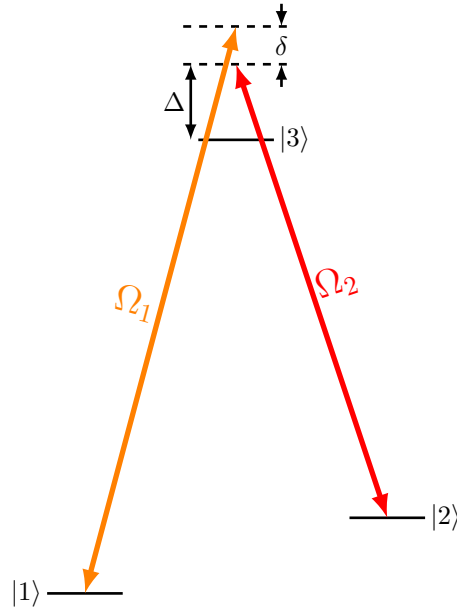# Electromagnetically Induced Transparency (EIT)

November 17, 2023

With Ω_2 coupling $|2\rangle$ and $|3\rangle$ together, the energies of the coupled states are (relative to the original energy of $|3\rangle$)

$$E_{\pm} = \frac{\Delta \pm \sqrt{\Delta^2 + \Omega_2^2}}{2}$$

The eigenstates are

$$|\pm\rangle = \frac{\sqrt{\sqrt{\Delta^2 + \Omega_2^2} \pm \Delta}}{\sqrt{2}\sqrt[4]{\Delta^2 + \Omega_2^2}}|2\rangle + \frac{\Omega_2}{\sqrt{2}\sqrt[4]{\Delta^2 + \Omega_2^2}\sqrt{\sqrt{\Delta^2 + \Omega_2^2} \pm \Delta}}|3\rangle$$

The Rabi frequencies from the $|1\rangle$ state to the $|\pm\rangle$ states are

$$\Omega_{\pm} = \frac{\Omega_1 \Omega_2}{\sqrt{2}\sqrt[4]{\Delta^2 + \Omega_2^2}\sqrt{\sqrt{\Delta^2 + \Omega_2^2} \pm \Delta}}$$

and the detunings,

$$\delta_{\pm} = \delta - E_{\pm}$$
$$= \delta - \frac{\Delta \pm \sqrt{\Delta^2 + \Omega_2^2}}{2}$$

Lifetime of the $|\pm\rangle$ states

$$\Gamma_\pm = \frac{\Gamma \Omega_2^2}{2\sqrt{\Delta^2 + \Omega_2^2}\left(\sqrt{\Delta^2 + \Omega_2^2} \pm \Delta\right)}$$