Quantum Optics P572 Teaser Question Feb. 17, 2015

Question: *Disappearing states.*

Consider three levels, $|1\rangle$, $|2\rangle$, and $|3\rangle$. We couple them with a Hamiltonian

$$(\Delta_2 + i\Gamma)\,|2\rangle\langle 2| + \frac{\Omega_{12}}{2}\,(|2\rangle\langle 1| + \text{H.c.}) + \frac{\Omega_{23}}{2}\,(|3\rangle\langle 2| + \text{H.c.}) \tag{1}$$

and you are given full control over the Ω_a's, but not the Δ_j's. Can you find a choice of Ω_a's such that $(1/\sqrt{2})(|1\rangle + |3\rangle)$ is the ground state of the system? Note that if you accomplish this, you have a somewhat remarkable way of coupling $|1\rangle$ and $|3\rangle$: you can couple them through $|2\rangle$, even though there is no population in $|2\rangle$. In practice, this can be especially important if the losses from $|2\rangle$, Γ, are large, since one can still use state $|2\rangle$ for coupling without worrying about its losses.