$$H_{izing} = \underbrace{J\sum \sigma_i^z \sigma_{i+1}^z + 2B\sum \sigma_i^x}\ ; \quad H_{t-b} = (\psi_{i+1}^+ \psi_i + h.c)\,\tau$$

$$H = \sum_Z H_Z$$

$Z_i = \{\cdot\ \cdot\}_{i\ i+1}$ | $Z = \{\cdot\ \cdot\}$, $\{\cdot\}$

$$H = \sum_i \sigma_i^z \sigma_{i+1}^z + 2B\sigma_i^x$$

пусть $\forall i: \sum_{X \ni i} \|H_X\|\, e^{\mu |X|}\, |X| \leq S \quad (*)$

Тогда $\left|[A_t^X, B]\right| \leq \|A\|\,\|B\|\, e^{-\mu\, dist(X,Y)} \left(e^{2S|t|} - 1\right)$

$$\sup \frac{|H|\psi\rangle|}{\langle\psi|\psi\rangle}$$

$$H_{1,2} = \begin{pmatrix} J & B & B & 0 \\ B & -J & 0 & B \\ B & 0 & -J & B \\ 0 & B & B & J \end{pmatrix}$$

$$\|H\| = \sqrt{J^2 + 4B^2}$$

$(\cdot\ \cdot)$
$(\cdot\ \cdot)$
$i$

$$4\,\|H\|\, e^{2\mu} \leq S$$

$$V_{LR} \leq \frac{2S}{\mu} \qquad S = 4e^{2\mu}|H|$$

$$\mu = \frac{1}{2} \qquad V_{LR} \leq 4\,\|H\| \cdot e$$

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$$H_{t-b} = \tau(\psi_{i+1}^+ \psi_i + h.c) = \tau\sum \psi_p^+ \psi_p \underbrace{\cos p}_{\varepsilon_p}$$

$$\psi(x,t) = \int e^{ipx + i\varepsilon t}\psi_p$$

$$\{\psi^+(t), \psi(0)\} = \underbrace{\int_0^{2\pi} e^{i\varepsilon_p t + ipx}\, dp}_{} = D(x,t)$$

$\varepsilon \sim \underline{pv}$

$\underline{\delta(x - vt)}$

$\varepsilon_p = \cos p$

$\Downarrow$

$x \sim vt$

$$D(x,t) = J_x(t) \overset{x \gg t > 0}{\approx} \frac{t^x}{\Gamma(\frac{x}{2})} \approx e^{-x \ln \frac{x}{t}}$$

$x > V_{LR}t$

$$\|[A_t', B]\| \leq t\, \|A\|\,\|B\|\, g(dist(X,Y))$$

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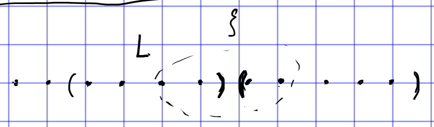



B Law | VL

$\rho = \max(2^L; 2^L)$

$N(L)$

$N(2L) = 2N(L) + \xi$ | $N(2L) = N(L)^2 + 2N(L)$

$N(L) \approx \underline{cL} - \xi$ | $N(L) \sim e^L$

---

1) proved : Area Law
MPS is good

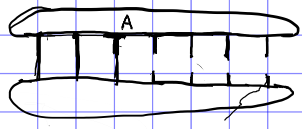
$\Psi_{\alpha\beta}|\alpha\rangle|\beta\rangle$ $\quad$ $\rho = \sum_{\alpha\gamma}\sum_{\beta}^{N} \Psi_{\alpha\beta}\bar{\Psi}_{\beta\gamma}\,|\alpha\rangle\langle\gamma|$ $\quad$ $( \quad )$ $(\cdot)$

чистое $\quad$ $\Psi_{\alpha\beta} = \xi_\alpha x_\beta$ ; $\rho = \sum \bar{x}_\alpha x_\beta |\beta\rangle\langle\alpha|$

$$S = \mathrm{tr}\,\rho \ln \rho = \sum_{1}^{N} \lambda_i \ln \lambda_i \le \sum \lambda_i \ln N \approx \ln N$$

Кол-во "важных состояний" = $e^{S}$

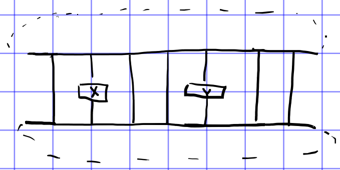
$$|\Psi_A\rangle = \sum_s \mathrm{tr}\left(A^{s_1}_{\alpha_1\alpha_2} A^{s_2}_{\alpha_2\alpha_3} \dots A^{s_N}_{\alpha_{N-1},\alpha_N}\right)|\varepsilon^1, \dots \varepsilon^N\rangle$$




$D \times D$

$S = \ln D$

$$I = \sum A^i \bar{A}^i \qquad D \times D$$




$\left(\sum_i \mathrm{tr}(A^i \bar{B}^i)\right)^N$

$\mathrm{tr}(A^i \bar{A}^i) = 1$

$D \times D$

$H$ $\qquad$ $E = \dfrac{\langle\Psi_A|H|\Psi_A\rangle}{|\Psi_A|^2} \to \min$

$\|(H - E)|\Psi\rangle\| = \varepsilon$