Polarizability and Master equations

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The goal of this note is to derive the polarizability formula for trapped atoms.

First, we start with a two-level atom interacting with a far-off resonance light field.

$|e\rangle$, $|g\rangle$, Γ, Ω.

$$\vec{E} = \frac{1}{2}E_0\vec{u}\,e^{-i\omega t} + \frac{1}{2}E_0\vec{u}^*e^{i\omega t}, \qquad \int d^2r_\perp\, \vec{u}_m^*(\vec{r}_\perp)\cdot\vec{u}_n(\vec{r}_\perp) = \delta_{mn}, \qquad \vec{u}_m(\vec{r}) = \vec{U}_m(\vec{r}_\perp)e^{i\beta_0 z - i\omega t}.$$

$$\hat{H} = \hat{H}_F + \hat{H}_A + \hat{H}_{int},$$

with

$$\hat{H}_F = \sum_k \hbar\omega_k\left(\hat{a}_k^+\hat{a}_k + \frac{1}{2}\right)$$

$$\hat{H}_A = \hbar\omega_0|e\rangle\langle e|$$ $\longrightarrow$ chose the ground state as the zero energy state.

$$\hat{H}_{int} = \hbar\sum_k\left(g_k\hat{a}_k^+\hat{\sigma}_+ + g\right.$$