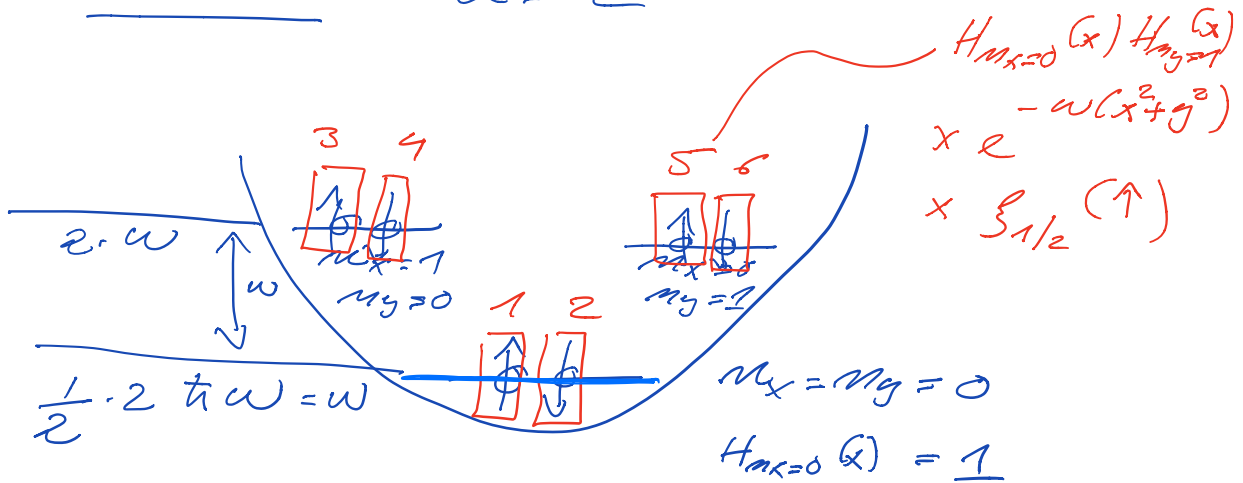


$$\underline{N=6} \quad d=2$$



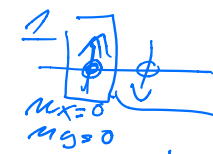
$$E_{m_x m_y} = \hbar \omega \left(m_x + m_y + \frac{d}{2} \right)$$

In code

- 1) set up various basis functions
 (6) \rightarrow 3 different spatial wf
 $- (x^2 + y^2)$
 1) $H_{m_x=0} H_{m_y=0} \underline{e}$
 2) $H_{m_x=1} H_{m_y=0} -1 -$
 3) $H_{m_x=0} H_{m_y=1} -1 -$
- 2) set up various 1st derivatives
 - quantum force
 - local energy
- 3) set up various 2nd derivatives
 - local energy

use wave functions,

$$N=2$$



The diagram shows a box with two particles. The first particle has an arrow pointing up, labeled $m_x=0$ and $m_y=0$. The second particle has an arrow pointing down. To the right, there are labels \vec{r}_1, \vec{s}_1 and \vec{r}_2, \vec{s}_2 with arrows pointing to the corresponding terms in the wave function.

$$\psi(\vec{r}_1, \vec{r}_2, \vec{s}_1, \vec{s}_2) = \frac{1}{\sqrt{2!}} \begin{vmatrix} \varphi_1 x_{\uparrow}(1) & \boxed{\varphi_1 x_{\uparrow}(2)} \\ \varphi_1 x_{\downarrow}(1) & \varphi_1 x_{\downarrow}(2) \end{vmatrix}$$

$$\varphi_1(\vec{r}_2) = H_{m_x=0}(x_2) H_{m_y=0}(y_2) \times e^{-\alpha(x_2^2 + y_2^2)}$$

$$= \frac{1}{\sqrt{2}} \left[\underline{\varphi_1 x_{\uparrow}(1)} \varphi_1 x_{\downarrow}(2) - \varphi_1 x_{\downarrow}(1) \varphi_1 x_{\uparrow}(2) \right]$$

$$\langle \psi | H | \psi \rangle$$

$$H = \sum_{i=1}^2 \left(-\frac{1}{2} \nabla_i^2 + \frac{1}{2} k(x_i^2 + y_i^2) \right) + \sum_{i' < j}^2 V(r_{i'j})$$

$$\hat{h}_0(\vec{r}_i) \varphi_{\alpha}(\vec{r}_i) = \epsilon_{\alpha} \varphi_{\alpha}(\vec{r}_i)$$

$$\begin{aligned} \langle \beta | \hat{h}_0 | \alpha \rangle &= \int d\vec{r} \varphi_{\beta}^*(\vec{r}) \hat{h}_0(\vec{r}) \varphi_{\alpha}(\vec{r}) \\ &= \epsilon_{\alpha} \delta_{\alpha\beta} \end{aligned}$$

$$\langle \tilde{\beta} | \hat{H}_0 | \tilde{\alpha} \rangle =$$

$$|\tilde{\alpha}\rangle = \varphi_{\alpha}(\vec{r}_i) \chi_{m_{s_i}}(s_i) \quad \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \uparrow$$

$$|\tilde{\beta}\rangle = \varphi_{\beta}(\vec{r}_i) \chi_{m_{s_i}}(s_i) \quad \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \downarrow$$

$$\rightarrow \sum_{\alpha} \delta_{\alpha\beta} \cdot (0 \ 1) \begin{pmatrix} 1 \\ 0 \end{pmatrix} = 0$$

$$\langle 4 | \hat{H}_0 | 4 \rangle =$$

$$\frac{1}{2} \sum_{s_1, s_2} \int d\vec{r}_1 \int d\vec{r}_2 \left[\underbrace{\varphi_1^* \chi_{\uparrow}(1)}_{\text{①}} \underbrace{\varphi_2^* \chi_{\downarrow}(2)}_{\text{②}} - \underbrace{\varphi_1^* \chi_{\downarrow}(1)}_{\text{③}} \underbrace{\varphi_2^* \chi_{\uparrow}(2)}_{\text{④}} \right] \left[\underbrace{\hat{H}_0(\vec{r}_1)}_{\text{⑤}} + \underbrace{\hat{H}_0(\vec{r}_2)}_{\text{⑥}} \right]$$

$$\begin{array}{ccccccc} \text{①} & + & 0 & + & 0 & & \text{④} \\ \text{②} & & \text{③} & & & & \end{array} \quad \begin{array}{c} \text{⑤} + \dots + \text{⑥} \\ = \frac{1}{2} (2\varepsilon_1 + 2\varepsilon_2) \end{array}$$

$$= \frac{\varepsilon_1 + \varepsilon_2}{2}$$

$$\langle 4 | \sum_{i < j} \sigma(\tau_{ij}) | 4 \rangle$$

$$= \langle 12 | \sigma(12) - \sigma(12/21) \rangle$$

$$= \dots$$