$H(t) = \sum_{i<j} h_{ij}(t) \|h_{ij}(t)\| \leq 1/r_{ij}^{\alpha} \|[A(t), B]\| ABXYXY |X|, |Y| = \emptyset 1 t_{si} XYt\delta = \Theta(1) ABXY \|[A(t), B]\| > \delta$**?**

$\ddot{}_0$??????????

?????????*non-unitarily*?????

a priori?dt?$t = Ø1$?$t = rr$?$\rho d\rho/dt = (\rho)$

$1/r^{\alpha} r \alpha > 0$???????

???

$\alpha > 2d$?> 3??

$Ł(t) \Lambda \mathcal{H} \mathcal{B}(\mathcal{H}) \mathcal{H} O \in \mathcal{B}(\mathcal{H}) \langle O(t) \rangle = [O(t)\rho] = [O\rho(t)] \rho \ddot{o} \rho(t) = e^{Łt} \rho O O(t) = e^{Ł^{\dagger} t} O Ł^{\dagger} Ł^{\dagger} O = +i[H, O] + \sum_i \left[L_i^{\dagger} O L_i - \frac{1}{2}\{L_i^{\dagger}\right.$

HL_i

$ŁŁ = \sum_{Z \subset \Lambda} Ł_Z i, j \sum_{Z \ni i,j} \|Ł_Z\|_{\infty} \sup_{O \in \mathcal{B}(\mathcal{H})} \frac{\|Ł_Z O\|}{\|O\|} \leq \frac{1}{dist(i,j),} \| \cdot \| \infty \| \cdot \|_{\infty} \infty \infty \infty dist(i,j) ij$

??$> dA \in \mathcal{B}(X) X K_Y \in L_Y Y e^{Ł^{\dagger} t}{}_Y(e^{Ł^{\dagger} t} A) \leq C \|K_Y\|_{\infty} A X Y \left(\frac{e^{vt} - 1}{r^{\alpha}} \right), r d(X,Y) C v Ø 1 K_Y K_Y(O_X) = i[O_X, O_Y] \|K_Y\|_{\infty} 2$

$v \propto 2 \infty$?${}_Y(e^{Ł^{\dagger} t} A) \leq C \|K_Y\|_{\infty} A X Y \left(\frac{e^{vt}}{[(1-\mu) r]^{\alpha}} \right.$

$\left. + e^{vt - \mu r} \right), \mu \in (0,1) v v$?$k$??$\leq d$?$N \Lambda J J = N^{1-/d} < dJ = \log N = d$??${}_Y(e^{Ł^{\dagger} t} A) \leq C \|K_Y\|_{\infty} A X Y \left(\frac{e^{Jt} - 1}{J r^{\alpha}} \right) . N$

$> 2d$

$> 2d$?${}_Y(e^{Ł^{\dagger} t} A) \leq C \|K_Y\|_{\infty} A \frac{t^{\alpha - d}}{r^{\alpha - 2d}}.$

$t = r^{\frac{-2d}{-d}}$

$d = 1 > 3 > 3d = 1$?$1/r 1/r^{\alpha - 2}$?$H = \sum_{ij} H_{ij}{}^{iHt} A e^{-iHt}, B] \leq CAB \frac{t}{r}, B \in \mathcal{B}(Y) Y Ł = \sum_{ij} Ł_{ijY}(e^{Ł^{\dagger} t} A) \leq C K_{Y \infty} A \frac{t}{r^{\alpha - 2 - o}}$

$Ł^{\dagger} A X \in r X \in_t runcated).$

$A X Ł^{\dagger} Ł^{\dagger} r X C(r,t)$

$AX \in ŁŁ r X \tilde{A}(t) A Ł^{\dagger} A(t) \tilde{A}(t) \|A(t) - \tilde{A}(t)\| \leq K \|A\| \mathcal{C}(r,t), K \mathcal{C}(r,t) r \alpha > d$

$\leq dN || r \propto N^{1/d}$

${}_t runcated. {}_t runcated follows straight forwardly from the open - system Lieb - Robinson bounds detailed in sec: open - LR. In$

$Ł\lambda$

$\lambda > 0 Ł$*primitive*$Ł$

$Ł s \sigma \Gamma_s Ł^{\dagger} = Ł \Gamma_s \Gamma_s \Gamma_s(f) = (\sigma^s f \sigma^{1-s} + \sigma^{1-s} f \sigma^s)/2 s \in [0,1] s \sigma Ł Ł^{\dagger}(I) = 0 s s L_i H = 0$?$\bar{H}[\bar{H}, L_{\pm}] = \pm \omega L_{\pm} |L_-|/|L_+| = \exp$

$\rho \Lambda$*covariance correlation*$X, Y \in \Lambda_{\rho}(X : Y) := sup_{f = g = 1} |Tr[(f \otimes g)(\rho_{XY} - \rho_X \otimes \rho_Y)]|, f g f X g Y \rho_X \rho X X Y$

?σ

fg

$f_t g_t f g Ł^{\dagger}$*static*

s??

$\lambda Ł f_t, g_t$

$[\sigma f_t] = [\sigma f] f_{\sigma}(f, g) - Cov_{\sigma}(f_t, g_t)|$

$= \frac{1}{2}(|[(fg - f_t g_t)\sigma] + [(gf - g_t f_t)\sigma]|)$

$= \frac{1}{2}(|[((fg)_t - f_t g_t)\sigma] + [((gf)_t - g_t f_t)\sigma]|)$

$\leq \frac{1}{2}(\|(fg)_t - f_t g_t\| + \|(gf)_t - g_t f_t\|)$

$\leq K f g \mathcal{C}(r,t), r d(X,Y) \mathcal{C}(r,t)_t runcated. Specifically, we use the following Lemma, which is itself a restatement of Corollary 7 in$

$f, g X Y d \Lambda Ł s \sigma \lambda c > 0 \lambda, v$

t

$\lambda' = 2\lambda, K' = K/4$

$\mathcal{C}(r,t) dh/dt = 0_c orr_m inimization leads to a minimum at time \bar{t} = -\left(\frac{1}{\lambda' + v}\right) \log\left(\frac{K' v}{\lambda r^{\alpha - d}}\right). (9) \bar{t}) = \left(\frac{K' v}{\lambda' r^{\alpha - d}}\right)^{\frac{\lambda'}{\lambda' + v}} + \frac{K'}{r^{\alpha - d}} \left(\frac{K}{\lambda' r}\right.$

$\leq c \left(r^{\alpha - d}\right)^{\frac{-2\lambda}{v + 2\lambda}} c \lambda, v, K f, g T_{\sigma}(X : Y) \alpha > d$

$t^* = 1 + \log(r^{\beta}) \mathcal{C}(r,t) \propto t^{\alpha - d + 1}/r^{\alpha - 3d} t^*) = e^{-\lambda(1 + \log(r^{\beta}))} + K \frac{(1 + \log(r^{\beta}))^{-d+1}}{r^{-3d}}$

$= \frac{e^{-\lambda}}{r^{\lambda \beta}} + K \frac{(\beta \log(r))^{-d+1}}{r^{-3d}} + Ø \frac{\log^{-d}(r)}{r^{-3d}} . \beta = (-3d)/\lambda > 3d^*) = \frac{e^{-\lambda} + K\left(\frac{\alpha - 3d}{\lambda} \log r\right)^{\alpha - d + 1}}{r^{\alpha - 3d}} + Ø \frac{\log^{-d}(r)}{r^{-3d}}$

$= K \left(\frac{-3d}{\lambda}\right)^{-d+1} \frac{\log^{-d+1}(r)}{r^{-3d}}$