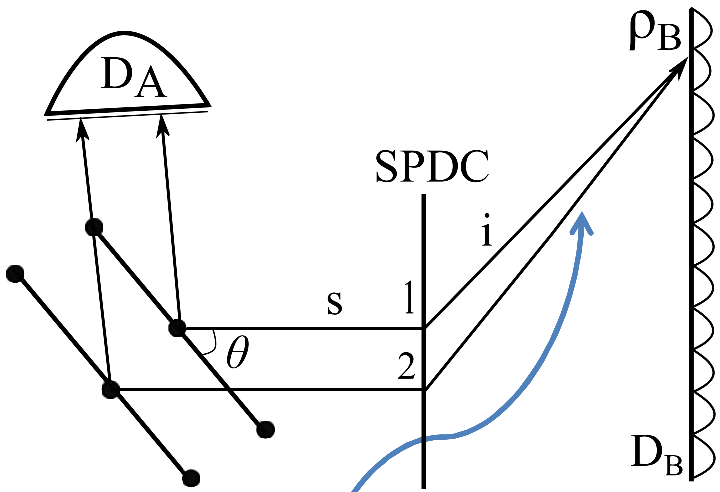
Radiation-damage-free two-photon diffraction



$$\hat{E}_A^{(+)} = \hat{a}_{1s} e^{ik_s r_{A1}} + \hat{a}_{2s} e^{ik_s r_{A2}}$$

$$\hat{E}_B^{(+)} = \hat{a}_{1i} e^{ik_i r_{B1}} + \hat{a}_{2i} e^{ik_i r_{B2}}$$

$$G_{AB} = \mathrm{Tr}\left[\hat{E}_A^{(-)} \hat{E}_B^{(-)} \hat{E}_B^{(+)} \hat{E}_A^{(+)} \hat{\rho} \right]$$

$$\simeq \left| e^{ik_s r_{A1} + ik_i r_{B1}} + e^{ik_s r_{A2} + ik_i r_{B2}} \right|^2$$

Due to entanglement, we have

$$\Delta(x_s - x_i)\Delta(k_s + k_i) = 0$$

Thus the Bragg condition is

$$2d\sin\theta + \frac{\lambda_{s,\mathrm{o}}}{\lambda_{i,\mathrm{X}}}\left(r_{B1} - r_{B2}\right) = n\lambda_{s,\mathrm{o}}$$

The phase is compensated by an optical path difference magnified $\frac{\lambda_{s,\mathrm{o}}}{\lambda_{i,\mathrm{X}}}$ times,

the Bragg condition can be satisfied though $d \ll \frac{\lambda_{s,\mathrm{o}}}{2}$.

D. N. Klyshko *et al.*, Usp. Fiz. Nauk (1988); JETP (1994)
D. V. Strekalov *et al.*, Phys. Rev. Lett. (1994)