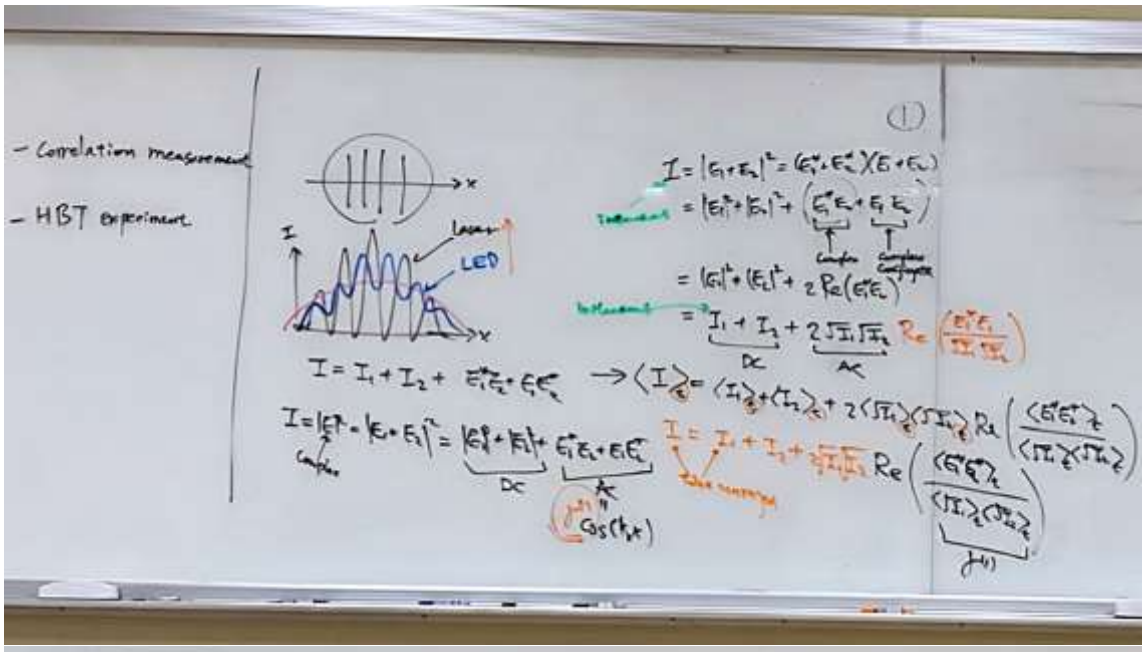
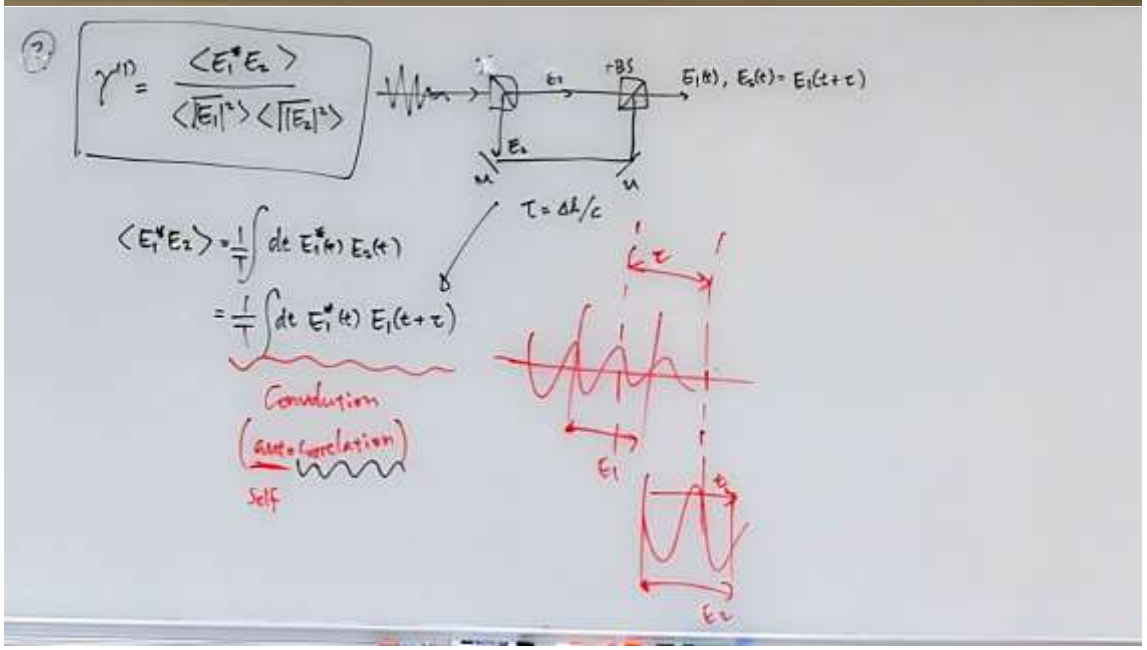
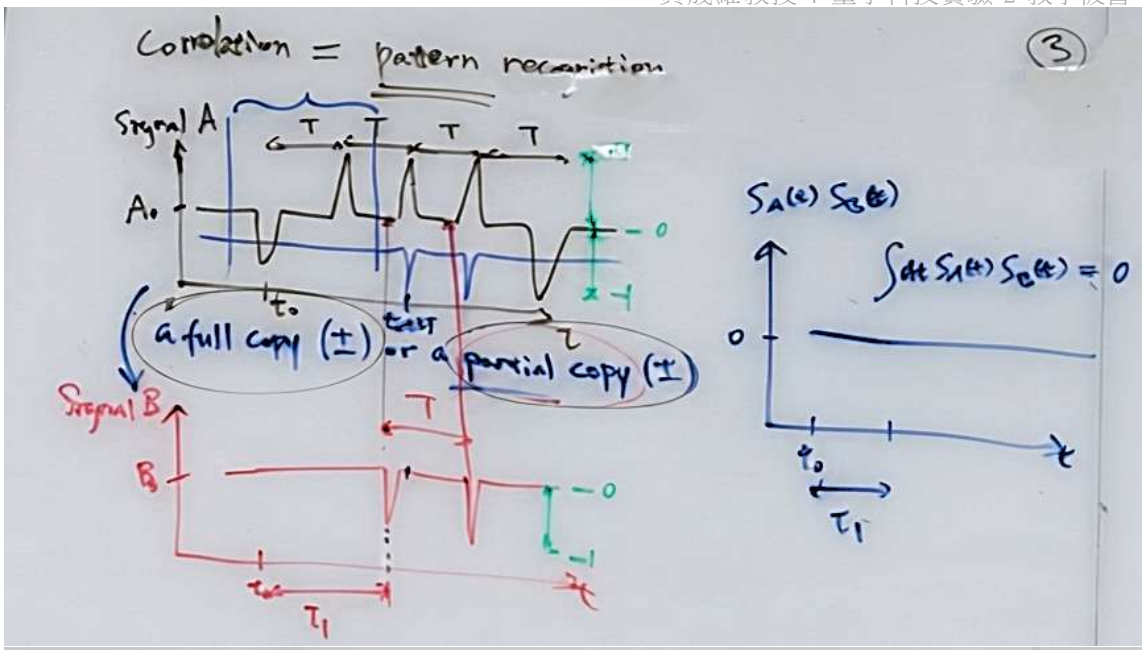
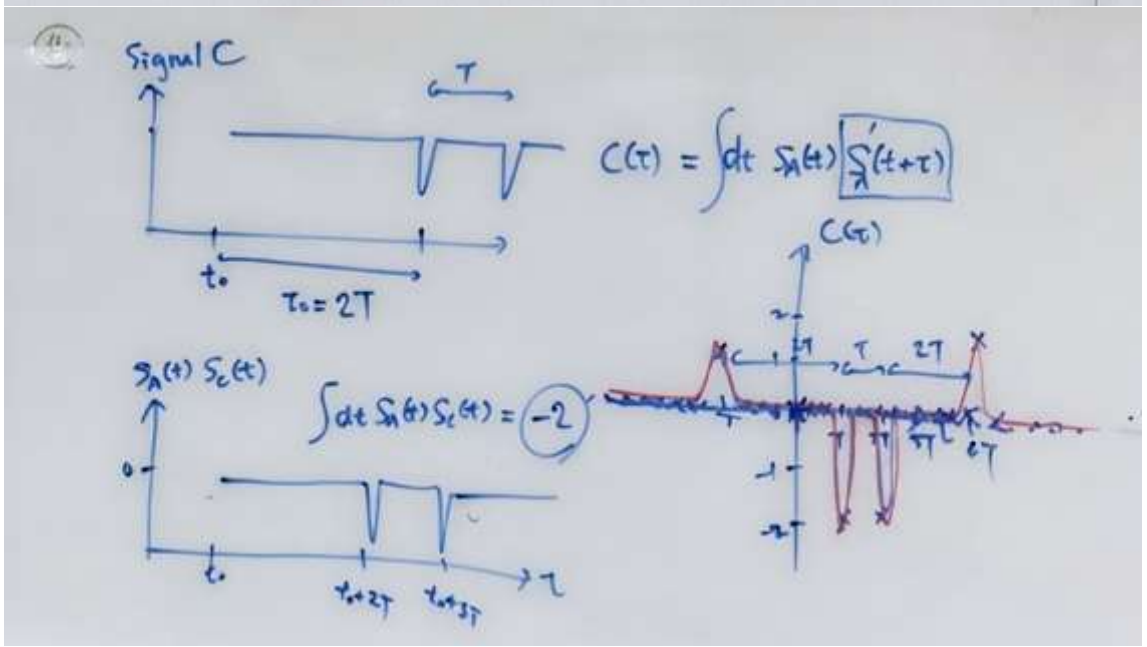
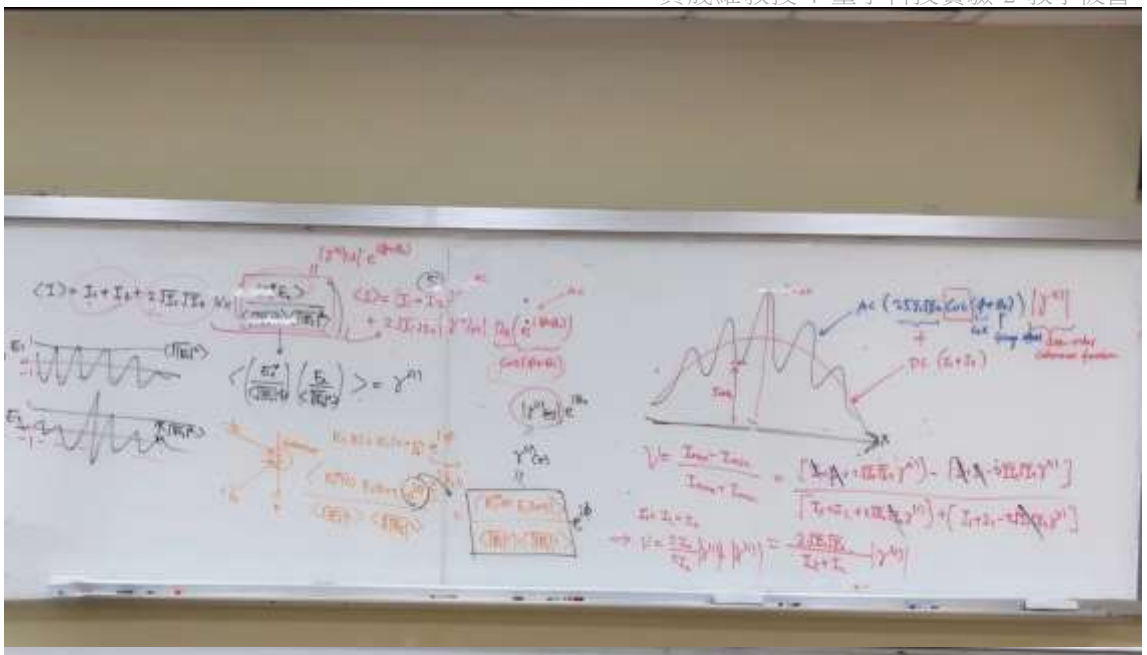
Lecture4 (optics) correlation and HBT experiment

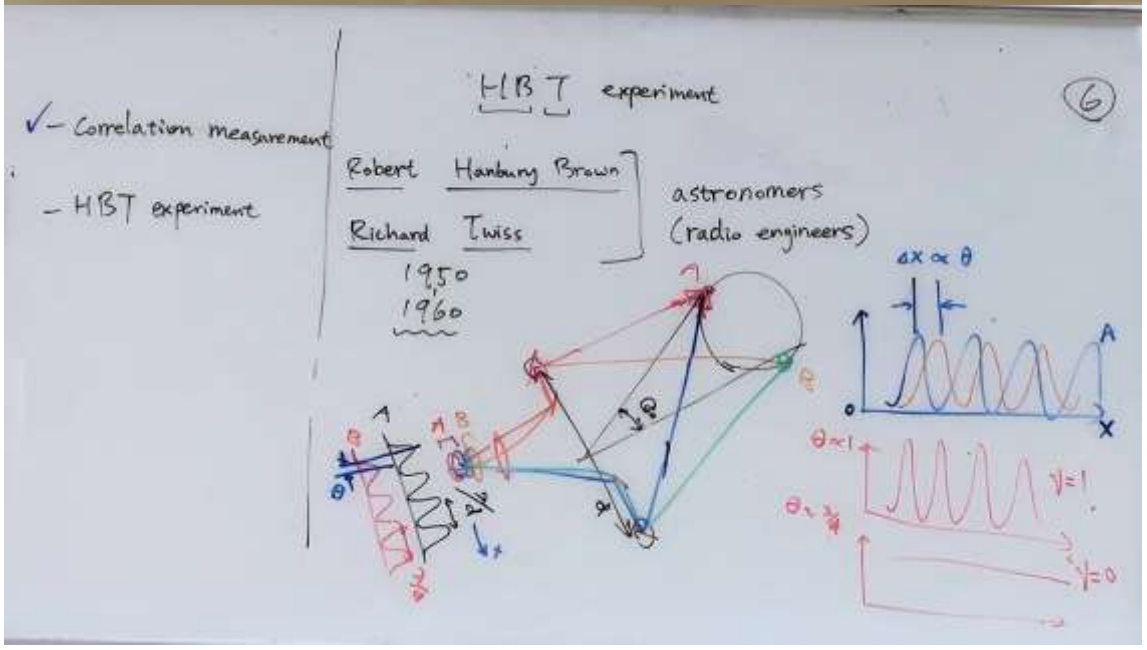


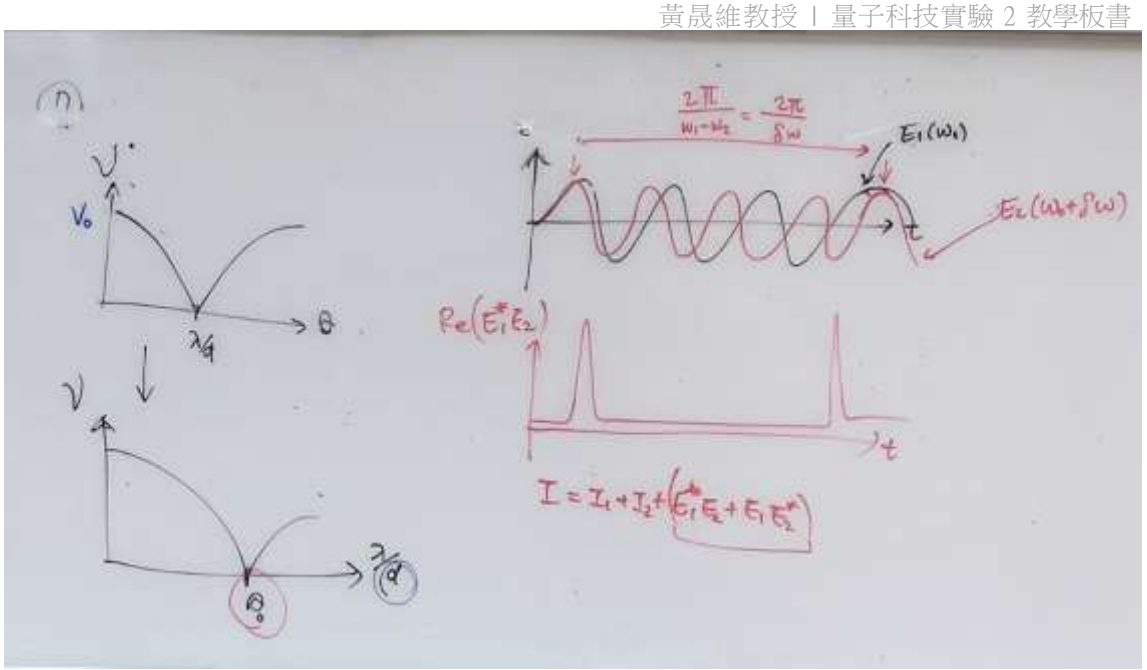


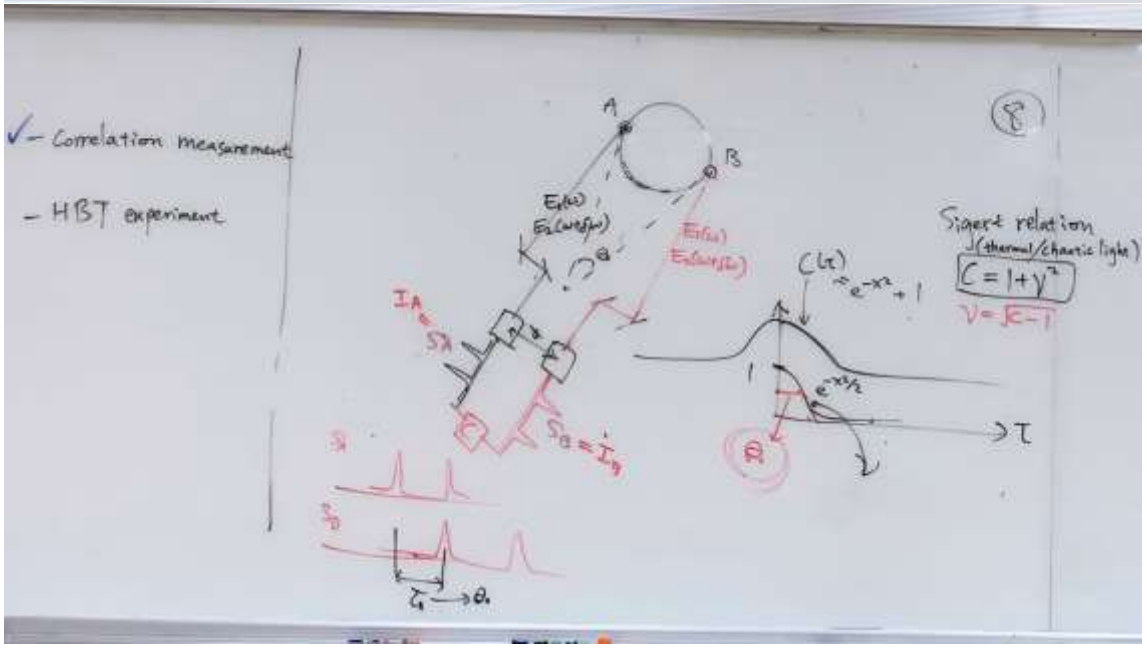

Correlation = pattern recognition
③
Signal A
A₀
T
T
T
T
+1
0
-1
t₀
t₀+T
τ
a full copy (±)
or a partial copy (±)
Signal B
B₀
T
+1
0
-1
t₀
T₁
τ
$S_A(t)\,S_B(t)$
$\int dt\, S_A(t)\,S_B(t) = 0$
0
t₀
T₁
t


Signal C
T
t₀
$\tau_0 = 2T$
$C(\tau) = \int dt\, S_A(t)\, S_C'(t+\tau)$
$S_A(t)\,S_C(t)$
$\int dt\, S_A(t)\,S_C(t) = -2$
0
t₀
t_0+2T
t_0+3T
τ
C(τ)
2
1
-1
-2
T
2T
T
2T



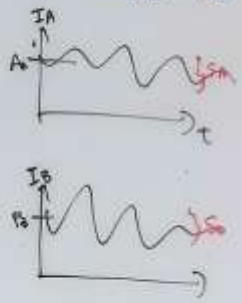

HBT experiment
6
✓– Correlation measurement
– HBT experiment
Robert Hanbury Brown
Richard Twiss
astronomers
(radio engineers)
1950
1960
Δx ∝ θ
A
X
θ≈1
V=1
V=0


(1)
V_0
θ
$\lambda/4$
θ_0
$\frac{2\pi}{\omega_1-\omega_2}=\frac{2\pi}{\delta\omega}$
$E_1(\omega_1)$
$E_2(\omega_1+\delta\omega)$
$Re(E_1^*E_2)$
$I=I_1+I_2+(E_1^*E_2+E_1E_2^*)$


✓- Correlation measurement
- HBT experiment
(2)
A
B
Siegert relation
(thermal/chaotic light)
$C=1+\gamma^2$
$V=\sqrt{C-1}$
τ

(9)

$$\gamma^{(2)} = \frac{\langle I_A(t)\, I_B(t+\tau)\rangle}{A_0 B_0} = (A_0 + S_A(t))(B_0 + S_B(t+\tau))$$



$$= \langle A_0 B_0 \rangle + \langle B_0 S_A(t) \rangle + \langle A_0 S_B(t+\tau) \rangle + \langle S_A(t) S_B(t+\tau) \rangle$$

$$= A_0 B_0 + B_0 \langle S_A(t) \rangle + A_0 \langle S_B(t) \rangle + \langle S_A(t) S_B(t+\tau) \rangle$$

$$= \left[A_0 B_0 + \langle S_A(t) S_B(t+\tau) \rangle \right] \frac{1}{A_0 B_0}$$

$$= 1 + \frac{\langle S_A(t) S_B(t+\tau) \rangle}{A_0 B_0}$$

$C \geq 0$

$1 < \gamma^{(2)} < \infty$

classical coherence theory

✓ – Correlation measurement

✓ – HBT experiment