$$\bar{\Omega}(n) = 2\lambda\sqrt{\bar{n}+1} \overset{\bar{n}\gg 1}{\approx} 2\lambda\sqrt{\bar{n}}$$

$$\to t_c \cdot \left[\Omega(\bar{n}+\Delta n) - \Omega(\bar{n}-\Delta n)\right] \overset{!}{=} 1$$

$\uparrow$ collapse time

$$\Rightarrow t_c \cdot 2\lambda\left[\underbrace{\sqrt{\bar{n}+\Delta n} - \sqrt{\bar{n}-\Delta n}}_{\sqrt{\bar{n}}\left[1+\frac{\Delta n}{2\bar{n}} - \left(1-\frac{\Delta n}{2\bar{n}}\right)\right]}\right] = 1$$

$$= \sqrt{\bar{n}}\left[\frac{\Delta n}{\bar{n}}\right] = \frac{\Delta n}{\sqrt{\bar{n}}} = \frac{|\alpha|}{|\alpha|} = 1$$

$$\boxed{t_c = \frac{1}{2\lambda}}$$

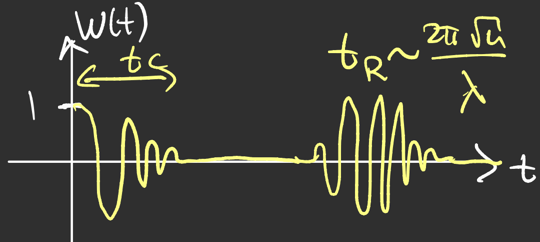
Revivals

$$\left[\Omega(\bar{n}+1) - \Omega(\bar{n})\right] t_R = 2\pi k, \quad k = 1, 2, 3 \ldots$$

$$2\lambda\left(\sqrt{\bar{n}+1} - \sqrt{\bar{n}}\right)$$

$$\approx 2\lambda\sqrt{\bar{n}}\,\frac{1}{2\bar{n}} = \frac{\lambda}{\sqrt{\bar{n}}}$$

$$\boxed{t_R = \frac{2\pi\sqrt{\bar{n}}}{\lambda}\,k}$$



*) true quantum effect
$\nwarrow$ different Rabi freq. at n and n+1

Dressed states

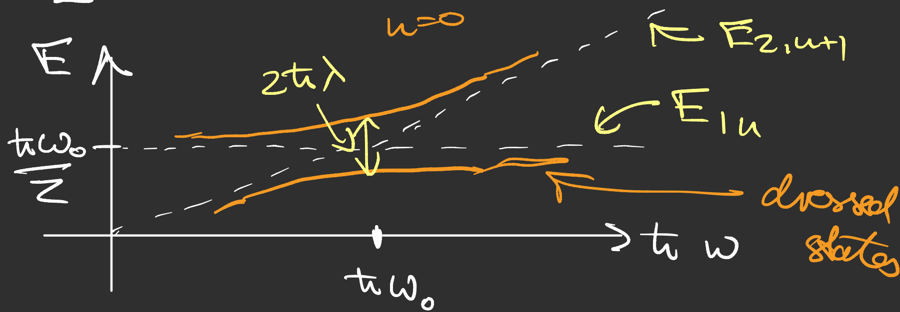
→ so far: considered coupled bare states (eigenstates of the unperturbed Hamiltonian)

→ alternative: dressed states

(eigenstates of the coupled light-matter Hamiltonian)

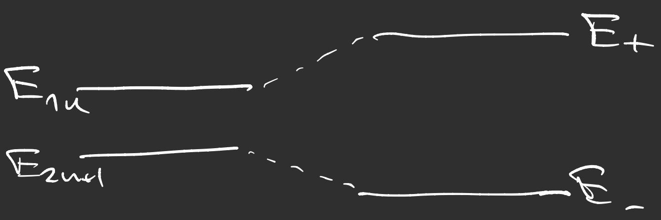
e.g. bare states of JC

$$\left.\begin{aligned} E_{1,n} &= \frac{\hbar\omega_0}{2} + n\hbar\omega \\ E_{2,n+1} &= -\frac{\hbar\omega_0}{2} + (n+1)\hbar\omega \end{aligned}\right\}\ \text{bare-state eigen energies}$$



Dressed states have an anticrossing behavior

↳ "Normal mode splitting"



⇒ splitting of bare states into dressed states is called AC Stark shift

The time dynamics of a general state is now easily solved

$$|\psi(t)\rangle = \sum_n c_n \left[\cos\frac{\theta_n}{2} |n,+\rangle e^{-iE_+(n)t/\hbar} - \sin\frac{\theta_n}{2} |n,-\rangle e^{-iE_-(n)t/\hbar} \right]$$

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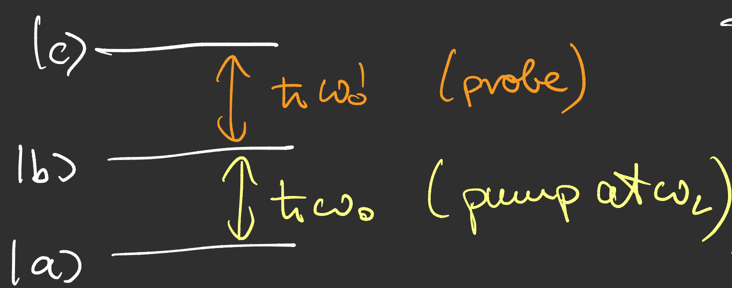
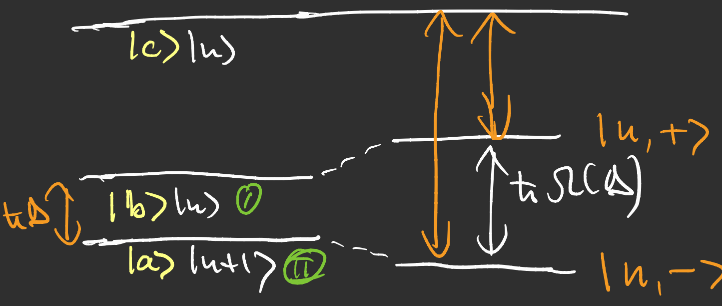
$e^{-i\varphi_n}$

7.4 Autler Townes Effect (Phys. Rev. 100, 703, (1955))



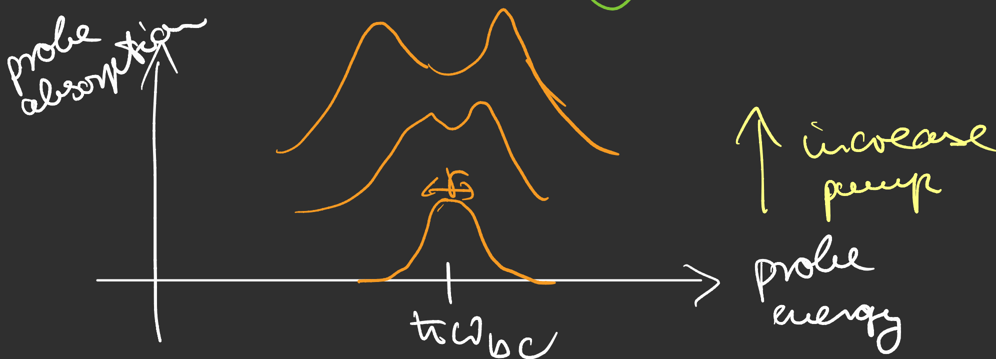
- only $|a\rangle \leftrightarrow |b\rangle$ and $|b\rangle \leftrightarrow |c\rangle$ are coupled
- $\omega_0 \neq \omega_0'$

- consider strong laser at $\omega_L \sim \omega_0$: $\Delta = \omega_0 - \omega_L$



both have $|b\rangle$ in their composition
$\Rightarrow$ transitions to $|c\rangle$ are allowed

$$E^{I} = E_b + \hbar\omega_L \cdot n$$
$$E^{II} = E_a + \hbar\omega_L (n+1)$$



$\rightarrow$ can be interpreted as AC-Stark splitting of bare states

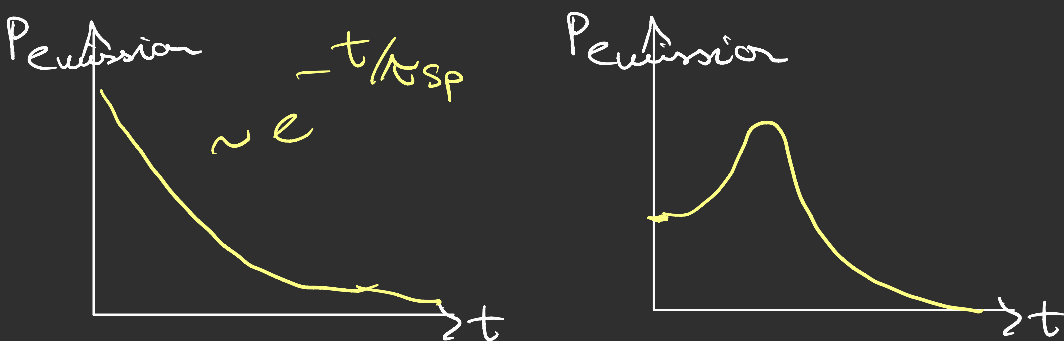
7.5 Mollow's Triplet

(Phys. Rev. 188, 1969 (1969))

- assume $\Delta = 0$ (resonance

7.6 Superradiance → main ref. Gross & Haroche Phys. Rep. 93, 301 (1982)

- an ensemble of N atoms can decay differently than N independent atoms
- reason: spontaneous emission into a shared light mode



same total emitted energy $N\hbar\omega$

Dicke model → Phys. Rev. 93, 99 (1954)

- consider an ensemble of N atoms (2LSs) placed in a volume of dimension $\ll \lambda$

(~ wavelength of transition)

For one atom: $\hat{\sigma}_+^i = |e\rangle\langle g|$, $\hat{\sigma}_3^i = |e\rangle\langle e| - |g\rangle\langle g|$

$$\Rightarrow [\hat{\sigma}_3^i, \hat{\sigma}_\pm^j] = \pm 2\delta_{ij}\hat{\sigma}_\pm^i$$

$$[\hat{\sigma}_+^i, \hat{\sigma}_-^j] = \delta_{ij}\hat{\sigma}_3^i$$