Non-decaying states in non-Hermitian system

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We consider a non-Hermitian 2×2 eigenvalue problem:

$$H\psi = \omega\psi, \quad H = \begin{pmatrix} \omega_1 - i\gamma_1 & \kappa - i\sqrt{\gamma_1\gamma_2} \\ \kappa - i\sqrt{\gamma_1\gamma_2} & \omega_2 - i\gamma_2 \, , \end{pmatrix} \tag{1}$$

where $\omega_{1,2}$ are the resonant frequencies of two coupled emitters (both are real), the real parameter κ describes the dispersive part of the coupling and the real parameters $\gamma_{1,2}$ describe the dissipation.

Goal: Find conditions for $\omega_{1,2}$, κ and $\gamma_{1,2}$, so that one of the eigenvalues ω is real.

Hint: Ref. (Friedrich and Wintgen, 1985).

References

Friedrich, H., and D. Wintgen, 1985, Phys. Rev. A **32**, 3231.