Collective eigenmodes for a finite array of emitters

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We consider collective eigenmodes for a finite array of emitters coupled to the waveguide. The eigenmodes are found from the system of equations

$$-\mathrm{i}\gamma_{1\mathrm{D}} \sum_{n=1}^{N} \mathrm{e}^{\mathrm{i}\varphi|m-n|}\psi_n = \omega\psi_m, \quad m = 1, 2 \ldots N \tag{1}$$

where $\varphi = 2\pi d/\lambda$ is the phase gained by light propagaring between the two neighboring emitters.

Goal: Calculate numerically the complex eigenfrequencies of Eq. (1) for $N = 10$. Plot on one panel the dependences of the real parts of all the eigenfrequiencies on d for $d = 0 \ldots \lambda$ and on another panel the same for the imaginary parts. Also, plot on the first panel the equations for the band gap edges, $\omega = \omega_0 + \gamma_{1\mathrm{D}} \cot(\varphi/2)$ and $\omega = \omega_0 - \gamma_{1\mathrm{D}} \tan(\varphi/2)$.

Answer:

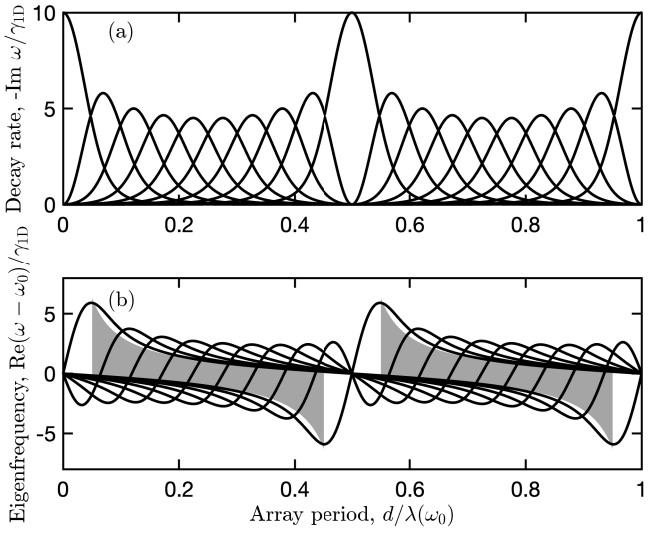

FIG. 1 From Ref. (Sheremet *et al.*, 2023). Imaginary (a) and real (b) parts of the complex eigenfrequencies of the array of $N = 10$ atoms coupled to a waveguide depending on the period of the array d. Shaded areas (b) show the edges of the polariton band gaps. Each value of d/λ corresponds to $N = 10$ eigenvalues.

References

Sheremet, A. S., M. I. Petrov, I. V. Iorsh, A. V. Poshakinskiy, and A. N. Poddubny, 2023, Rev. Mod. Phys. **95**, 015002.