



Lecture 7 SPDC mechanism

①

$$g^{(1)} \rightarrow \langle \hat{E}_2^* \hat{E}_1 \rangle \not\rightarrow \hat{n}$$

$$g^{(2)} \rightarrow \langle \hat{I}_2 \hat{I}_1 \rangle = \langle \hat{E}_2^* \hat{E}_1 \hat{E}_1^* \hat{E}_2 \rangle \rightarrow \hat{n}$$

$$|K\rangle = \sum |n\rangle$$

②

- generation of nonclassical light (SPDC mechanism)
- single-mode squeezing

laser 405 nm $|\alpha\rangle$

β -BBO

810 nm 810 nm

SPDC?

$\omega_p = 405\text{ nm}$ $\omega_0 = 810\text{ nm}$

Poisson distribution

$\hbar\omega_p = \hbar\omega_0 + \hbar\omega_0$



③

$E_p \rightarrow \vec{d}(t) \rightarrow \alpha(t) \rightarrow E'$
 Current oscillation

$F = ma$
 QE

$\vec{d}(t)$ induced dipole moment

U
 x E
 linear
 nonlinear

$\vec{d}(t) = \chi^{(1)} E + \chi^{(2)} E^2 + \chi^{(3)} E^3 + \dots$
 $U = \vec{E} \cdot \vec{d} = \chi^{(1)} E^2 + \chi^{(2)} E^3 + \chi^{(3)} E^4 + \dots$

④

- generation of nonclassical light (SPDC mechanism)
- Single-mode Squeezing

$W = \int F \cdot v dt$
 $\omega = 2\omega_0$
 $2\omega - \omega_0, 2\omega + \omega_0$
 $\omega = \frac{2\omega_0}{3}$

$m\ddot{x} = -m\omega_0^2 x - \gamma\dot{x} + eE(t)$
 $\rightarrow \ddot{x} = -\omega_0^2 x$
 $\rightarrow x = A \cos(\omega_0 t) + B \sin(\omega_0 t) + \chi^{(1)} E_1(t) + \chi^{(2)} E_2(t)$





⑤

$$\frac{1}{n_p^2} = \frac{\cos^2 \theta_p}{n_o^2(\lambda_p)} + \frac{\sin^2 \theta_p}{n_e^2(\lambda_p)}$$

$n_1 = n_o(\lambda_1)$
 $n_2 = n_o(\lambda_2)$

anisotropic

Input $\lambda_1 = 405 \text{ nm}$
 $\theta = 29.13^\circ$
 $\lambda_2 = 810 \text{ nm}$

birefringence

$n_p = 1.6599$
 $n_1 = 1.6694$
 $n_2 = 1.6502$

$\lambda_1 = 405 \text{ nm}$
 $\lambda_2 = 810 \text{ nm}$

$\theta_1 = 1.7973^\circ$
 $\theta_2 = 1.7973^\circ$

$\phi_1 = 29.13^\circ$
 $\phi_2 = 29.13^\circ$

$k_p = k_1 \cos \theta_1 + k_2 \cos \theta_2$

$k_p = 2k_o \cos \theta$
 $k_o \sin \theta = k_o' \sin \theta$

$k_p = 2k_o' \cos \theta$

$\hbar \omega_p = \hbar \omega_1 + \hbar \omega_2$
 $\hbar \omega_p = \hbar \omega_o + \hbar \omega_o$
 $\vec{k}_p = \vec{k}_o + \vec{k}_o$

$\omega_p = c k_p$
 $= \frac{c}{n(\lambda)} k_p$
 $= c k_p'$

$\frac{\hbar \omega_p}{c} \frac{1}{n(\lambda)} = \frac{2 \hbar \omega_o}{c} \frac{1}{n(\lambda_o)}$

$\cos \theta$

$n_1(\lambda_1) = 1.6694$
 $n_2(\lambda_2) = 1.6502$

$\lambda_1 = 405 \text{ nm}$
 $\lambda_2 = 810 \text{ nm}$

