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1 Equations

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$$\hat{H} = \hat{K} + g\hat{V} \quad (1)$$

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$$\hat{H} = \sum_x \sum_{p,p'} h_{p'}^p(x) \hat{e}_{p'}^p(x) + g \sum_{x \neq y} \sum_{p,p',q,q'} V_{p'q'}^{pq}(x,y) \hat{e}_{p'}^p(x) \hat{e}_{q'}^q(y) \quad (2)$$

$$\equiv \sum_x \sum_{p,p'} \hat{h}_{p'}^p(x) + g \sum_{x \neq y} \sum_{p,p',q,q'} \hat{V}_{p'q'}^{pq}(x,y) \quad (3)$$

$$(4)$$

$$\hat{e}_{p'}^p(x) = |p\rangle \langle p'| (x) \quad (5)$$

$$\hat{e}(x) = (\cos(\varphi), \sin(\varphi)) \quad (6)$$

$$\hat{H} = \sum_{i=1}^N \hat{h}_i + g \sum_{i=1}^{N-1} [\hat{e}_i \hat{e}_{i+1} + g(1 - 3 \cos \gamma)(\hat{e}_i \hat{r})(\hat{e}_{i+1} \hat{r})] \quad (7)$$

$$\langle p, q | \hat{V} | p', q' \rangle \quad (8)$$

$$|p - q| = |p' - q'| = 1 \quad (9)$$

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$$\dim(\hat{H}) = N \times N \quad (10)$$

$$N = \text{state}^{\text{site}} \quad (11)$$

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$$M_{dense}(state^{site}) = \frac{8 (state^{site})^2}{1024^3} \quad (12)$$

$$M_{sparse}(state^{site}) = \frac{24(2state - 2)^2 state^{site-2}}{1024^3} \quad (13)$$

$$M_{dense}(state^{site}) \approx state^{2 \times site} \quad (14)$$

$$M_{sparse}(state^{site}) \approx state^{site-2} \quad (15)$$

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$$\phi : M \longrightarrow P, \quad \phi(m) = \begin{cases} 2|m+1|+1, & m < 0 \\ 2m, & m \geq 0 \end{cases} \quad (16)$$

$$M = \{-n, \dots, n\}, \quad P = \{0, \dots, 2n\} \text{ (so } N = 2n) \quad (17)$$

$$\langle \lambda, p', \mu | h | \lambda, p, \mu \rangle = \hat{h}_{p'}^p \quad (18)$$

$$\langle \lambda, p', \nu, q', \mu | V | \lambda, p, \nu, q, \mu \rangle = \hat{V}_{p'q'}^{pq} \quad (19)$$

$$(20)$$

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$$\hat{H} = \sum_x \sum_{p,p'} h_{p'}^p(x) \hat{e}_{p'}^p(x) + g \sum_{x \neq y} \sum_{p,p',q,q'} V_{p'q'}^{pq}(x,y) \hat{e}_{p'}^p(x) \hat{e}_q^q(y) \quad (21)$$

$$\equiv \sum_x \sum_{p,p'} \hat{h}_{p'}^p(x) + g \sum_{x \neq y} \sum_{p,p',q,q'} \hat{V}_{p'q'}^{pq}(x,y) \quad (22)$$

$$(23)$$

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$$\hat{D}_1 = D_{p'}^p = \sum_{\lambda, \mu} C_{(\lambda, p, \mu)}^* C_{(\lambda, p', \mu)} \quad (24)$$

$$\hat{D}_1 \psi_i = N_i \psi_i, \quad 0 \leq N_i \leq 1 \quad (25)$$

$$f : \mathbb{R} \longrightarrow \mathbb{R}, \quad f(x) = x^2 \quad (26)$$

$$U_{NO} = [\psi_1 \ \psi_2 \ \cdots \ \psi_n] \quad (27)$$

$$\hat{\mathbf{h}} = U_{NO}^\dagger \cdot \hat{V} \cdot U_{NO} \quad (28)$$

$$\hat{V} = (U_{NO} \otimes U_{NO})^\dagger \cdot \hat{V} \cdot (U_{NO} \otimes U_{NO}) \quad (29)$$

$$\hat{H} = \sum_x \sum_{p,p'} \hat{h}_{p'}^p(x) + g \sum_{x < y} \sum_{p,p',q,q'} \hat{V}_{p'q'}^{pq}(x,y) \quad (30)$$

$$(31)$$

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$$\hat{D}_1 = D_{p'}^p = \sum_{\lambda, \mu} C_{(\lambda, p, \mu)}^* C_{(\lambda, p', \mu)} \quad (32)$$

$$\lambda_1, \lambda_2 \approx 0.495081, 0.495081 \quad (33)$$

$$\mathbf{v}_1 = \begin{pmatrix} -9.770 \times 10^{-1} \\ 0 \\ 0 \\ 1.507 \times 10^{-1} \\ 1.507 \times 10^{-1} \\ 0 \\ 0 \\ -1.727 \times 10^{-3} \\ -1.727 \times 10^{-3} \\ 0 \\ 0 \end{pmatrix}, \quad \mathbf{v}_2 = \begin{pmatrix} 0 \\ -8.765 \times 10^{-4} \\ 8.765 \times 10^{-4} \\ 0 \\ 0 \\ 3.192 \times 10^{-5} \\ -3.192 \times 10^{-5} \\ 0 \\ 0 \\ -1.509 \times 10^{-7} \\ 1.509 \times 10^{-7} \end{pmatrix}. \quad (34)$$

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$$(-1) \frac{d}{d\tau} |\Psi(\tau)\rangle = \hat{H} |\Psi(\tau)\rangle \quad (35)$$

$$|\Psi(\tau)\rangle = e^{\hat{T}(\tau)} |0\rangle \quad (36)$$

$$(-1) \frac{dt_\lambda}{d\tau} = R_\lambda \quad (37)$$

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$$\hat{h}_{p'}^p(0) = \hat{h}_{p'}^p(x) \quad 0 \leq x \leq N_{sites} \quad (38)$$

$$\hat{V}_{p'q'}^{pq}(0, 1) = \hat{V}_{p'q'}^{pq}(x, x+1) \quad 0 \leq x \leq N_{sites} - 1 \quad (39)$$

$$\hat{V}_{p'q'}^{pq}(x, y) = \hat{V}_{p'q'}^{pq}(y, x) \quad 0 \leq x, y \leq N_{sites}, |x - y| = 1 \quad (40)$$

$$(41)$$

$$Rt_{ij}^{ab}(x < y) = Rs_{ij}^{ab}(x < y) + Rn_{ij}^{ab}(x, y) + Rn_{ij}^{ab}(y, x) \quad (42)$$

$$= Rs_{ij}^{ab}(x < y) + 2 \times Rn_{ij}^{ab}(x, y) \quad (43)$$

$$(44)$$

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$$D(\text{state}, \text{site}) = \frac{E_{\text{state}}}{E_{\text{site}}} = \frac{\text{site}}{\ln(\text{state})}. \quad (45)$$

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$$A_p^a(x) A_q^b(y) V_{cd}^{pq}(x, y) t_{ij}^{cd}(x, y) \longrightarrow A_p^a(x) A_q^b(y) V_{cd}^{pq}(x, y) t_{ij}^{cd}(x, y) \longrightarrow AA_{Q=pq}^{B=ab}(x, y) V_C^Q(x, y) t^C(x, y)$$