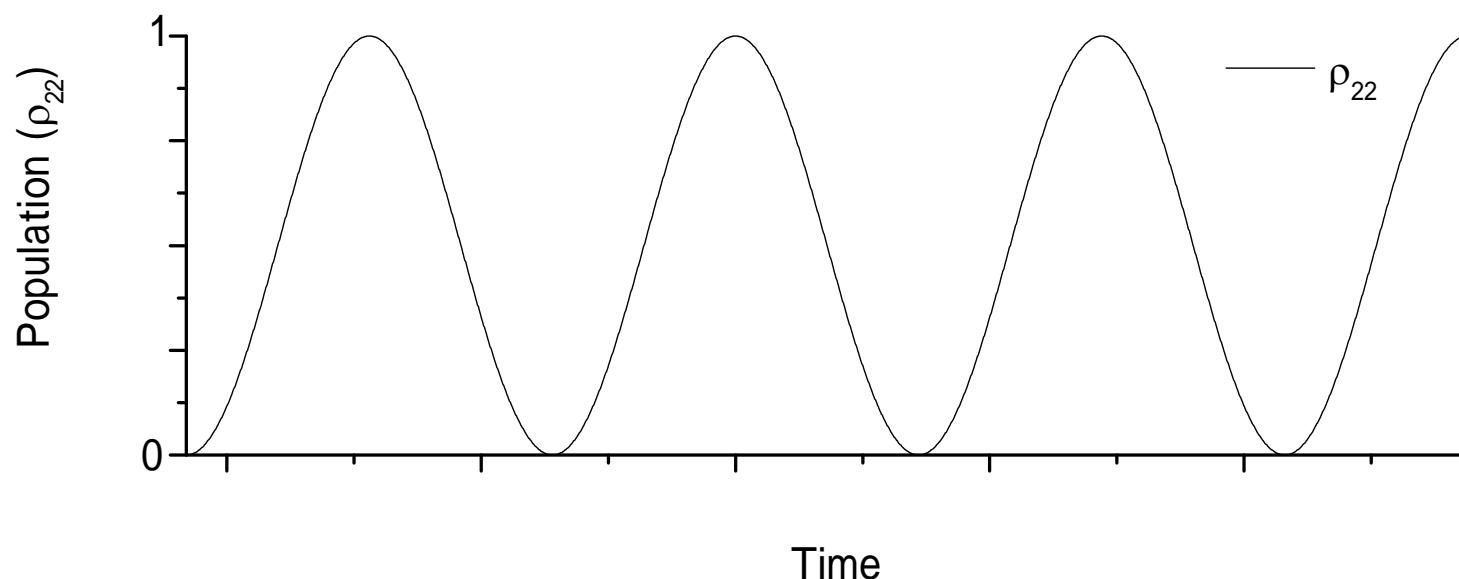


Rabi振動

電磁波と物質のコピー・レントな相互作用

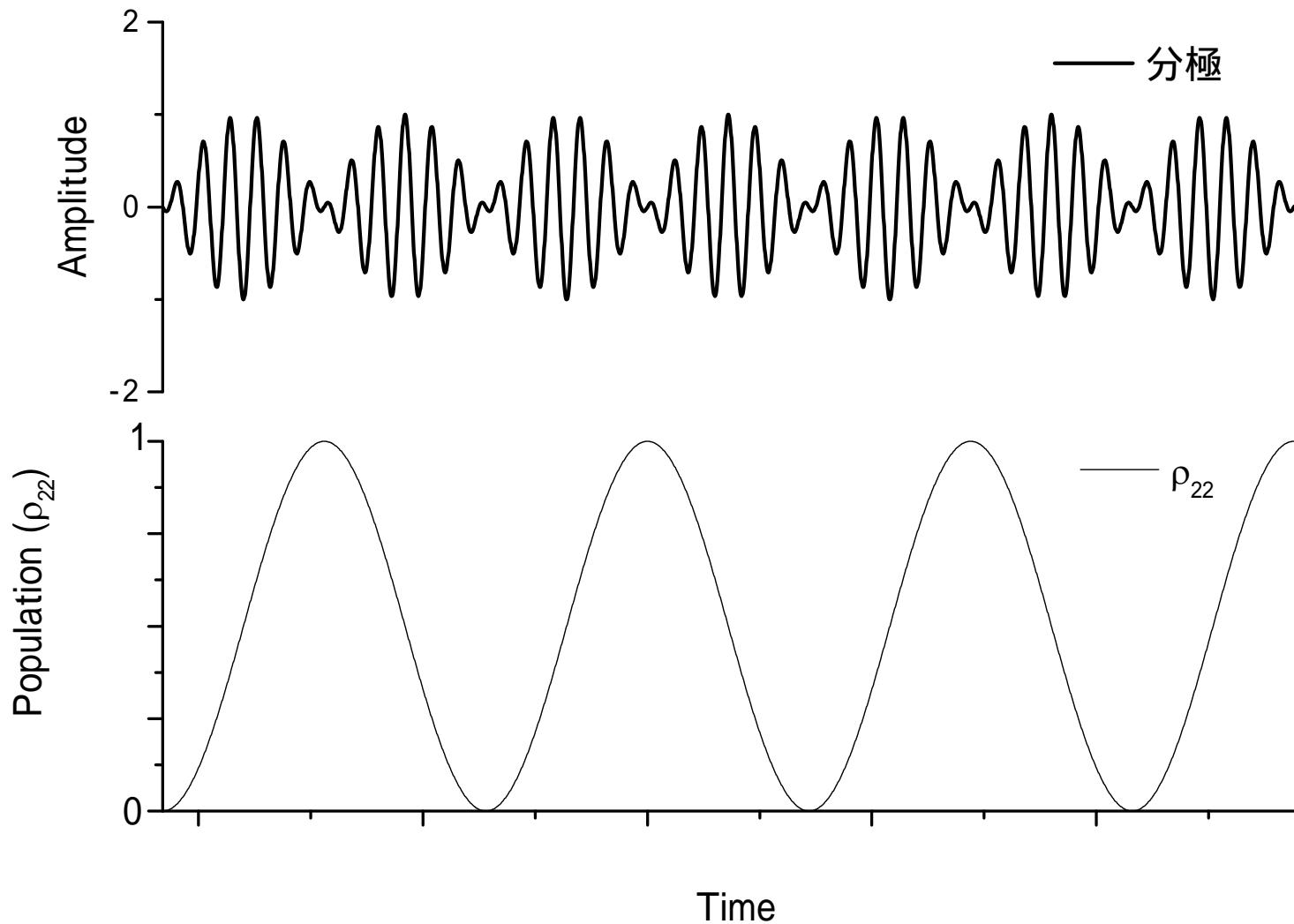
定常電磁波で二準位系を共鳴励起
緩和過程を無視
このとき分極は？

$$\xi = \frac{\mu_{12} E_0}{\hbar} \gg \gamma$$



Rabi振動

電磁波と物質のコピー・レントな相互作用



Frenkel励起子の振動子強度

$$\begin{aligned} \text{振動子強度} &\propto \left| \left\langle \Psi_g \left| \sum_i \mathbf{r}_i \cdot \mathbf{E} \right| \Psi_{K=0} \right\rangle \right|^2 \\ &= \left| \left\langle \prod_j \phi_s(\mathbf{r}_j) \left| \sum_i \mathbf{r}_i \cdot \mathbf{E} \right| \frac{1}{\sqrt{N}} \sum_n \left[\phi_p(\mathbf{r}_n) \prod_{k \neq n} \phi_s(\mathbf{r}_k) \right] \right\rangle \right|^2 \\ &= \left| \frac{1}{\sqrt{N}} \sum_{i=1}^N \left\langle \phi_s(\mathbf{r}_i) \left| \mathbf{r}_i \cdot \mathbf{E} \right| \phi_p(\mathbf{r}_i) \right\rangle \right|^2 \\ &= \left| \frac{1}{\sqrt{N}} N \left\langle \phi_s(\mathbf{r}_i) \left| \mathbf{r}_i \cdot \mathbf{E} \right| \phi_p(\mathbf{r}_i) \right\rangle \right|^2 \\ &= N \left| \left\langle \phi_s(\mathbf{r}_i) \left| \mathbf{r}_i \cdot \mathbf{E} \right| \phi_p(\mathbf{r}_i) \right\rangle \right|^2 \quad \text{单一分子に比べてN倍に増強} \end{aligned}$$

$$\text{Wannier励起子} \quad N \left| \left\langle \phi_s(\mathbf{r}_i) \left| \mathbf{r}_i \cdot \mathbf{E} \right| \phi_p(\mathbf{r}_i) \right\rangle \right|^2 |F(0)|^2$$

$$\Psi_{K=0} = \frac{1}{\sqrt{5}} \left(\begin{array}{c} r_1 \\ r_2 \\ r_3 \\ r_4 \\ r_5 \end{array} \right)$$

電子座標

$$+ \begin{pmatrix} r_1 \\ r_2 \\ r_3 \\ r_4 \\ r_5 \end{pmatrix}$$

$$+ \begin{pmatrix} r_1 \\ r_2 \\ r_3 \\ r_4 \\ r_5 \end{pmatrix}$$

$$+ \begin{pmatrix} r_1 \\ r_2 \\ r_3 \\ r_4 \\ r_5 \end{pmatrix}$$

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$$+ \begin{pmatrix} r_1 \\ r_2 \\ r_3 \\ r_4 \\ r_5 \end{pmatrix}$$

$$\sum_i \mathbf{r}_i \cdot \mathbf{E}$$

$\Psi_g = \left| \begin{array}{c} \text{---} \\ | \\ \text{---} \\ | \\ \text{---} \\ | \\ \text{---} \\ | \\ \text{---} \end{array} \right\rangle =$

$$\sum_{i=1}^5 \frac{1}{\sqrt{5}} \left\langle \begin{array}{c} r_i \\ \text{---} \\ \text{---} \end{array} \right| \mathbf{r}_i \cdot \mathbf{E}_i \left| \begin{array}{c} r_i \\ \text{---} \\ \text{---} \end{array} \right\rangle = \sqrt{5} \left\langle \begin{array}{c} r \\ \text{---} \\ \text{---} \end{array} \right| \mathbf{r} \cdot \mathbf{E} \left| \begin{array}{c} r \\ \text{---} \\ \text{---} \end{array} \right\rangle$$

$$| \quad |^2 = 5 \left| \begin{array}{c} r \\ \text{---} \\ \text{---} \end{array} \right| \mathbf{r} \cdot \mathbf{E} \left| \begin{array}{c} r \\ \text{---} \\ \text{---} \end{array} \right\rangle |^2$$

価電子帶波動関数

$$\Psi_V = \frac{1}{\sqrt{N}} \left(\overline{\langle r_1 |} e^{-i\mathbf{K} \cdot \mathbf{R}_1} + \overline{\langle r_2 |} e^{-i\mathbf{K} \cdot \mathbf{R}_2} + \cdots + \overline{\langle r_N |} e^{-i\mathbf{K} \cdot \mathbf{R}_N} \right)$$

$\mathbf{R}_1 \quad \mathbf{R}_2 \quad \mathbf{R}_N$

$$\sum_i \mathbf{r}_i \cdot \mathbf{E}$$

$$\Psi_C = \frac{1}{\sqrt{N}} \left(\langle r_1 | e^{i\mathbf{K} \cdot \mathbf{R}_1} + \langle r_2 | e^{i\mathbf{K} \cdot \mathbf{R}_2} + \cdots + \langle r_N | e^{i\mathbf{K} \cdot \mathbf{R}_N} \right)$$

伝導帶波動関数

$$= \frac{1}{N} \left(N \left\langle \begin{array}{c} \text{---} \\ | \\ \text{---} \end{array} \middle| \mathbf{r} \cdot \mathbf{E} \middle| \begin{array}{c} \text{---} \\ | \\ \text{---} \end{array} \right\rangle \right)$$

振動子強度の増大なし