responsible for the high harmonic generation in dynamical Casimir effect.