EIT & dark resonances

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Solution: *a. We put $\Delta_{12} = \Delta_{23}$ and we consider the stationary solution $\dot{\rho} = 0$. The Bloch equations are,*

$$\begin{aligned}
0 &= \Gamma_{12}\rho_{22} + \tfrac{\imath}{2}\Omega_{12}(\rho_{12} - \rho_{21}) \\
0 &= \Gamma_{23}\rho_{22} - \tfrac{\imath}{2}\Omega_{23}(\rho_{23} - \rho_{32}) \\
0 &= \left(-\tfrac{1}{2}\Gamma_{12} - \tfrac{1}{2}\Gamma_{13} + \imath\Delta_{12}\right)\rho_{12} + \tfrac{\imath}{2}\Omega_{12}(\rho_{11} - \rho_{22}) + \tfrac{\imath}{2}\Omega_{23}\rho_{13} \\
0 &= \left(-\tfrac{1}{2}\Gamma_{12} - \tfrac{1}{2}\Gamma_{23} + \imath\Delta_{12}\right)\rho_{23} + \tfrac{\imath}{2}\Omega_{23}(\rho_{22} - \rho_{33}) - \tfrac{\imath}{2}\Omega_{12}\rho_{13} \\
0 &= \tfrac{\imath}{2}\Omega_{23}\rho_{12} - \tfrac{\imath}{2}\hbar\Omega_{12}\rho_{23} \ ,
\end{aligned}$$

Eliminating ρ_{22} in equations I and II gives $\frac{\Omega_{12}}{\Gamma_{12}}\rho_{12} - \frac{\Omega_{12}}{\Gamma_{12}}\rho_{21} = \frac{\Omega_{23}}{\Gamma_{23}}\rho_{23} - \frac{\Omega_{23}}{\Gamma_{23}}\rho_{32}$. Insertion of the equation V in this equation gives $\frac{\Omega_{12}}{\Gamma_{12}}(\rho_{12} - \rho_{21}) = \frac{\Omega_{23}}{\Gamma_{23}}\left(\frac{\Omega_{23}}{\Omega_{12}}\rho_{21} - \frac{\Omega_{23}}{\Omega_{12}}\rho_{12}\right)$. Hence, $\rho_{23} = \rho_{21}$. Since $\rho_{12} = \rho_{21}^*$ we need $\rho_{12} = \rho_{21} = 0 = \rho_{22}$.
b. The Liouville matrix can be found in the numerical MATLAB code given in the file 'LM_Bloch_DarkResonance.m'. Fig. 2.18 shows the results of the simulations. The curves in Fig. 2.18(a) show that the contrast of the dark resonance decreases as the decay rate of coherence increases.

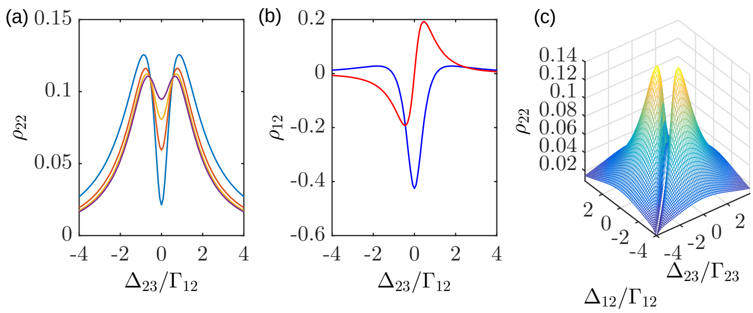

Figure 2.18: (code for download) (a) Population of the state excited as a function of the detuning Δ_{23} for several decay rates γ_{13} of the coherence. (b) Real and imaginary part of the susceptibility. (c) Population of the excited state as a function of the detunings Δ_{12} and Δ_{23}.