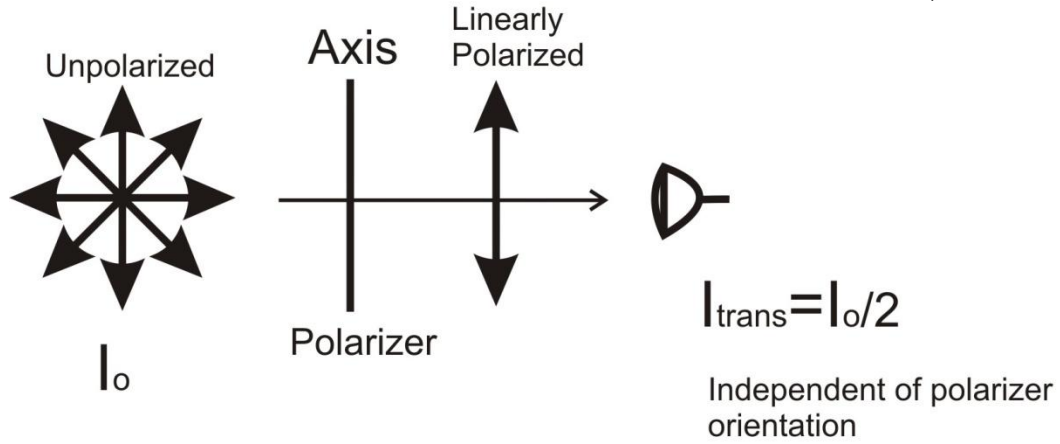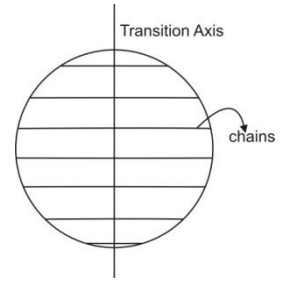**Phys 4061/5061 – Tutorial Six**

Details Pertaining to laboratory experiments covered in this tutorial can be found in the lab manual under the following sections

1. Laser Linewidth → Faraday Isolator

Polarization
- degree of freedom along horizontal for molecular chains in sheet polarizer
  - horizontally polarized light is absorbed
  - vertically polarized light is transmitted

Transition Axis

chains

Unpolarized   Axis   Linearly Polarized

I_o

Polarizer

$I_{trans} = I_o/2$

Independent of polarizer orientation

$I_{trans} = I_o / 2$

- independent of polarizer orientation

Axis (y)

θ
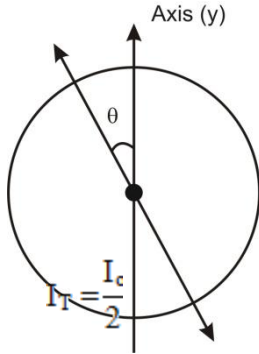
$I_T = \dfrac{I_o}{2}$

$E_y = E_o \cos\theta$

$I_T \ \alpha \ E_o^2 \cos^2\theta = \ I_o \cos^2\theta$

$<\cos^2\theta> = \frac{1}{2}$

For Polarized Light
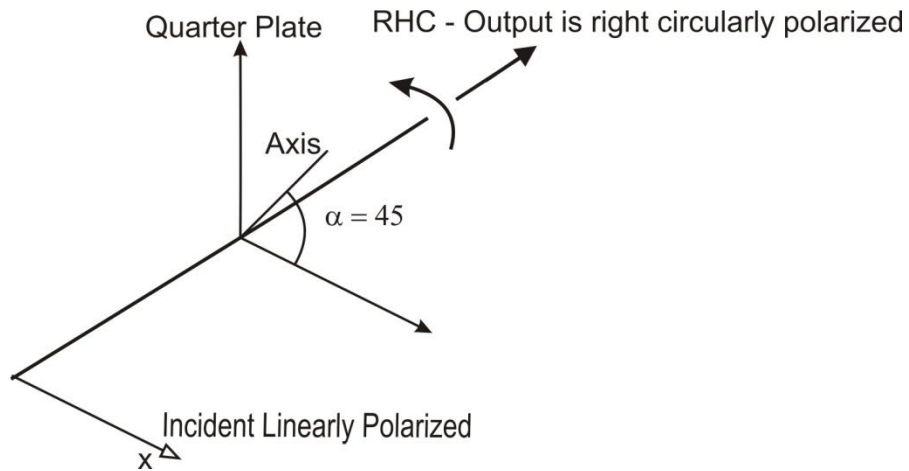
$I_T = \ I_o \cos^2\theta$

I_t

I_o

θ
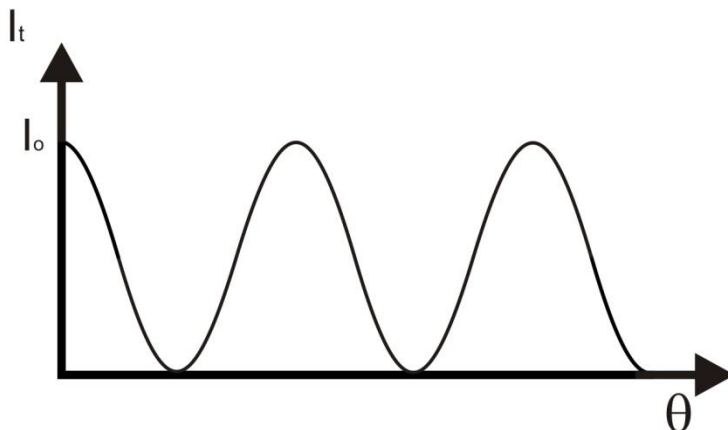
- offset is nonzero if partially polaried
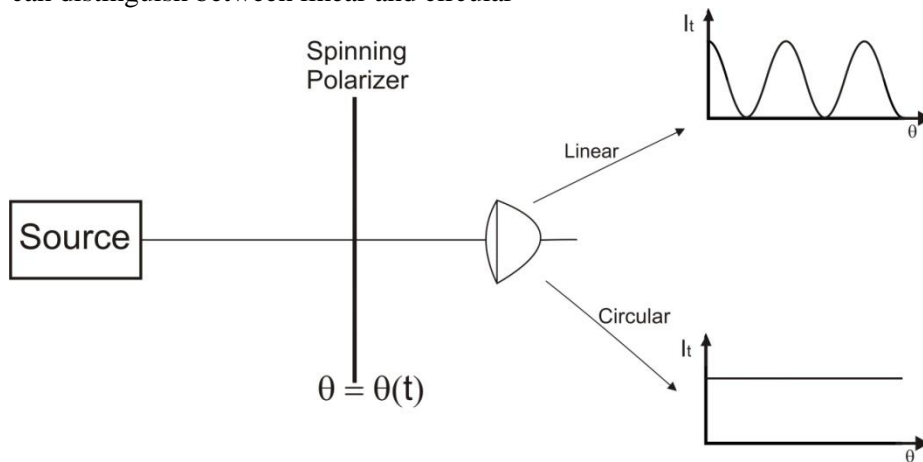
Circular Polarization
- combine 2 perpendicular E fields with 90˚ phase shift
- cannot distinguish circular and random using linear polarizer
- Definition of RHC and LHC --> direction of Spin of E field when light approaches
  - RHC – clockwise spin
  - LHC – counter-clockwise spin

Quarter Wave Plate

Spinning Polarizer Test
- can distinguish between linear and circular

λ/4 Plate

δ = 90° = phase shift between E field components parallel and perpendicular to optical axis of plate

Path difference

$$p = \frac{2\pi}{\lambda}\delta = d(n_\perp - n_\parallel) = \frac{\lambda}{4}$$

Where d is the plate thickness and $n_\perp$ and $n_\parallel$ are indices perpendicular and parallel to axis

a (angle of Optical Axis)	Input	Output
0	X	X (Lin Polarized – No effect)
90	X	X (Lin Polarized – No effect)
45	X	RHC
-45	X	LHC
α	X	Elliptical

λ/2 Plate

Looks like two λ/4 plates
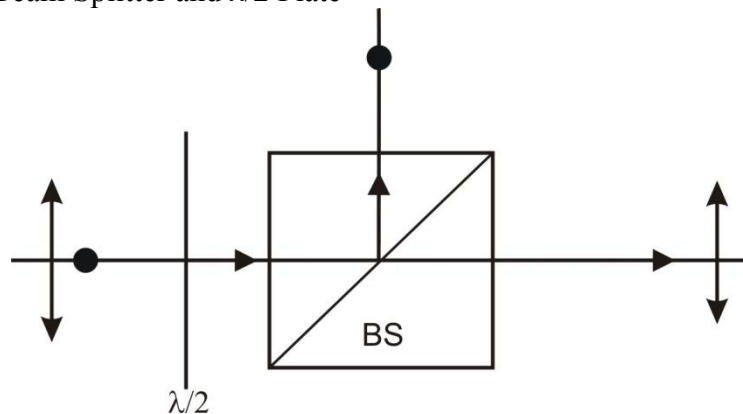δ = 180° = phase shift between E field components parallel and perpendicular to optical axis of plate
Path Difference

$$p = \frac{2\pi}{\lambda}\delta = d(n_\perp - n_\parallel) = \frac{\lambda}{2}$$

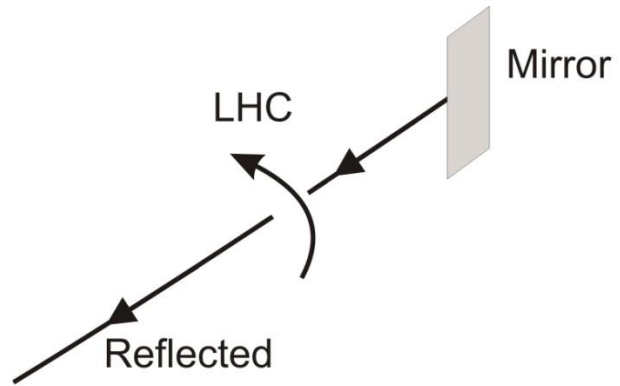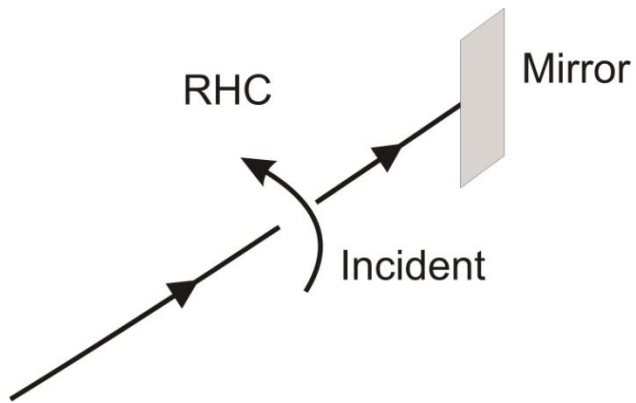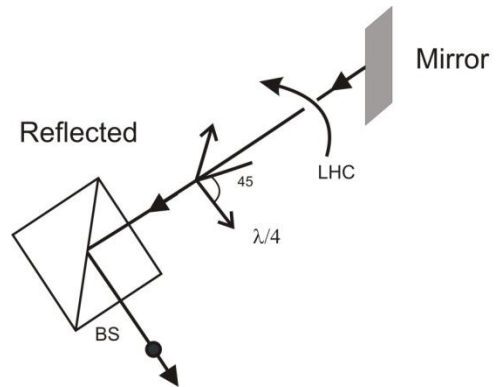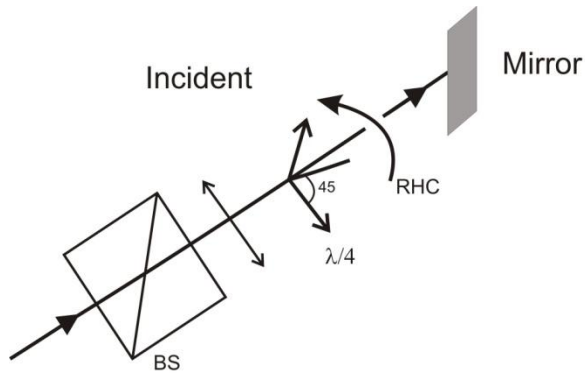| α	Input	Output
0	X	X
90	X	X
45	X	Y
-45	X	Y
α	X	Linear, Rotated by 2α
α	RH Elliptical	LH Elliptical

Cube Beam Splitter and λ/2 Plate

- use half wave plate to control relative power in two directions

Mirror Reversal
- changes RHC to LHC
- does not change angular momentum **L**

Mirror Reversed

Contrast with Time Reversal
- what goes in must come out – different from mirror reversal