

Influence of initial qubits coherence and Izing coupling on the dynamics of Tavis-Cummings model

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Negativity calculations for coherent initial atomic state $g \equiv \gamma$

Hamiltonian

$$H = (1/2)\hbar\Xi(r_{K_1}^z + r_{K_2}^z) + \hbar g \sum_{m=K_1}^{K_2} (r_m^+ \eta + \eta^+ r_m^-) + \hbar Z r_{K_1}^z r_{K_2}^z$$

Separable coherent initial atomic states

$$|\psi_{A_1}\rangle = \cos \mathcal{G}_1 |+\rangle_1 + \sin \mathcal{G}_1 |-\rangle_1,$$

$$|\psi_{A_2}\rangle = \cos \mathcal{G}_2 |+\rangle_2 + \sin \mathcal{G}_2 |-\rangle_2,$$

Initial thermal cavity field state

$$P_{EF}(0) = \sum_k h_k |k\rangle\langle k|,$$

$$h_k = \langle k \rangle^k (1 + \langle k \rangle)^k,$$

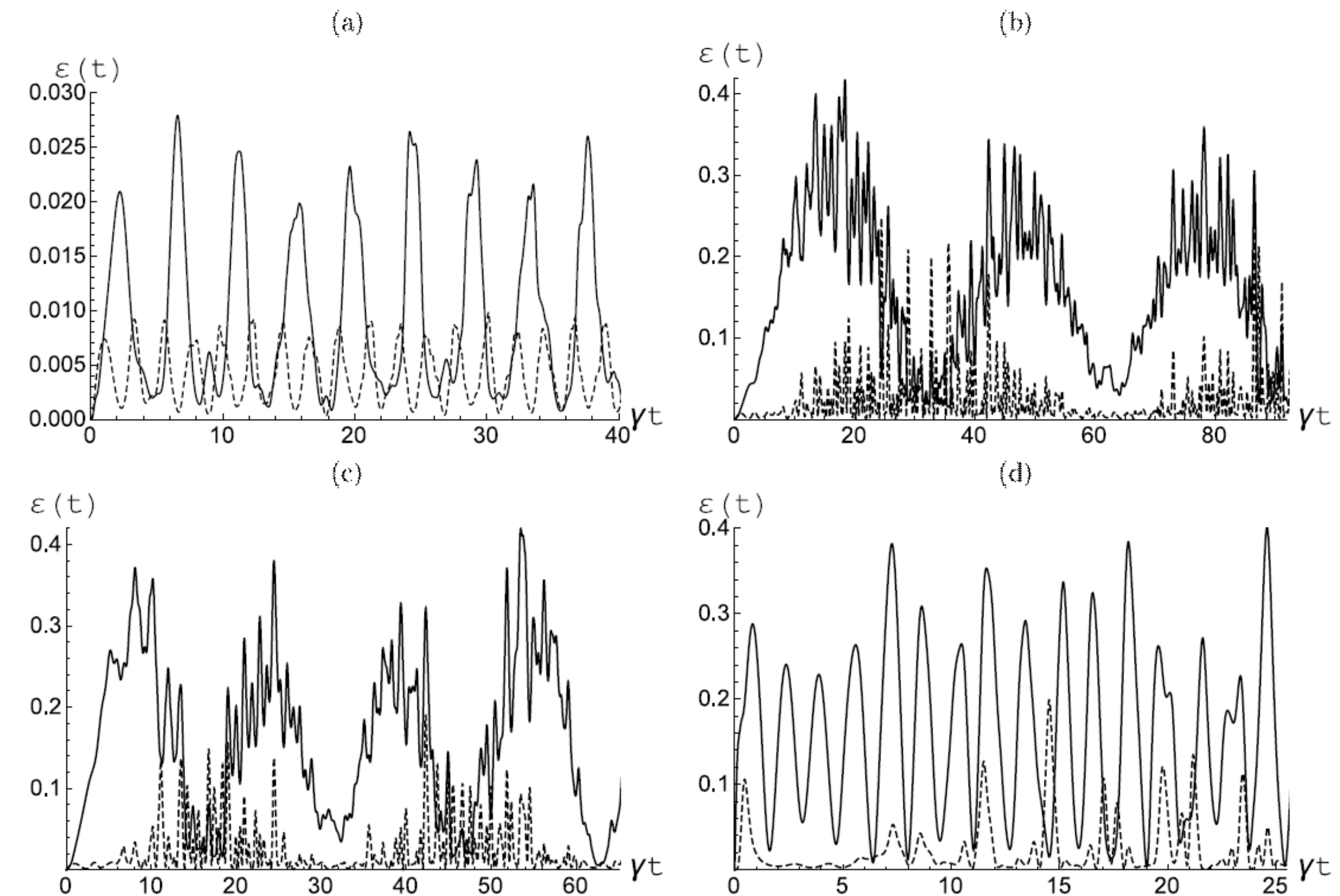
Transposed reduced two-atom matrix

$$P_{K_1 K_2}^{T_1}(t) = \begin{pmatrix} w_{11}(t) & 0 & 0 & w_{14}(t) \\ 0 & w_{22}(t) & 0 & 0 \\ 0 & 0 & w_{33}(t) & 0 \\ w_{14}(t)^* & 0 & 0 & w_{44}(t) \end{pmatrix}$$

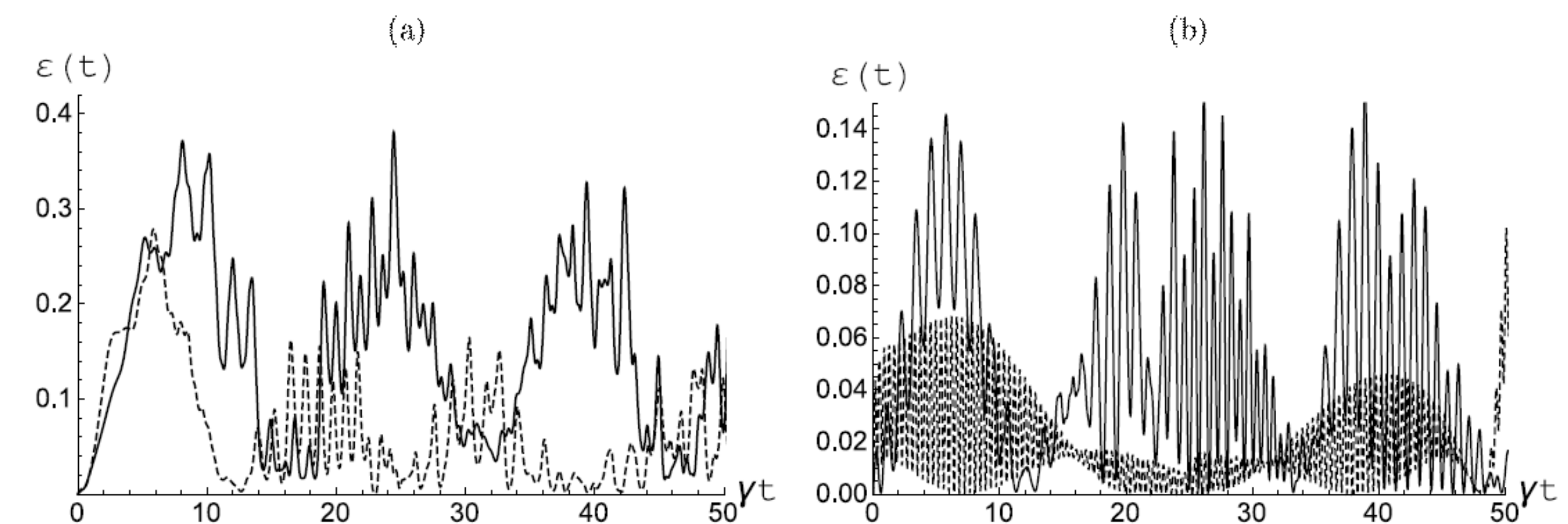
Negativity

$$\varepsilon = -2 \sum \mu_i^-$$

$$\varepsilon(t) = \sqrt{(w_{11}(t) - w_{44}(t))^2 + 4 |w_{14}(t)|^2} - w_{11}(t) - w_{44}(t)$$



The negativity $\varepsilon(t)$ vs scaled time γt for resonance interaction between qubits and field. The mean thermal photon number in the mode $\bar{n} = 0.01$. The solid lines correspond to coherent initial qubits state $|\Psi(0)\rangle_{Q_1} = 1/\sqrt{2}(|+\rangle_1 + |-\rangle_1)$, $|\Psi(0)\rangle_{Q_2} = 1/\sqrt{2}(|+\rangle_1 - |-\rangle_1)$, and the dashed lines correspond to separable qubits state $|\Psi(0)\rangle_{Q_1 Q_2} = |+, -\rangle$. The scaled Izing couplings are $\zeta = 0$ (a), $\zeta = 0.05$ (b), $\zeta = 0.1$ (c) and $\zeta = 1$ (d)



The negativity $\varepsilon(t)$ vs scaled time γt for not-resonance interaction between qubits and field. The mean thermal photon number in the mode $\bar{n} = 10$. The scaled Izing coupling $\zeta = 0.1$. Initial coherent qubits state $|\Psi(0)\rangle_{Q_1} = 1/\sqrt{2}(|+\rangle_1 + |-\rangle_1)$, $|\Psi(0)\rangle_{Q_2} = 1/\sqrt{2}(|+\rangle_1 - |-\rangle_1)$. Scaled detuning $\xi = 0$ (solid) and $\xi = 1$ (dashed) (a), $\xi = 5$ (solid) and $\xi = 15$ (dashed) (b)