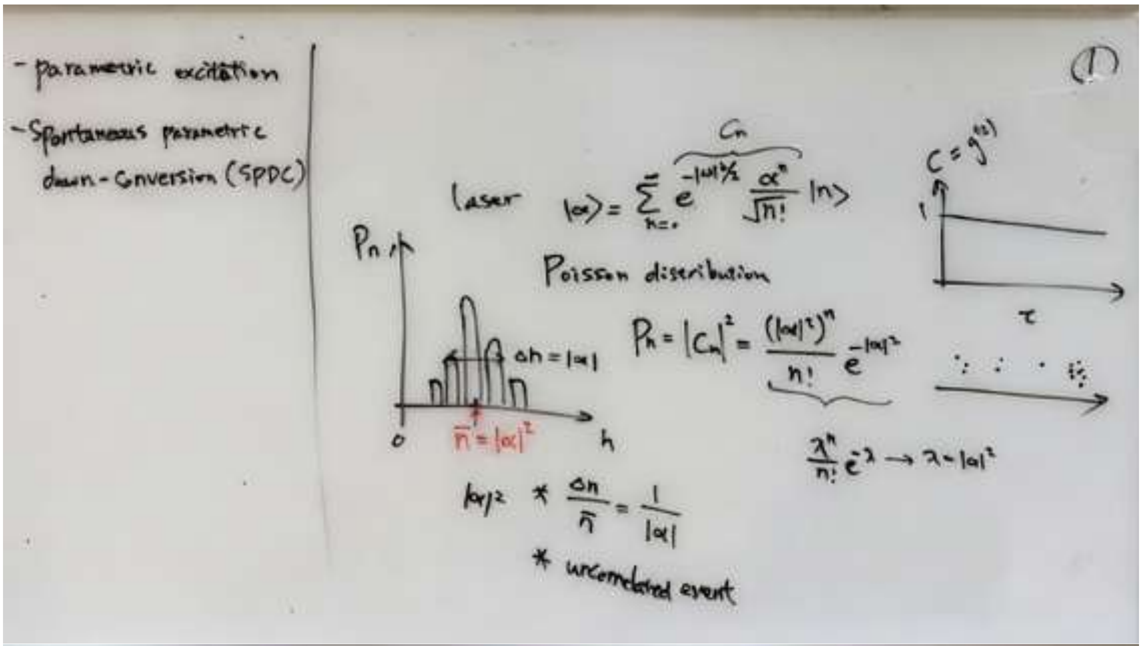
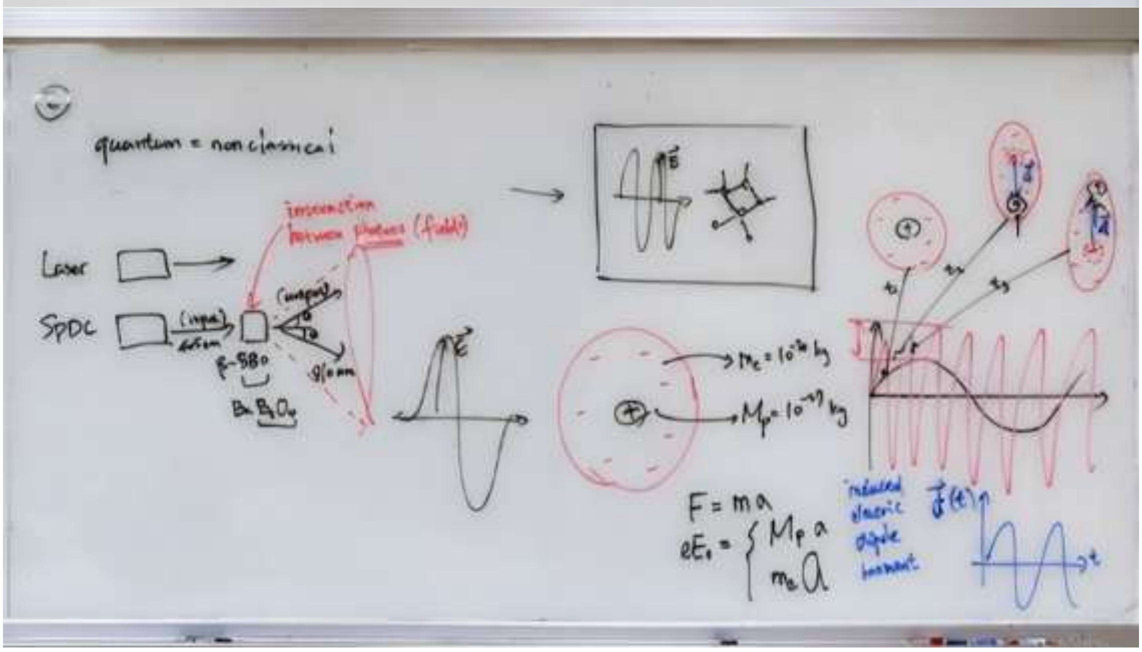
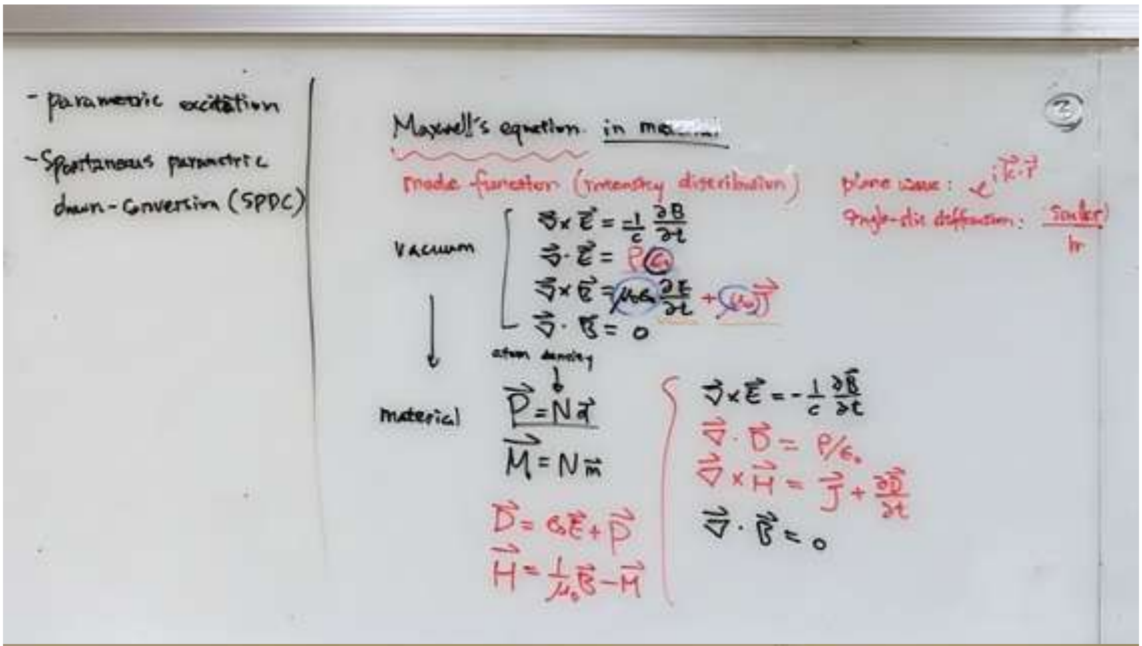
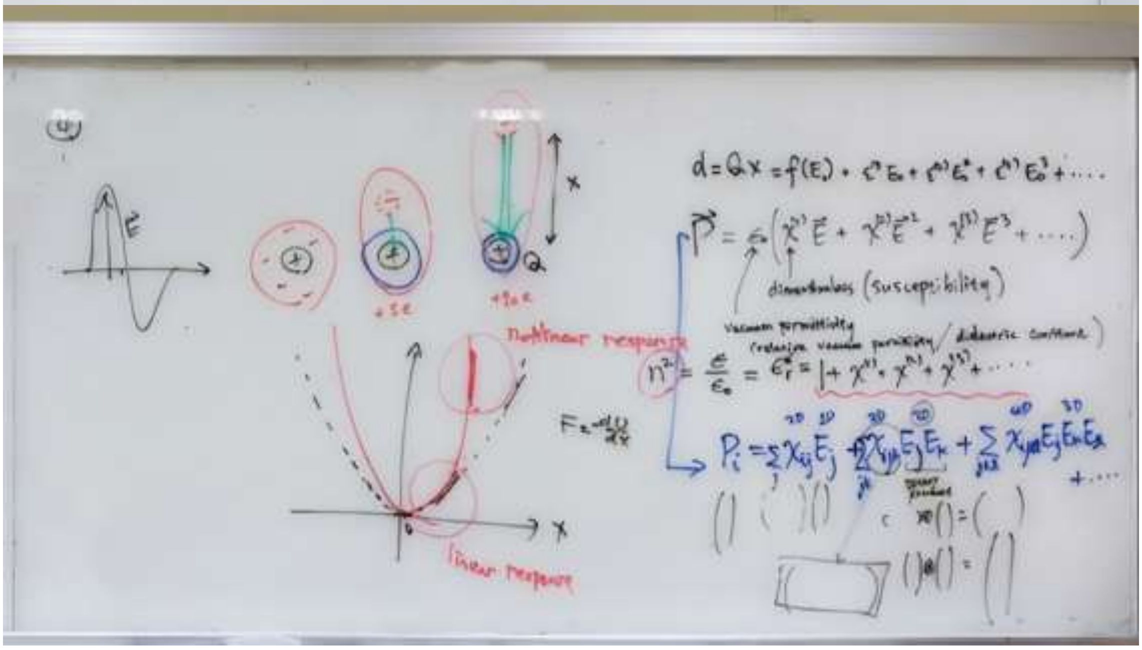
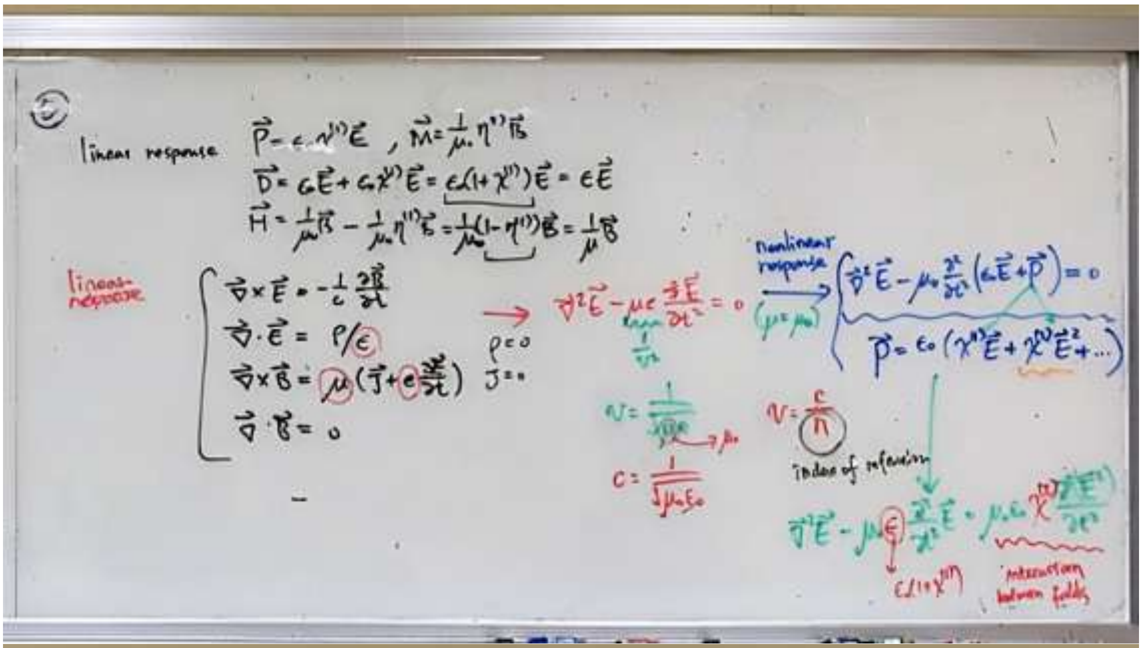
Lecture8 (optics) SPDC mechanism

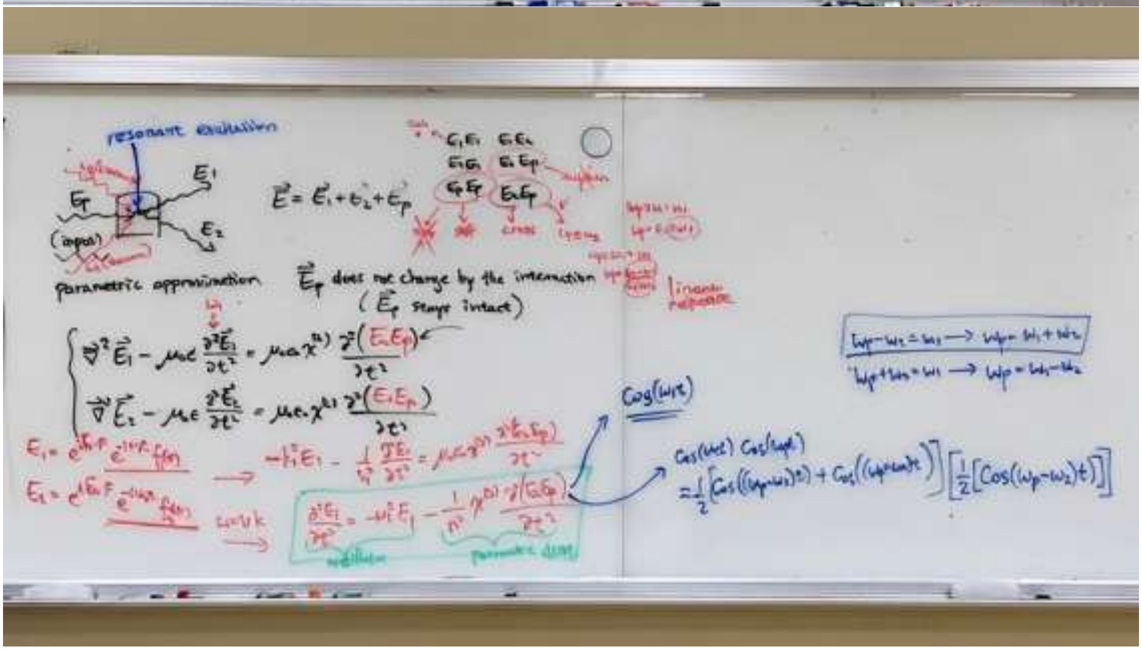


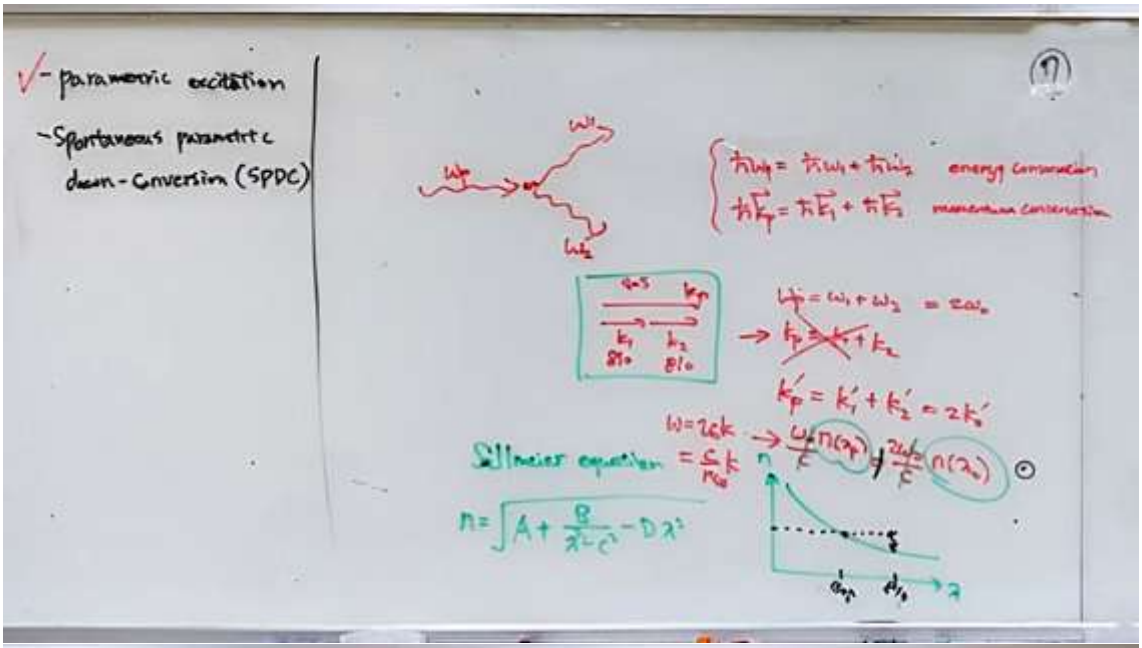



- parametric excitation
- Spontaneous parametric down-conversion (SPDC)
Maxwell's equation in material
mode function (intensity distribution)
plane wave
vacuum
atom density
material

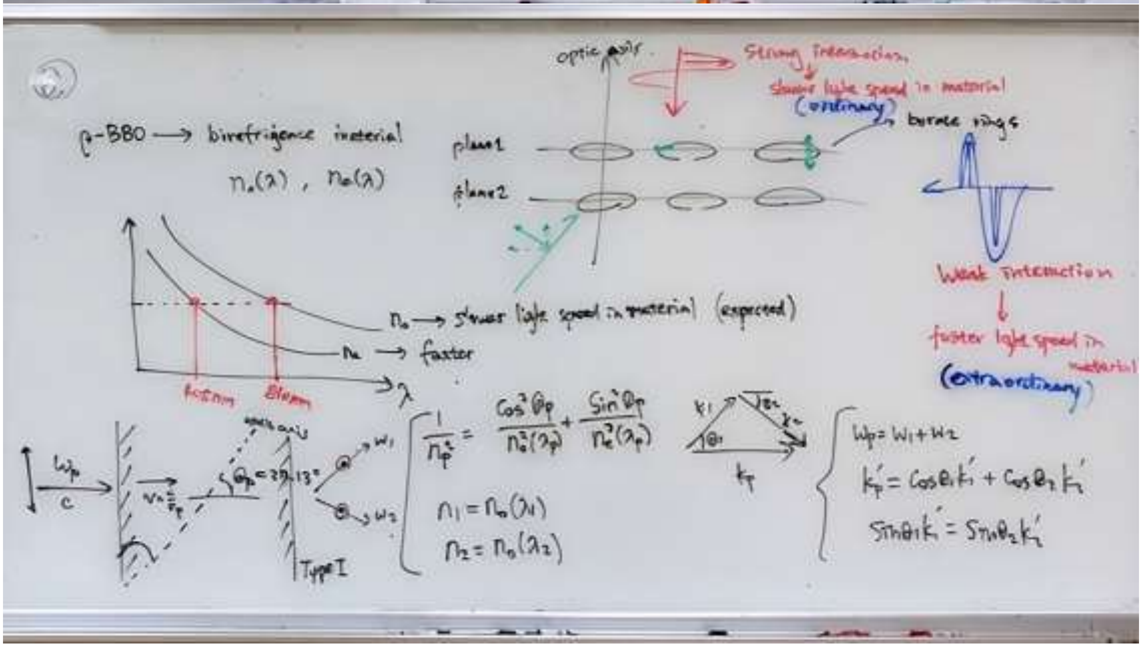

(susceptibility)
nonlinear response
linear response


linear response
linear response
nonlinear response
index of refraction
interaction between fields

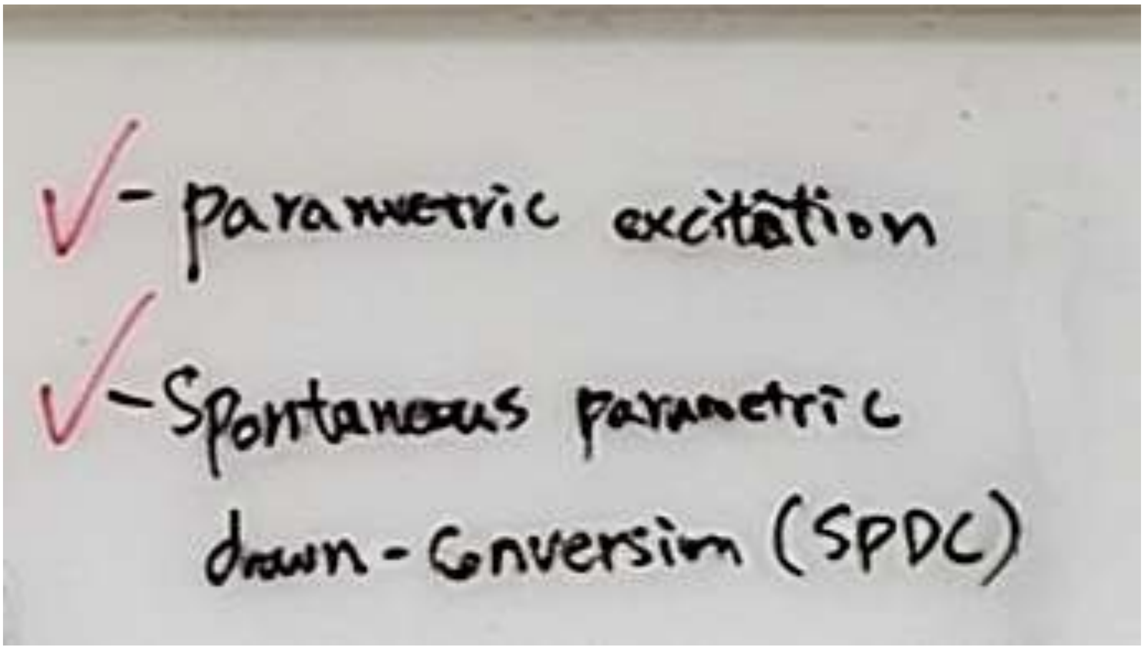

resonant excitation
(input)
parametric approximation
$\vec{E}_p$ does not change by the interaction
($\vec{E}_p$ stays intact)
linear response



✓ - parametric excitation
- Spontaneous parametric down-conversion (SPDC)
⑰
ω_p
ω_1
ω_2
$\hbar\omega_p = \hbar\omega_1 + \hbar\omega_2$ energy conservation
$\hbar\vec{k}_p = \hbar\vec{k}_1 + \hbar\vec{k}_2$ momentum conservation
405
k_p
k_1 810
k_2 810
$\omega_p = \omega_1 + \omega_2 = 2\omega_0$
$\rightarrow \cancel{k_p = k_1 + k_2}$
$k_p' = k_1' + k_2' = 2k_0'$
$\omega = 2\pi k$
$\frac{\omega_p}{c} n(\lambda_p) \neq \frac{2\omega_0}{c} n(\lambda_0)$
Sellmeier equation
$= \frac{c}{n_0} k$
$n = \sqrt{A + \frac{B}{\lambda^2 - C^2} - D\lambda^2}$
n
λ



β-BBO → birefrigence material
$n_o(\lambda)$, $n_e(\lambda)$
n_o → slower light speed in material (expected)
n_e → faster
405nm
810nm
λ
optic axis
Strong interaction, slower light speed in material (ordinary)
plane 1
plane 2
bounce rings
Weak interaction
faster light speed in material (extraordinary)
ω_p
c
$v = \frac{c}{n_p}$
optic axis
$\theta_p = 29.13°$
ω_1
ω_2
Type I
$\frac{1}{n_p^2} = \frac{\cos^2\theta_p}{n_o^2(\lambda_p)} + \frac{\sin^2\theta_p}{n_e^2(\lambda_p)}$
$n_1 = n_o(\lambda_1)$
$n_2 = n_o(\lambda_2)$
k_1
k_2
θ_1
θ_2
k_p
$\omega_p = \omega_1 + \omega_2$
$k_p' = \cos\theta_1 k_1' + \cos\theta_2 k_2'$
$\sin\theta_1 k_1' = \sin\theta_2 k_2'$


- parametric excitation
- Spontaneous parametric down-conversion (SPDC)