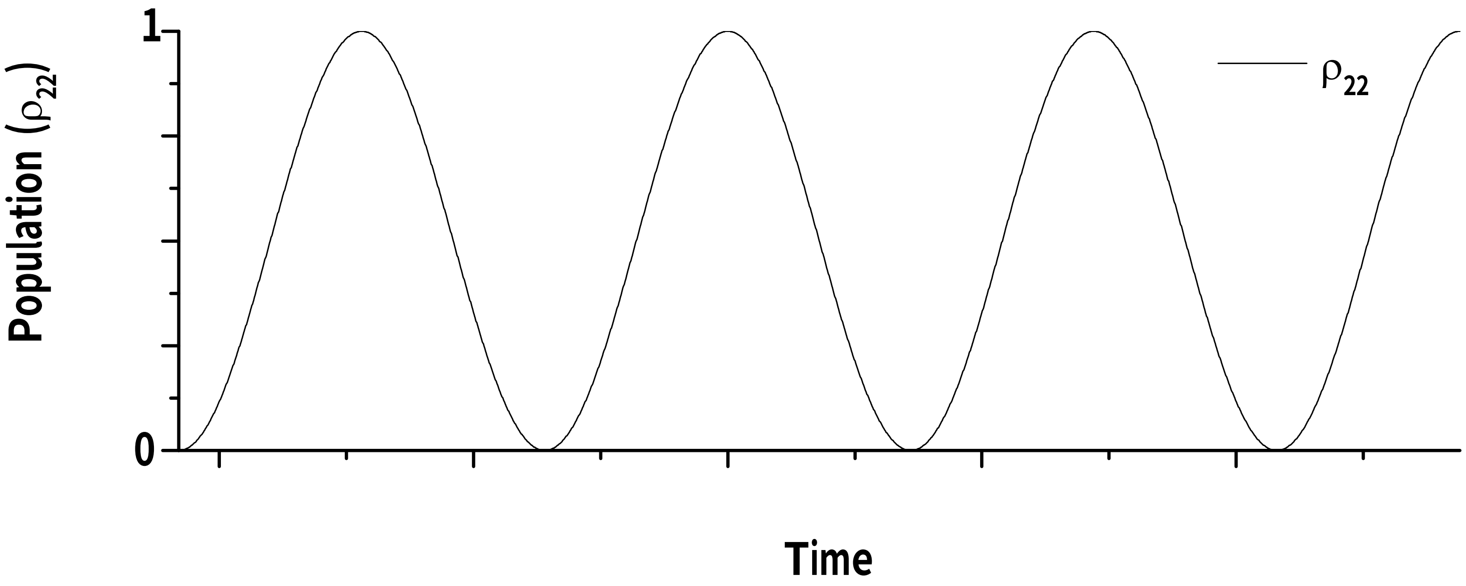
Rabi振動
電磁波と物質のコヒーレントな相互作用

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？

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



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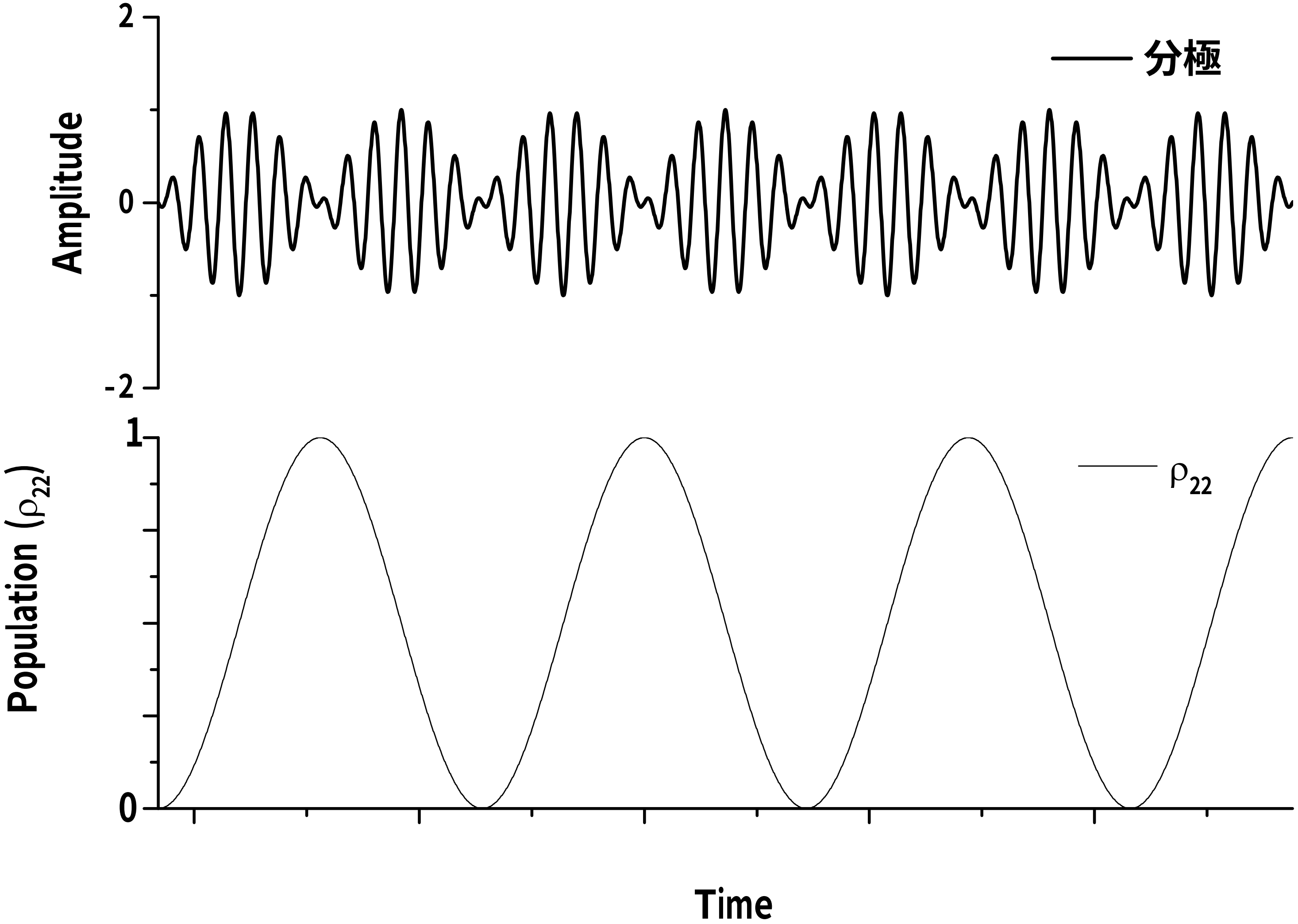


Frenkel励起子の振動子強度

$$\text{振動子強度} \propto \left| \left\langle \Psi_g \left| \sum_i \boldsymbol{r}_i \cdot \boldsymbol{E} \right| \Psi_{\boldsymbol{K}=0} \right\rangle \right|^2$$

$$= \left| \left\langle \prod_j \phi_s(\boldsymbol{r}_j) \left| \sum_i \boldsymbol{r}_i \cdot \boldsymbol{E} \right| \frac{1}{\sqrt{N}} \sum_n \left[\phi_p(\boldsymbol{r}_n) \prod_{k \neq n} \phi_s(\boldsymbol{r}_k) \right] \right\rangle \right|^2$$

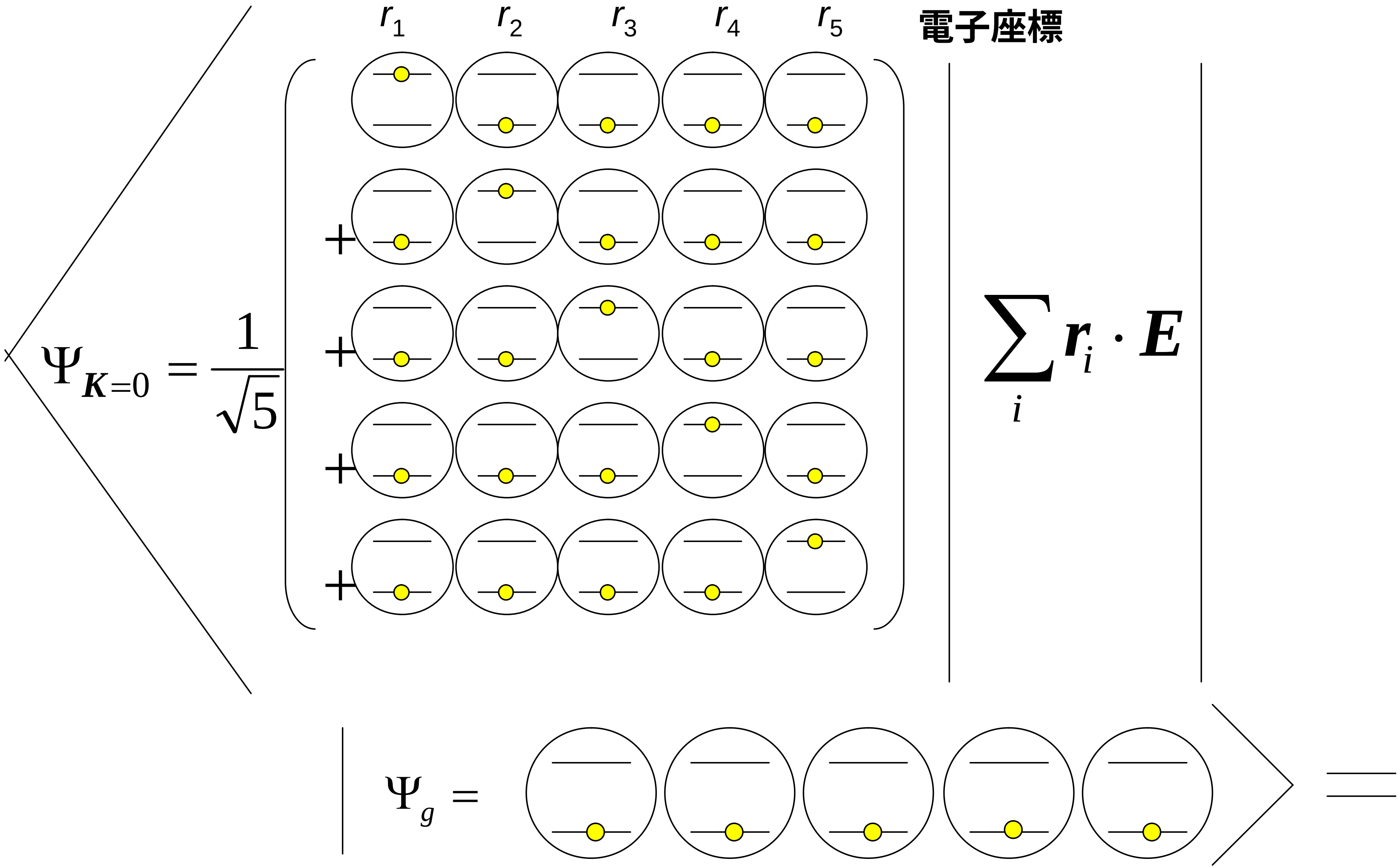
$$= \left| \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \left\langle \phi_s(\boldsymbol{r}_i) \left| \boldsymbol{r}_i \cdot \boldsymbol{E} \right| \phi_p(\boldsymbol{r}_i) \right\rangle \right|^2$$

$$= \left| \frac{1}{\sqrt{N}} N \left\langle \phi_s(\boldsymbol{r}_i) \left| \boldsymbol{r}_i \cdot \boldsymbol{E} \right| \phi_p(\boldsymbol{r}_i) \right\rangle \right|^2$$

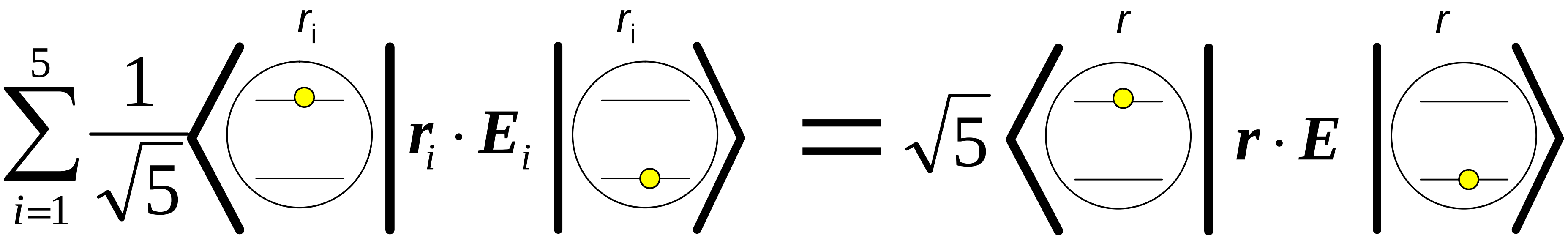
$$= N \left| \left\langle \phi_s(\boldsymbol{r}_i) \left| \boldsymbol{r}_i \cdot \boldsymbol{E} \right| \phi_p(\boldsymbol{r}_i) \right\rangle \right|^2$$

単一分子に比べてN倍に増強

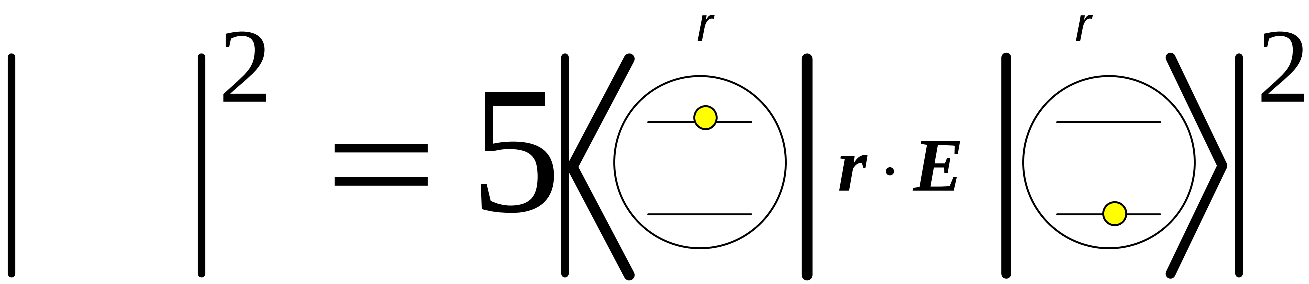
Wannier**励起子** $N \left| \left\langle \phi_s(\boldsymbol{r}_i) \left| \boldsymbol{r}_i \cdot \boldsymbol{E} \right| \phi_p(\boldsymbol{r}_i) \right\rangle \right|^2 \left| F(0) \right|^2$



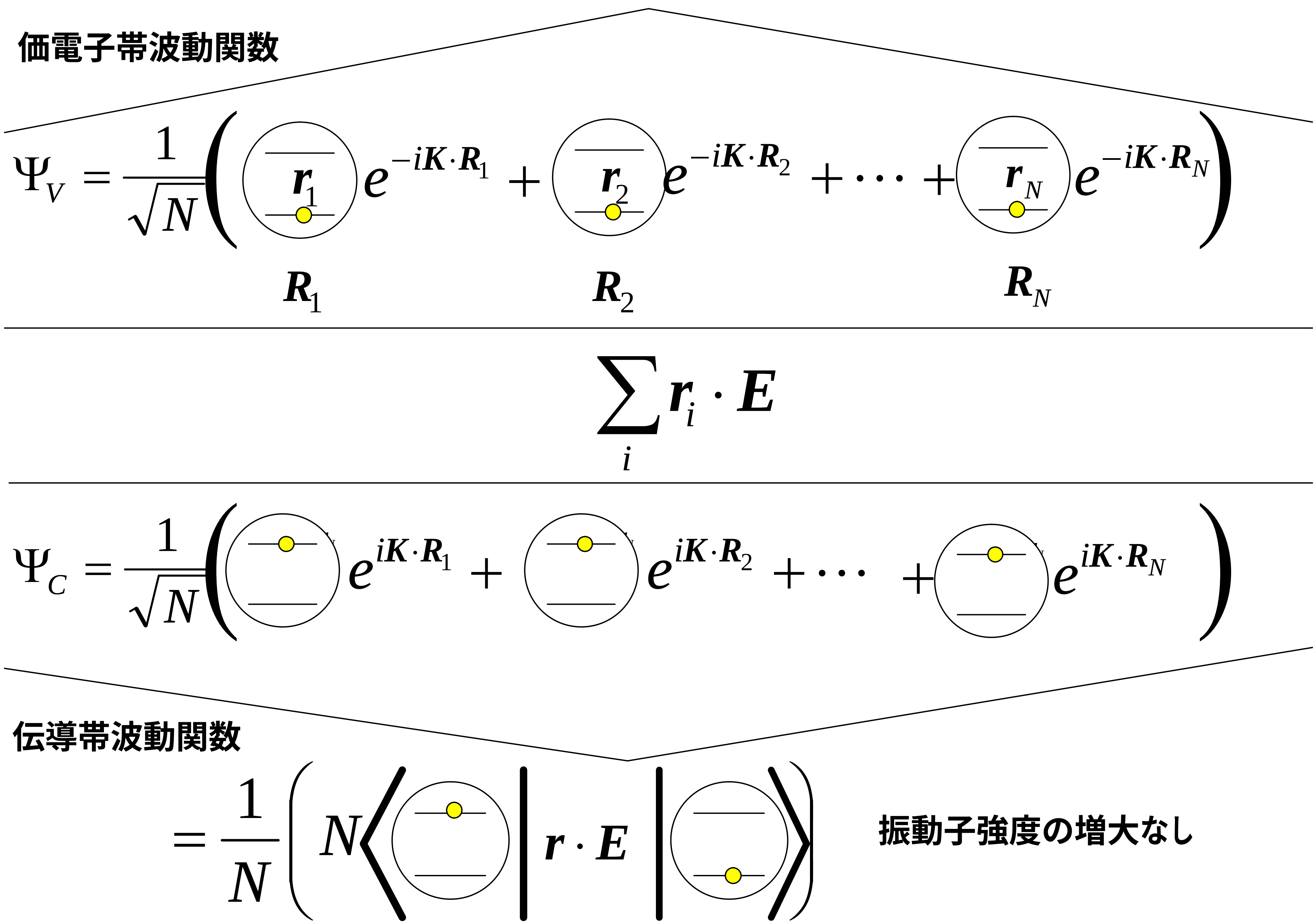
r_1 r_2 r_3 r_4 r_5
電子座標
$\Psi_{K=0} = \frac{1}{\sqrt{5}}$
+
+
+
+
$\sum_i \boldsymbol{r}_i \cdot \boldsymbol{E}$
$\Psi_g =$



5
i=1
1
√5
r_i
r_i · E_i
r_i
= √5
r
r · E
r



2
= 5
r
r · E
r
2



価電子帯波動関数
$\Psi_V = \frac{1}{\sqrt{N}}\left(\boldsymbol{r}_1 e^{-i\boldsymbol{K}\cdot\boldsymbol{R}_1} + \boldsymbol{r}_2 e^{-i\boldsymbol{K}\cdot\boldsymbol{R}_2} + \cdots + \boldsymbol{r}_N e^{-i\boldsymbol{K}\cdot\boldsymbol{R}_N} \right)$
$\boldsymbol{R}_1$
$\boldsymbol{R}_2$
$\boldsymbol{R}_N$
$\sum_i \boldsymbol{r}_i \cdot \boldsymbol{E}$
$\Psi_C = \frac{1}{\sqrt{N}}\left(e^{i\boldsymbol{K}\cdot\boldsymbol{R}_1} + e^{i\boldsymbol{K}\cdot\boldsymbol{R}_2} + \cdots + e^{i\boldsymbol{K}\cdot\boldsymbol{R}_N} \right)$
伝導帯波動関数
$= \frac{1}{N}\left(N \langle \; | \boldsymbol{r}\cdot\boldsymbol{E} | \; \rangle \right)$
振動子強度の増大なし