$$\rho = \sum_{n=0}^{\infty} p(n)\, |n\rangle\langle n|$$

$|k_j\rangle$

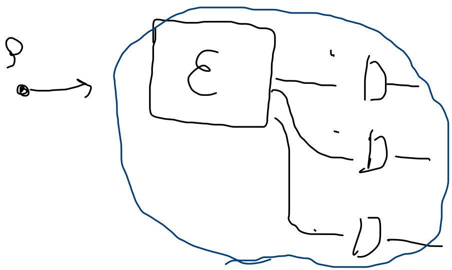
$k_1, \; k_2, \; k_3, \; \dots$

$\hat{p}(n)$

$$\langle X_{11}^{\dagger} H_2^{\dagger} |00\rangle =$$

$$= CX_{21}^{\dagger}\left[\frac{|00\rangle + |01\rangle}{\sqrt{2}}\right] =$$

$$= \frac{|00\rangle + |11\rangle}{\sqrt{2}}$$



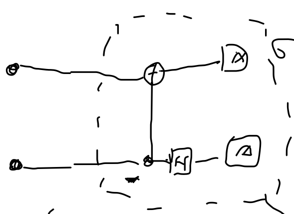
$k_1^{(1)}, \quad k_1^{(1)} \dots$

$k_1^{(2)}, \quad k_2^{(2)} \dots$

$$U = \cos\left(\frac{\theta}{2}\right) I - i \sin\frac{\theta}{2}\, \vec{n}\cdot\vec{\sigma}$$

$$U^{\dagger} = \cos\left(-\frac{\theta}{2}\right) I - i \sin\left(-\frac{\theta}{2}\right) \vec{n}\cdot\vec{\sigma}$$

$$|\psi\rangle = c_{00}|00\rangle + c_{01}|01\rangle + c_{10}|10\rangle + c_{11}|11\rangle$$



σ_z

t

"0", "1"

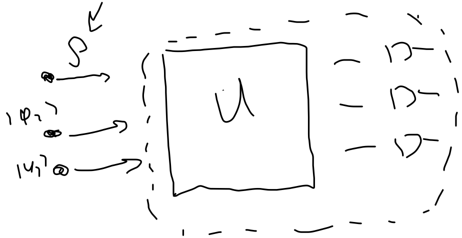
$00, \; 01, \; 10, \; 11$

$$P_{k_j} = \Big|\underbrace{\langle k_j | H_2\, CX_{21}}_{\langle \varphi_{k_j}|}|\psi\rangle\Big|^2$$

$$\Rightarrow |\varphi_{k_j}\rangle = CX_{21}^{\dagger} H_2^{\dagger} |k_j\rangle$$

$$(AB)^{\dagger} = B^{\dagger} A^{\dagger}$$

$$\big[|x\rangle\big]^{\dagger} = \; = \langle x|$$



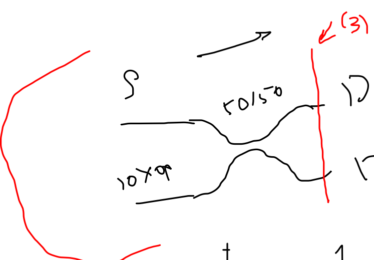
$$U a_j U^\dagger = \sum_k M_{jk} a_k$$

$$U a_j^\dagger U^\dagger = \left[\left(U a^\dagger U^\dagger\right)^\dagger\right]^\dagger = \left[\underbrace{U a U^\dagger}\right]^\dagger =$$

$$= \left[\sum_k M_{jk} a_k\right]^\dagger = \sum_k M_{jk}^* a_k^\dagger$$

$(n_1^{(1)}, n_2^{(1)}), (n_1^{(2)}, n_2^{(2)})$

$$P_{123}(n_1, n_2, n_3) = \underbrace{\langle n_1 n_2 n_3| U}\left[\rho_\theta \otimes |\varphi_2\rangle\langle\varphi_2| \otimes \underline{|\varphi_3\rangle\langle\varphi_3|}\right] \underbrace{U^\dagger |n_1 n_2 n_3\rangle}_{|\varphi_{n_1 n_2 n_3}\rangle}$$



$p(n_1, n_2)$

$$\underline{U = \exp\left[\frac{\pi}{4}\left(a_1^\dagger a_2 - a_1 a_2^\dagger\right)\right]}$$

$U a U^\dagger$ $\quad U U^{-1}$ $\quad U U^\dagger$

$$U^\dagger(\hat n_1 \hat n_2) U = U^\dagger\left(a_1^\dagger a_1 a_2^\dagger a_2\right) U =$$

$$(-a_1^\dagger + a_2^\dagger)(-a_1 + a_2) =$$

$$= \frac{1}{4}(a_1^\dagger + a_2^\dagger)(a_1 + a_2)$$

$$\underline{= \frac{1}{4}\left(a_1^\dagger a_1 + a_1^\dagger a_2 + a_2^\dagger a_1 + a_2^\dagger a_2\right)\left(+a_1^\dagger a_1 - a_1^\dagger a_2 - a_2^\dagger a_1 + a_2^\dagger a_2\right)}$$

$$U a_1 U^\dagger = \frac{1}{\sqrt{2}}(a_1 + a_2)$$

$$U a_2 U^\dagger = \frac{1}{\sqrt{2}}(-a_1 + a_2)$$

$$M = \frac{1}{\sqrt{2}}\begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix}$$

$$|n\rangle = \frac{(a^\dagger)^n}{\sqrt{n!}}|0\rangle$$

$$U^\dagger |n_1 n_2\rangle = \frac{1}{\sqrt{n_1! n_2!}} \underbrace{U^\dagger (a_1^\dagger)^{n_1} (a_2^\dagger)^{n_2} U}\, \underbrace{U^\dagger |00\rangle}_{|00\rangle}$$

$$|00\rangle = |00\rangle$$

$$|10\rangle = U^\dagger a_1^\dagger U |00\rangle = \frac{a_1^\dagger + a_2^\dagger}{\sqrt{2}}|00\rangle = \frac{|10\rangle + |01\rangle}{\sqrt{2}}$$

$$|01\rangle = \ldots \frac{-|10\rangle + |01\rangle}{\sqrt{2}}$$

$$a^\dagger |n\rangle = \sqrt{n+1}\,|n+1\rangle$$

$$|11\rangle = \frac{1}{2}\left(a_1^\dagger + a_2^\dagger\right)\left(-a_1^\dagger + a_2^\dagger\right)|00\rangle =$$

$$= \frac{1}{2}\left(-a_1^\dagger a_1^\dagger - \cancel{a_2^\dagger a_1^\dagger} + \cancel{a_1^\dagger a_2^\dagger} + a_2^\dagger a_2^\dagger\right)|00\rangle =$$

$$= \frac{1}{\sqrt{2}}\left(-|20\rangle + |02\rangle\right)$$

$$(a_1^\dagger)(a_1^\dagger)|0\rangle =$$

$$= a_1^\dagger |1\rangle = \sqrt{2}\,|2\rangle$$

$$\langle n_1 n_2 \rangle = \mathrm{Tr}\left(n_1 n_2 \; U(\rho \otimes |0\rangle\langle 0|) U^\dagger \right) =$$

$$= \mathrm{Tr}\left(\underbrace{U^\dagger n_1 n_2 U \; \rho \otimes |0\rangle\langle 0|}_{} \right)$$

$$\langle 0| a^\dagger = 0$$

$$U^\dagger n_1 n_2 U = U^\dagger a_1^\dagger a_1 a_2^\dagger a_2 a_1 \quad a_1$$

$$(\;)(a_1^\dagger a_1 - a_2^\dagger a_1) |0\rangle$$

$$(\;)(\cancel{a_1^\dagger a_1} - \cancel{a_1^\dagger a_2} - a_2^\dagger a_1 + \cancel{a_2^\dagger a_2}) |0\rangle \rightarrow$$

$$\langle 0| (a_1^\dagger a_1 + a_1^\dagger a_2 + \cancel{a_2^\dagger a_1} + \cancel{a_2^\dagger a_2}) (\;) (\underbrace{a_1^\dagger a_1}_{n_1} - a_2^\dagger a_1) = \frac{1}{4} \left(n_1 n_1 - n_1 \cancel{a_2^\dagger a_1} + \cancel{a_2^\dagger a_2} n_1 - a_1^\dagger a_2 a_2^\dagger a_1 \right) |0\rangle$$

$$\langle 0| \quad + \cancel{a_1^\dagger a_2} n_1 +$$

$$\frac{1}{4} \left(\underbrace{a_1^\dagger a_1}_{n_1} + a_1^\dagger a_2 \right) \rightarrow \frac{1}{4} \left(n_1 n_1 - n_1 [\cancel{a_2^\dagger a_2} + I_2] \right) \rightarrow$$

$$- a_1^\dagger \underbrace{a_2 a_2^\dagger}_{} a_1 \Big)$$

$$\rightarrow \frac{1}{4} n_1 (n_1 - I)$$

$$= \frac{1}{4} \left(n_1 n_1 - a_1^\dagger \underbrace{a_2 a_2^\dagger}_{} a_1 \right.$$

$$[a, a^\dagger] = I \qquad \underline{a a^\dagger} - a^\dagger a = I$$

$$a a^\dagger = I + a^\dagger a$$

$$\langle n_1 n_2 \rangle = \mathrm{Tr}\left(n_1 n_2 \; U (\rho \otimes |0\rangle\langle 0|) U^\dagger \right) =$$

$$= \mathrm{Tr}\left(U^\dagger n_1 n_2 U \; \rho \otimes |0\rangle\langle 0| \right)$$

$$\langle 0| a^\dagger = 0$$

$$U^\dagger n_1 n_2 U = U^\dagger a_1^\dagger a_1 a_2^\dagger a_1 \, a_1$$

$$(\;)(a_1^\dagger a_1 - a_2^\dagger a_1)|0\rangle$$

$$(\;)(a_1^\dagger a_1 - \cancel{a_1^\dagger a_2} - a_2^\dagger a_1 + \cancel{a_2^\dagger a_2})|0\rangle$$

$$\langle 0|(a_1^\dagger a_1 + a_1^\dagger a_2 + a_2^\dagger a_1 + a_2^\dagger a_2)(\;)$$

$$(\underbrace{a_1^\dagger a_1}_{n_1} - a_2^\dagger a_1) = \frac{1}{4}\Big(n_1 n_1 - n_1 a_2^\dagger a_1 + a_1^\dagger a_2 n_1 - a_1^\dagger a_2 a_2^\dagger a_1 \Big)|0\rangle$$

$$\langle 0| \quad + \cancel{a_1^\dagger a_2 n_1} - a_1^\dagger a_2 a_2^\dagger a_1$$

$$\frac{1}{4}\left(\underbrace{a_1^\dagger a_1}_{n_1} + a_1^\dagger a_2 \right)(\;)$$

$$\frac{1}{4}\left(n_1 n_1 - n_1 [a_2^\dagger a_2 + I_2] \right) \rightarrow$$

$$\frac{1}{4}\left(a_1^\dagger a_1 \quad a_1 \right) \longrightarrow \frac{1}{4}\left(n_1 n_1 - n_1(n_1 - I) \right)$$

$$\longrightarrow \frac{1}{4} \; n_1$$

$$= \frac{1}{4}\left(n_1 n_1 - a_1^\dagger a_2 a_2^\dagger a_1 \right.$$

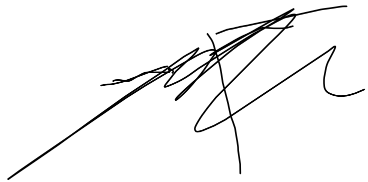
$$[a, a^\dagger] = I \qquad a a^\dagger - a^\dagger a = I$$

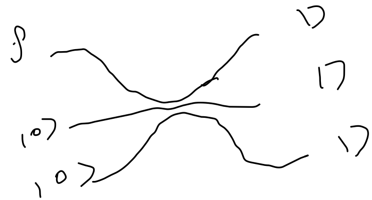
$$a a^\dagger = I + a^\dagger a$$

$$Tr(\hat{n}(\hat{n}-1)\rho) = \langle n(n-1)\rangle$$

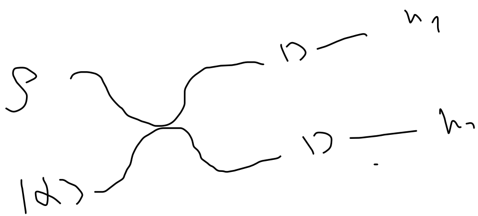
$$g^{(2)} = \frac{\langle n(n-1)\rangle}{\langle n\rangle^2}$$

$g^{(3)}$





$$\langle n_1 n_2 n_3\rangle \rightarrow \langle n(n-1)(n-2)\rangle_\rho$$



$$\langle \widehat{n_1 - n_2} \rangle = \langle x_\theta \rangle = \langle \hat{x}\cos\theta + \hat{p}\sin\theta \rangle$$

$$\hat{x} = \frac{1}{\sqrt{2}}(a^\dagger + a)$$

$$\hat{p} = \frac{i}{\sqrt{2}}(a^\dagger - a)$$

$x_{\theta,1}$ $x_{\theta,2}$

$$a_2^\dagger |\alpha\rangle = \alpha^* |\alpha\rangle$$

$$\underline{a_2 |\alpha\rangle = \alpha |\alpha\rangle}$$

$$a_2^\dagger a_2 |\alpha\rangle = \frac{1}{\alpha}\left(a_2 a_2^\dagger - I\right)|\alpha\rangle$$

$$|\alpha+1\rangle \to (a_2^\dagger |\alpha\rangle = a_2^\dagger \frac{a_2}{\alpha} |\alpha\rangle$$

$$a_2^\dagger a_2 = a_2 a_2^\dagger - I$$

$$\alpha = |\alpha| e^{i\theta}$$

$$|\alpha\rangle = e^{-\frac{|\alpha|^2}{2}} \sum_{n=0}^{\infty} \frac{\alpha^n}{\sqrt{n!}} |n\rangle$$

$$\hat{E} = \underbrace{\hat{E}^+}_{\hat{x}} \cos(\omega t - \varphi) + \underbrace{\hat{E}^-}_{\hat{p}} \sin(\omega t - \varphi)$$

$$\rho = \sum p(n) |n\rangle\langle n|$$

$$a a^\dagger - a^\dagger a = I$$

$$a^\dagger a = a a^\dagger - I$$

$p(n)$ $\qquad G(z) = \sum_{n=0}^{\infty} p(n) z^n$

$$\frac{\partial^m}{\partial z^m} G(1) = \langle n(n-1)\dots(n-m+1)\rangle$$

$$g^{(k)} = \frac{1}{\mu^k}\frac{\partial^m}{\partial z^m} G(1)$$

$p(0) \quad p(1)$

$d=2 \qquad N = \sum_{n=0}^{d-1} p(n) = 1-\varepsilon$

$\cancel{P_{12}(n_1, n_2)}$

$(0,0) \to 105$

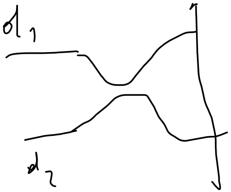
$$\begin{pmatrix} 105 & 8 \\ 9 & 12 \end{pmatrix}$$

$(0,1) \to 8$

$(1,0) \to 9$

$(1,1) \to 12$

$\overline{n_1 \cdot n_2} \quad \overline{n_1} \quad \overline{n_2}$

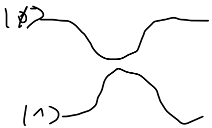


$$a_{1,nm} = \langle n | a_1 | m \rangle,$$

$$a_1 \qquad a_2$$

$$d_1 + d_2$$

$$d = 4$$



$$\frac{|02\rangle - |20\rangle}{\sqrt{2}}$$

$$\rho = \begin{pmatrix} p_0 & & & & & & & & & \\ & p_1 & & & & & & & & \\ & & p_2 & & & & & & & \\ & & & p_3 & & & & & & \\ & & & & 0 & & & & & \\ & & & & & 0 & & & & \\ & & & & & & 0 & & & \\ & & & & & & & 0 & & \\ & & & & & & & & 0 & \\ & & & & & & & & & 0 \end{pmatrix}$$

$$\rho = \sum_{n=0}^{\infty} p(n) |n\rangle\langle n|$$

$$|\rho\rangle = \sum_{n=0}^{\infty} \sqrt{p(n)}\, |n\rangle$$