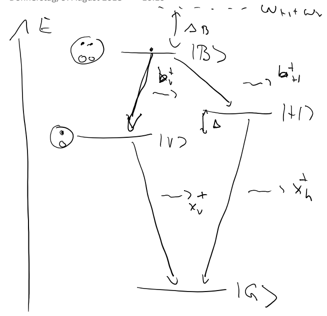
Quantum State Tomography. Julian.

Donnerstag, 9. August 2018 16:10



Biexzit-Bindungsenergie

$\Delta_B = \omega_B - (\omega_V + \omega_H)$

Fine-structure splitting

$\Delta = \Delta_{FSS} = |\omega_H - \omega_V|$

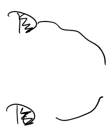
$$|\psi\rangle = c_B |B\rangle + \int dk \left(c_{Hk} |H, 1_{kH}\rangle + c_{Vk} |V, 1_{kV}\rangle \right)$$
$$+ \int dk \int dk' \left(c_{Hkk'} |G, 1_{kH}, 1_{k'H}\rangle + c_{Vkk'} |G, 1_{kV}, 1_{k'V}\rangle \right)$$

Effektive Dynamik:

$$\dot{\rho} = i[\rho, H] + \Gamma \sum_{i=H,V} \left(D[\sigma_{iB}] + D[\sigma_{Gi}] \right) \rho$$
$$\rho(0) = |B\rangle\langle B|$$

Idee: t_{xx} : B-photon, t_x : X-photon

$$|\psi\rangle_{ph} = \frac{1}{\sqrt{2}} \left(|HH\rangle + e^{i\Delta\tau} |VV\rangle \right), \quad \tau = t_x - t_{xx}$$



$$G^{(2)}_{ijkl} = N \int_0^\infty dt \int_0^\infty dt' \left\langle \sigma_{Bi}(t)\, \sigma_{jG}(t')\, \sigma_{Gk}(t')\, \sigma_{lB}(t) \right\rangle$$

$$\Delta = 0: \quad \rho_{ph} = \frac{1}{2} \begin{pmatrix} 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 \end{pmatrix}$$ in der 2-Photon Basis $\{ |HH\rangle, |HV\rangle, |VH\rangle, |VV\rangle \}$

$$|\psi\rangle_{ph} = \frac{1}{\sqrt{2}} \left(|HH\rangle + |VV\rangle \right)$$

$$\rho = |\psi\rangle\langle\psi| = \frac{1}{2} \big(|HH\rangle\langle HH| + |HH\rangle\langle VV|$$
$$+ |VV\rangle\langle HH| + |VV\rangle\langle VV| \big)$$

Wie messe ich das?

$$\Delta \neq 0: \quad \rho = \frac{1}{2} \begin{pmatrix} 1 & 0 & 0 & \frac{1}{1 + i\Delta/\Gamma} \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ \frac{1}{1 - i\Delta/\Gamma} & 0 & 0 & 1 \end{pmatrix}$$

$\Delta \gg \Gamma$

$\rightarrow$ wenig Entanglement

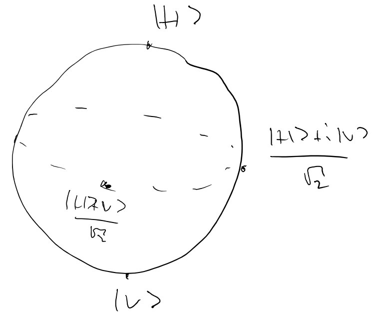
Quantum State Tomography:

Single-photon state representation.

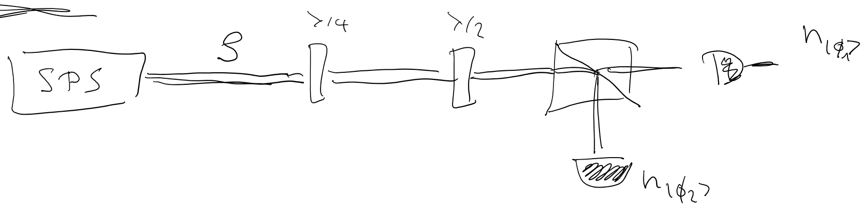
$$|\psi\rangle = \alpha |H\rangle + \beta |V\rangle$$

$$\rho = |\psi\rangle\langle\psi| \in \mathbb{C} \times \mathbb{C}$$

$$\rho = \frac{1}{2} \sum_{i=0}^{3} \underbrace{\mathrm{Tr}[\sigma_i \rho]}_{\text{Stokes parameter } S_i} \sigma_i$$



$$\boxed{P_{|\phi\rangle} = \mathrm{Tr}[\,|\phi\rangle\langle\phi| \rho\,]}$$



$$N = n_H + n_V \vee n_D + n_A \vee n_L + n_R$$

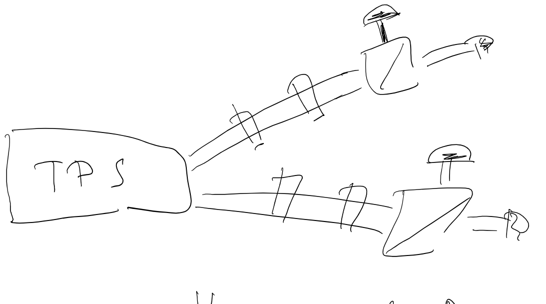
$$S_1 = \frac{n_D - n_A}{N_1}, \quad S_2 = \frac{n_L - n_R}{N_2}, \quad S_3 = \frac{n_H - n_V}{N_3}$$

$$S_0 = 1$$

2-Photon Tomography:

$$|\psi\rangle = \alpha |HH\rangle + \beta |HV\rangle + \gamma |VH\rangle + \delta |VV\rangle$$

$$\rho = \frac{1}{2^2} \sum_{i_1, i_2 = 0}^{3} \mathrm{Tr}[(\sigma_{i_1} \otimes \sigma_{i_2}) \rho] (\sigma_{i_1} \otimes \sigma_{i_2})$$



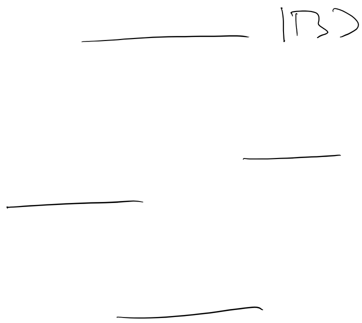
$$\rho = \begin{pmatrix} & \otimes \\ \otimes & \end{pmatrix}, \quad \underline{S_{1,1} = P_{D,D} - P_{D,A} - P_{A,D} + P_{A,A}}$$

$$|DD\rangle = \frac{1}{2}(|H\rangle + |V\rangle) \otimes (|H\rangle + |V\rangle)$$

$$|DD\rangle = \frac{1}{2}\left(|H\rangle + |V\rangle\right) \otimes \left(|H\rangle + |V\rangle\right)$$

$$|D\rangle = \frac{1}{\sqrt{2}}\left(|H\rangle + |V\rangle\right)$$

$$\langle c_H^\dagger c_H^\dagger c_V c_V \rangle$$



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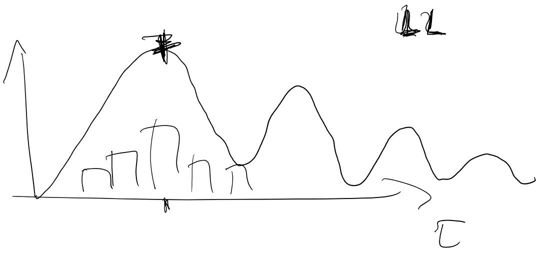
$$|\psi(0)\rangle = \frac{1}{\sqrt{2}}\left(|H\rangle \otimes |1_H\rangle + |V\rangle \otimes |1_V\rangle\right)$$

Zeitaufgelöste Messung $t_2 - t_1 = \tau$



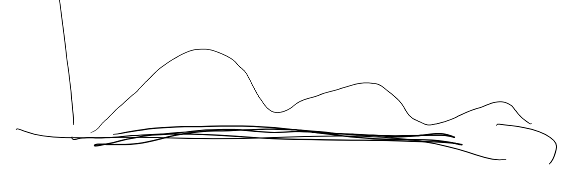
Wahrscheinlichkeitsverteilung:

$$P[i,j,\tau] = N \langle \sigma_{iG}(\tau)\, \sigma_{Gj}(\tau) \rangle_{\rho(0)} = N\, \mathrm{Tr}\left[\rho(0)\, \sigma_{iG}(\tau)\, \sigma_{Gj}(\tau)\right]$$

$U^\dagger(\tau)$ $\quad \mathbb{1}$ $\quad U(\tau)$

$+|V\rangle$

$$= N\, \mathrm{Tr}\left[\underbrace{U(\tau)\rho(0)U^\dagger(\tau)}_{\rho(\tau)}\, \sigma_{iG}\, \sigma_{Gj}\right]$$



$$H_{flip} = g\left(\sigma_{HV} + \sigma_{VH}\right)$$