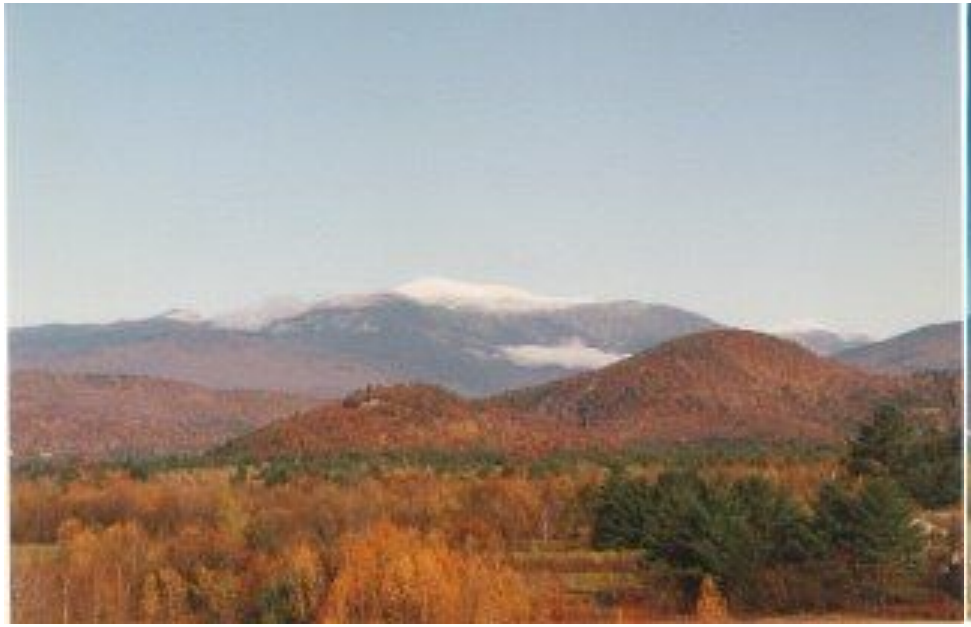
Basic Principles of Light Polarization

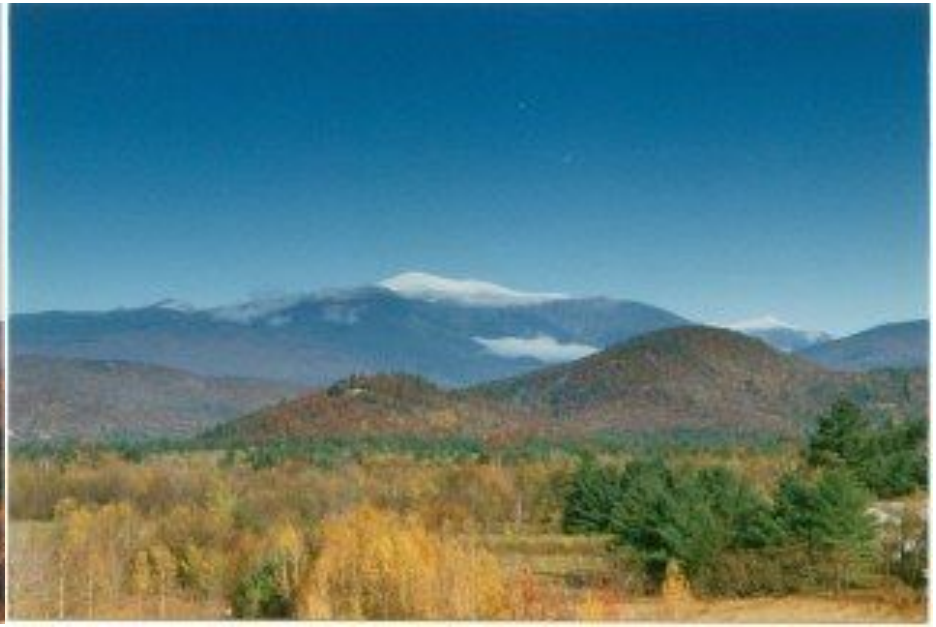
Polarization Photography

Reduce Sun Glare
Reduce Reflections
Darkens Sky
Increase Color Saturation
Reduce Haze

Polarization Photography



Without Polarizer



With Polarizer

- Provides better Color Saturation
- Darkens the sky

Polarization Photography

Without Polarizer

With Polarizer

Polarization Photography : Scattering

Haze

De-hazed

Polarization Photography : Wide Angle Lenses

Vignetting of the Sky

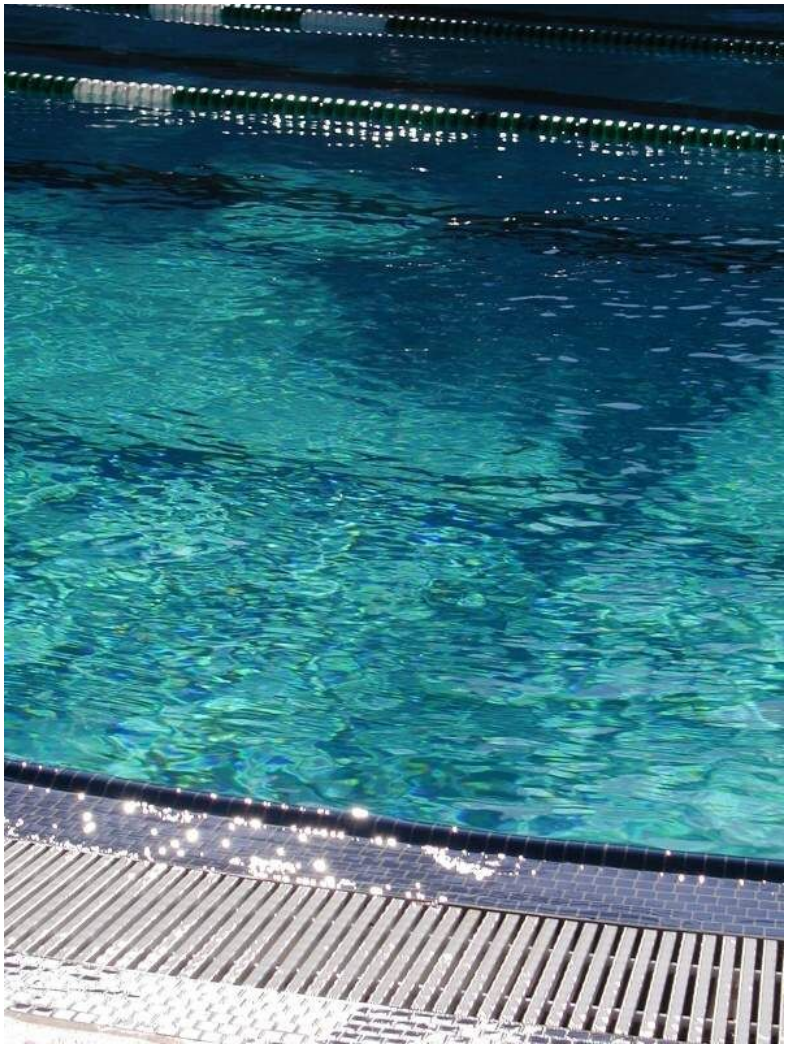
Polarization Photography : Reflections

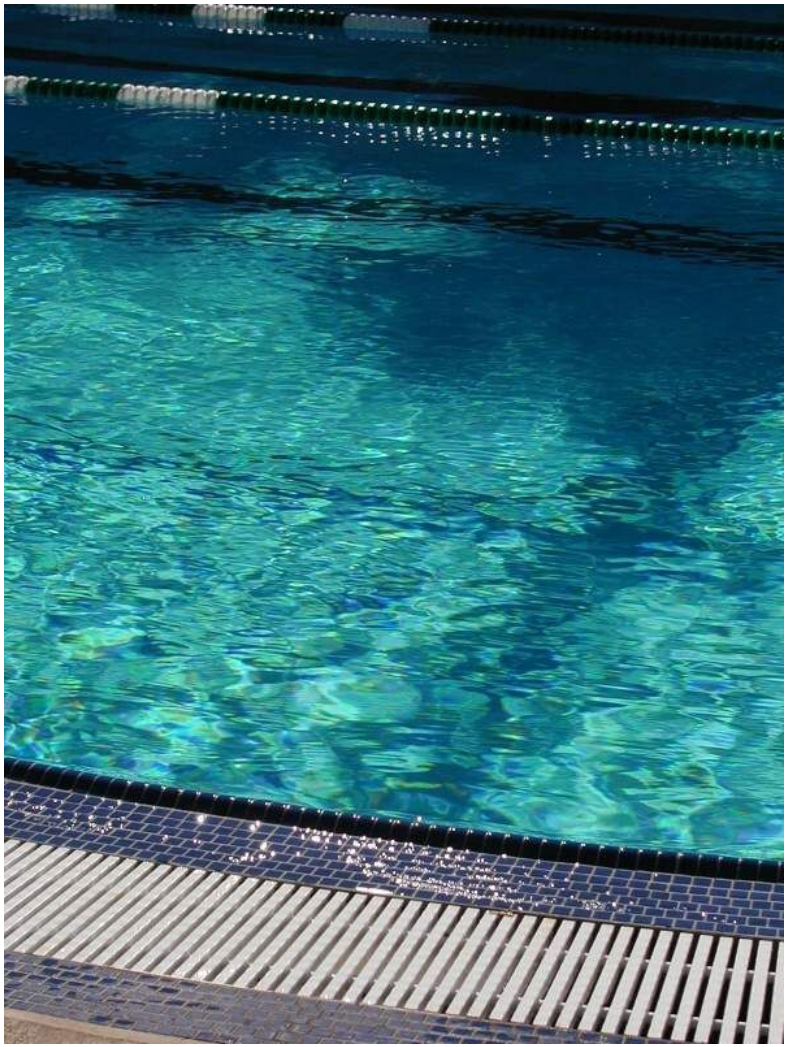
Reduce Reflections

Polarization Photography : Reflections

Reduce Reflections

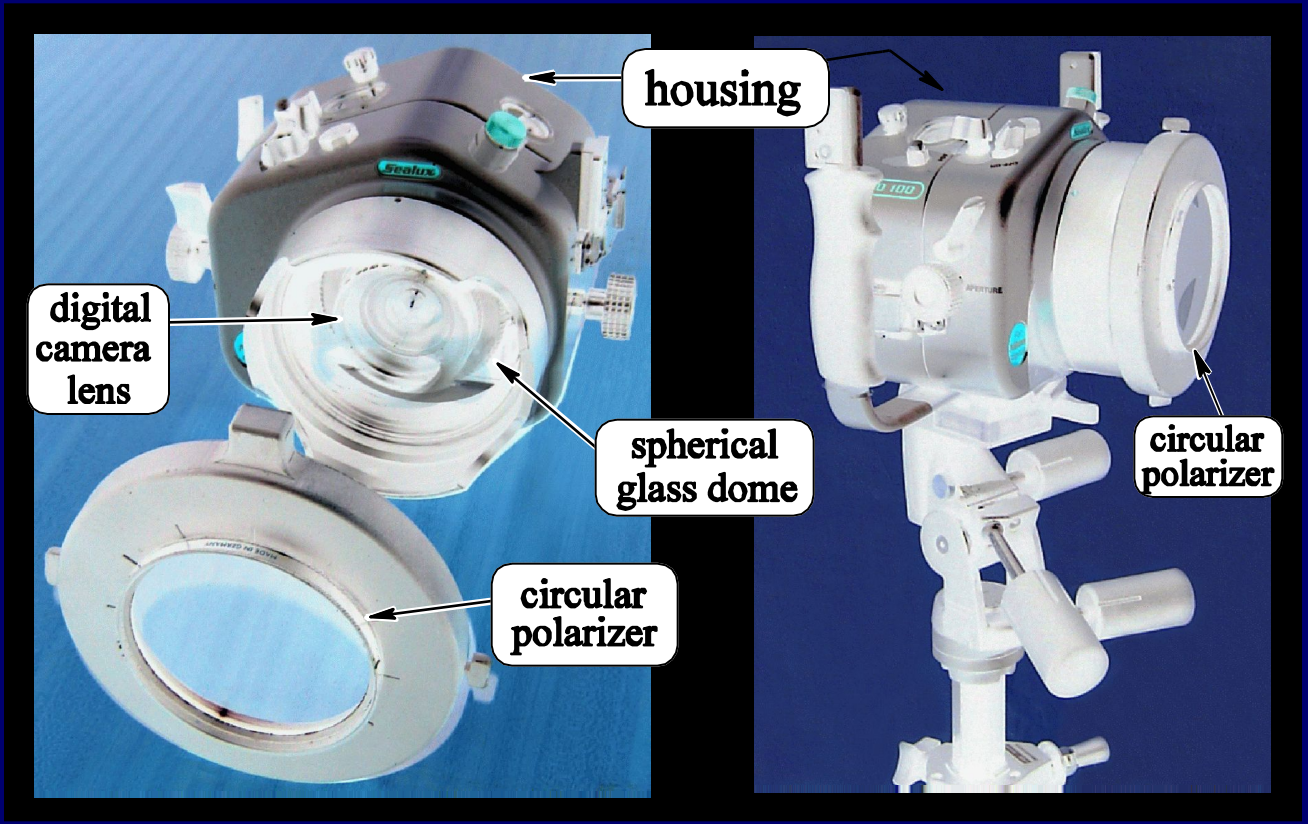
Polarization Photography : Reflections





Many titled planes

Aqua-polaricam

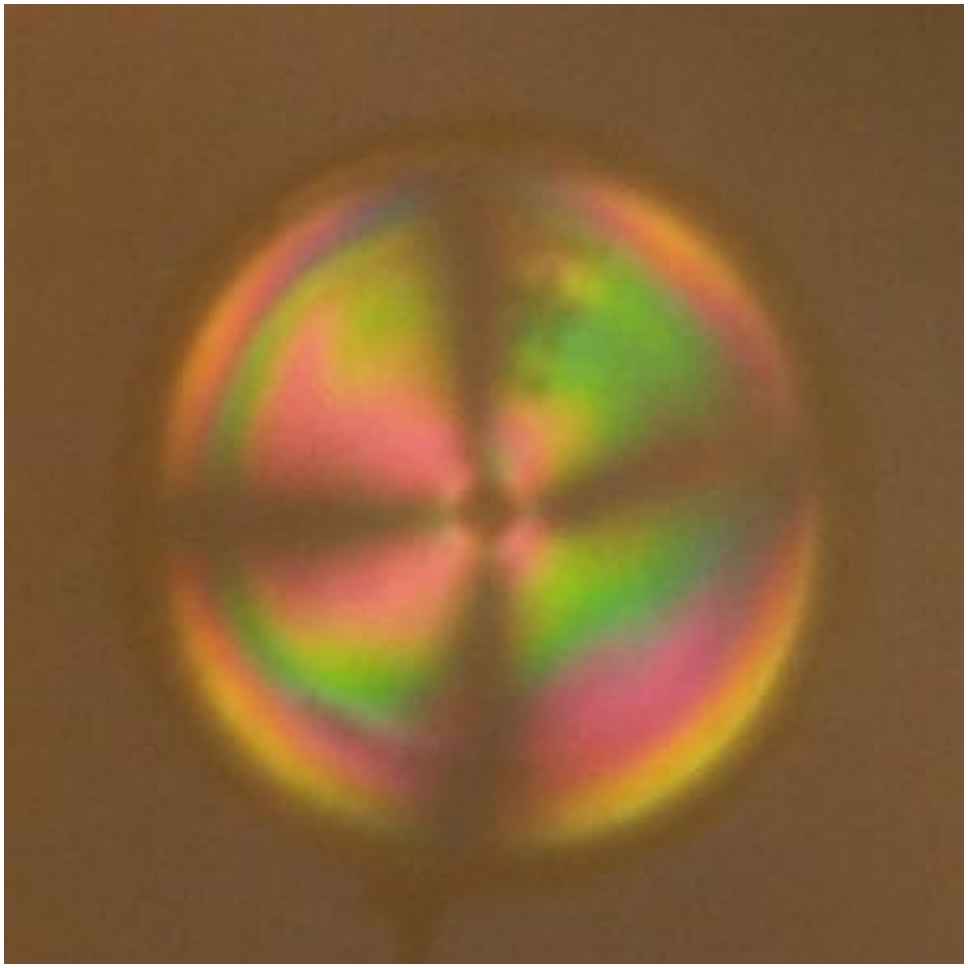


Y. Schechner & N. Karpel, *underwater imaging*

Polarization Photography : Underwater

- Underwater pipelines and communication
- Offshore structures
- Offshore drilling rigs
- Vessel inspection
- Underwater ROV/AOV
- Marine biology
- Recreational photography
- Marine archaeology
- Underwater mapping

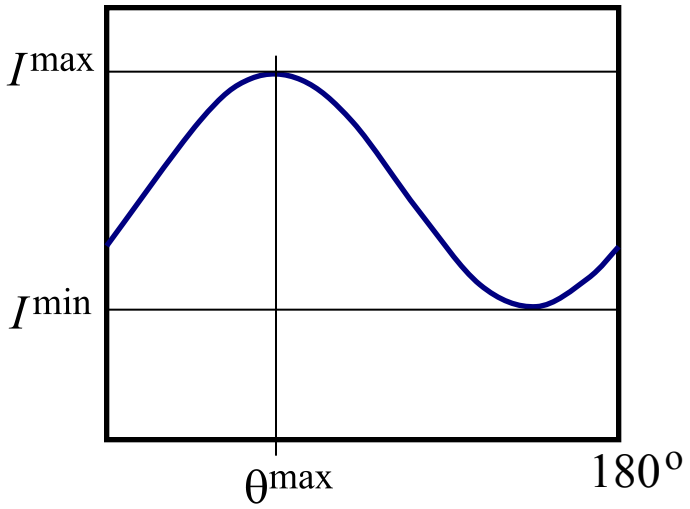
Birefrengence



Interference pattern due to different refractive indices

Light as Plane Waves

- Sinusoidal plane waves very good approximation.
- Very useful for characterizing polarization.



- Polarized Wave: Has only one preferred orientation.
- Un-polarized Wave: Has no preferred orientation.
  or has all orientations.
- Partially polarized wave: Has preferred orientation but has energy in other orientations as well.

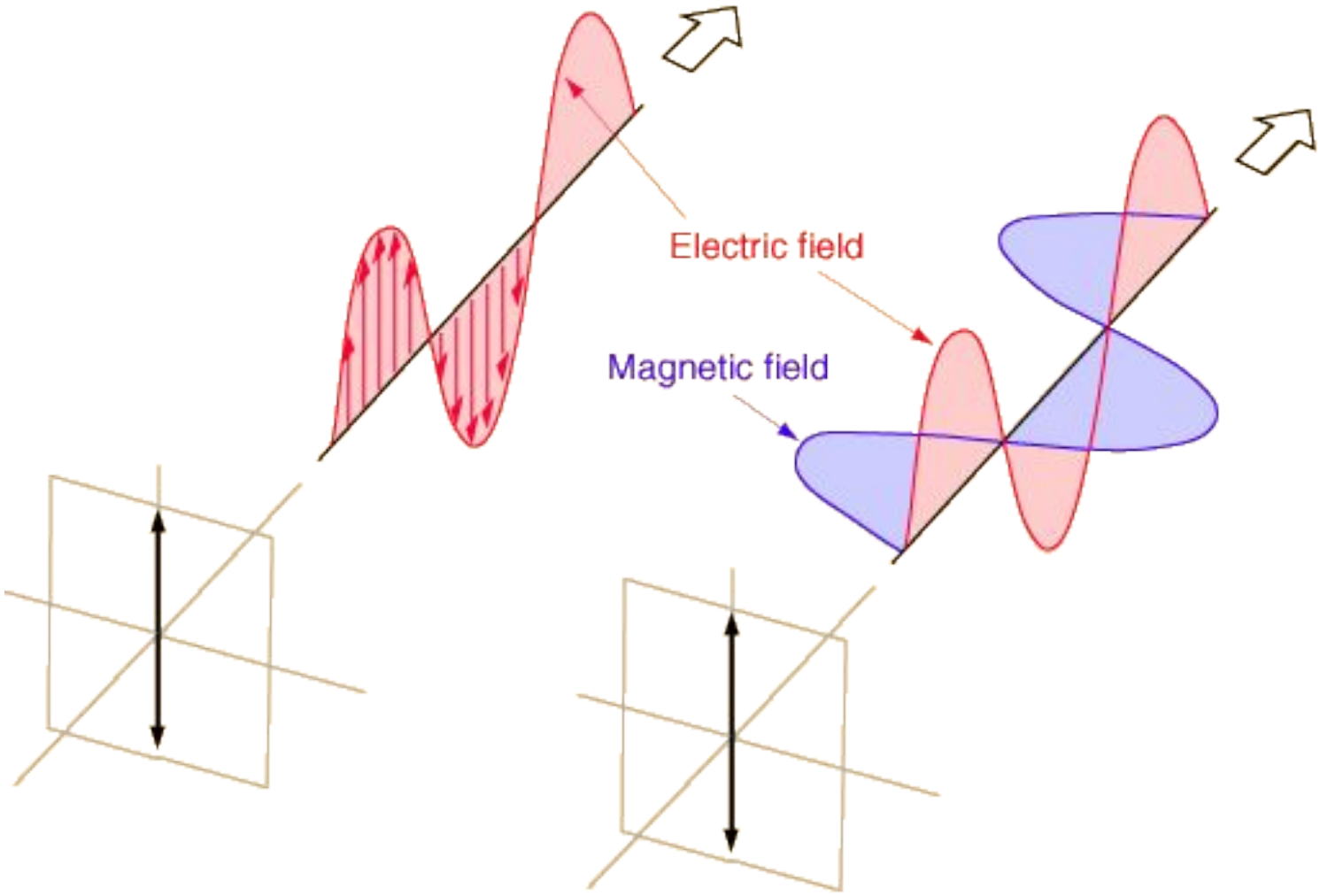
Classification of Polarization

Linear : Two orthogonal plane waves with same phase but possibly different amplitudes.

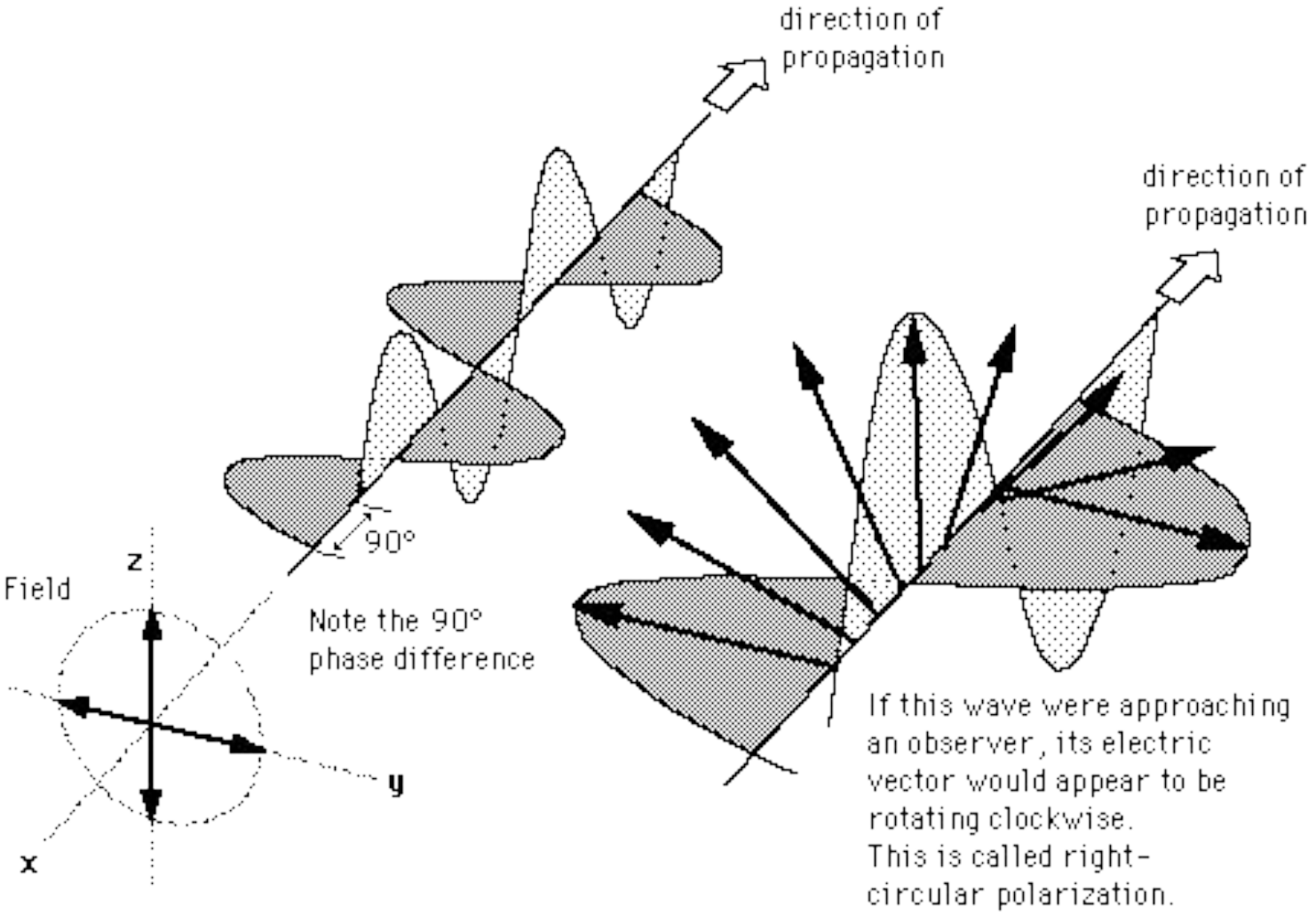
Circular: Two orthogonal plane waves with 90 deg phase shift but same amplitudes.

Elliptical: Possibly any degree phase shift with different amplitudes.

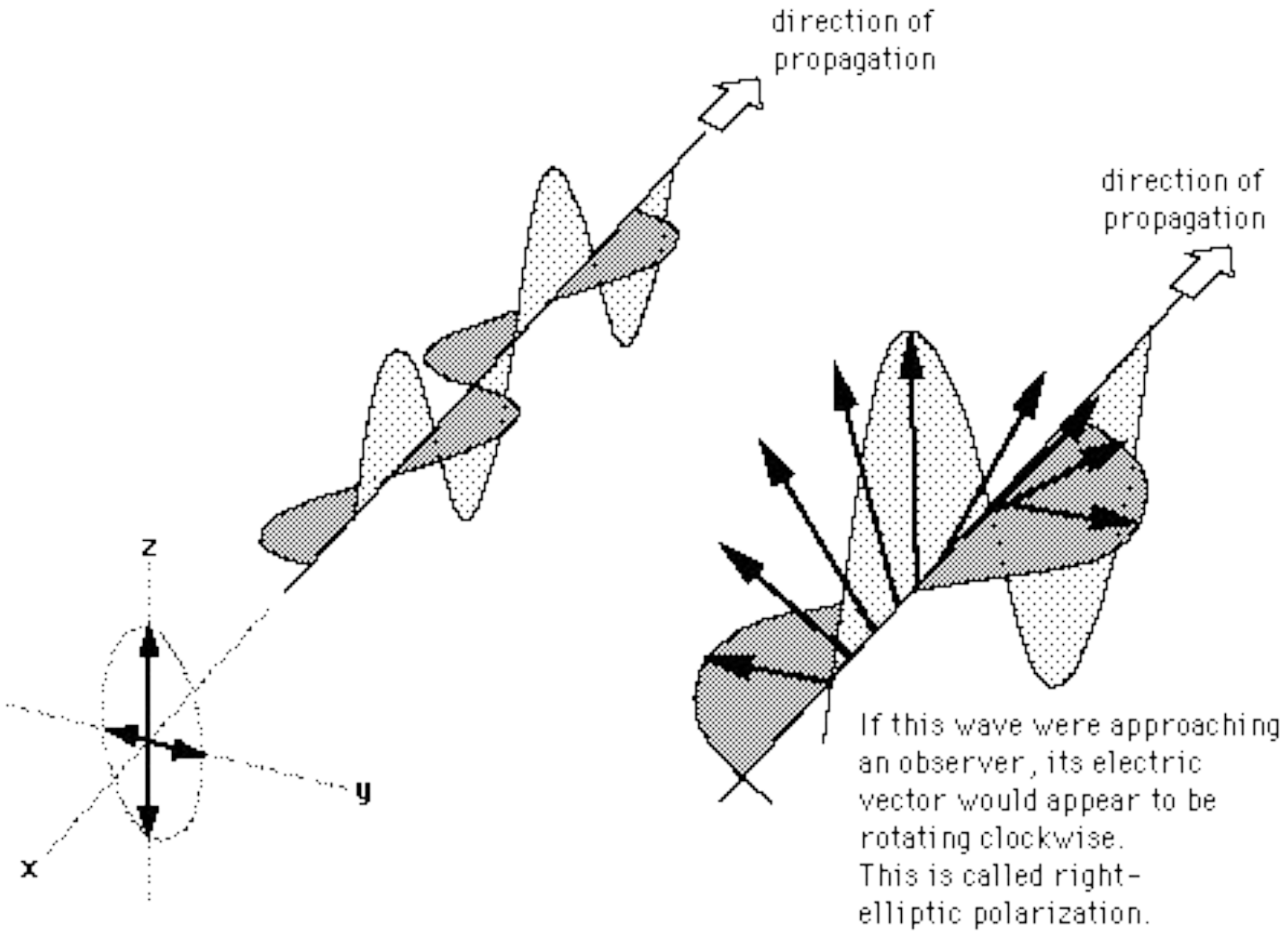
Linear Polarization



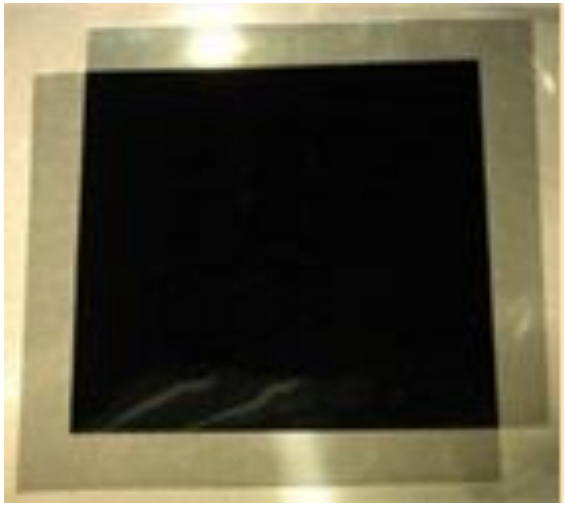
Circular Polarization

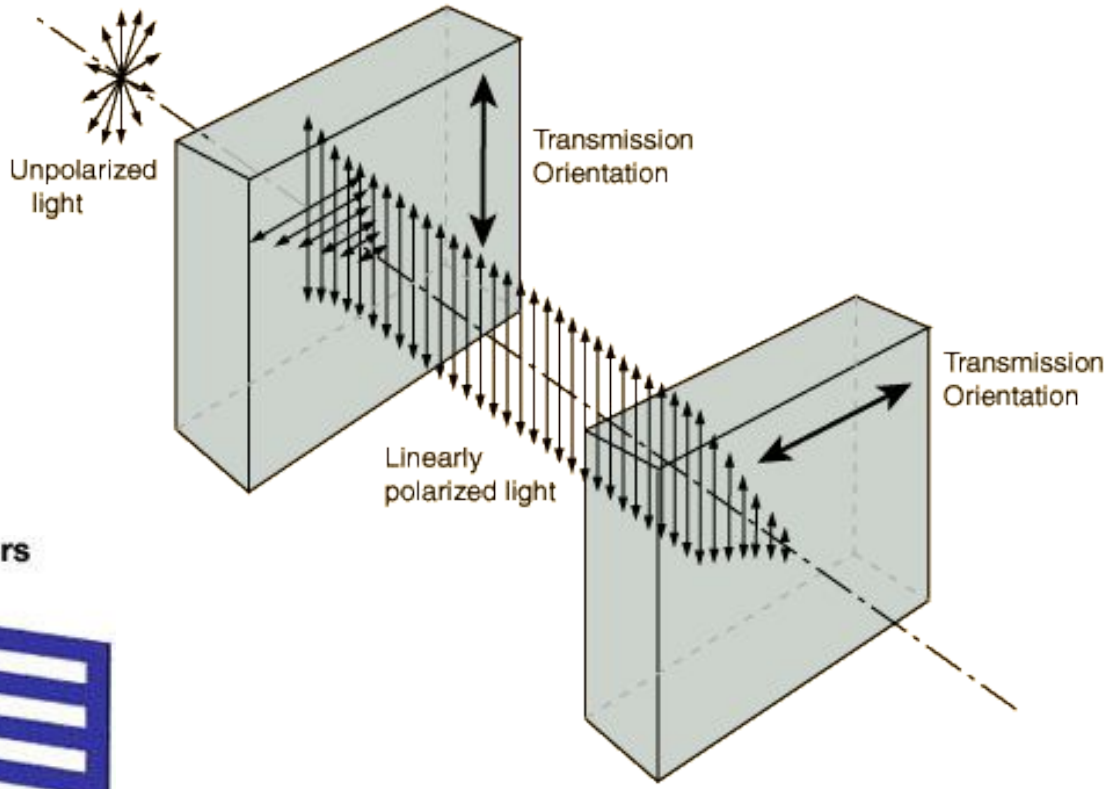


Elliptical Polarization



Crossed Polarizers





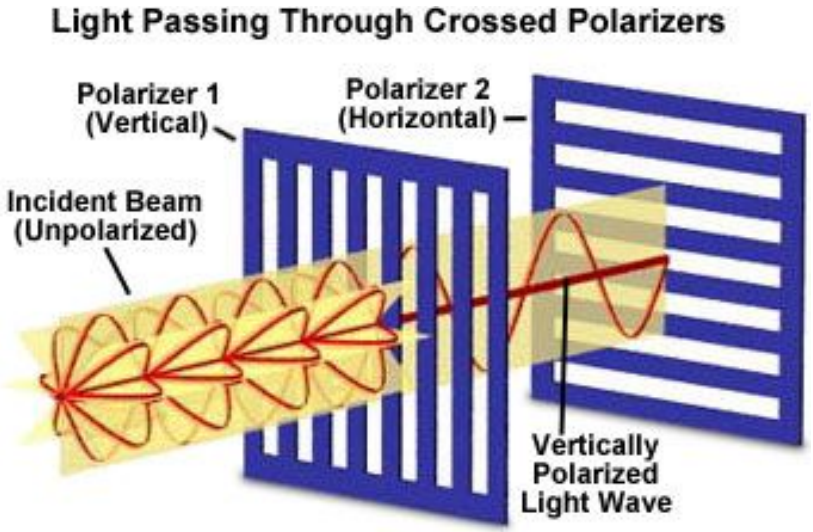
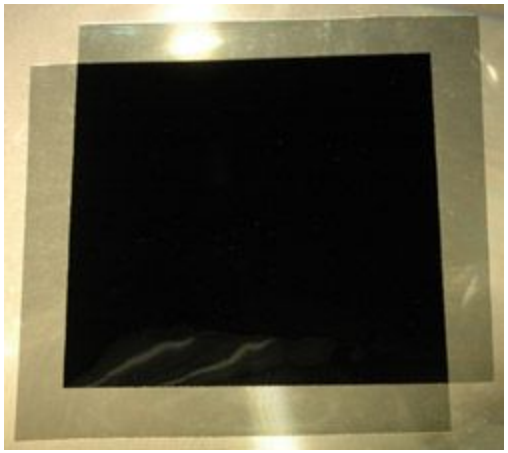
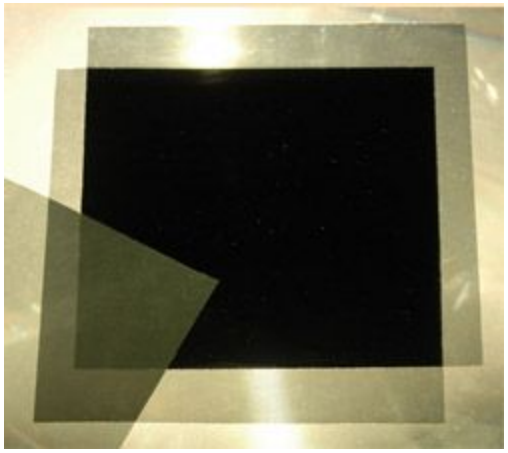


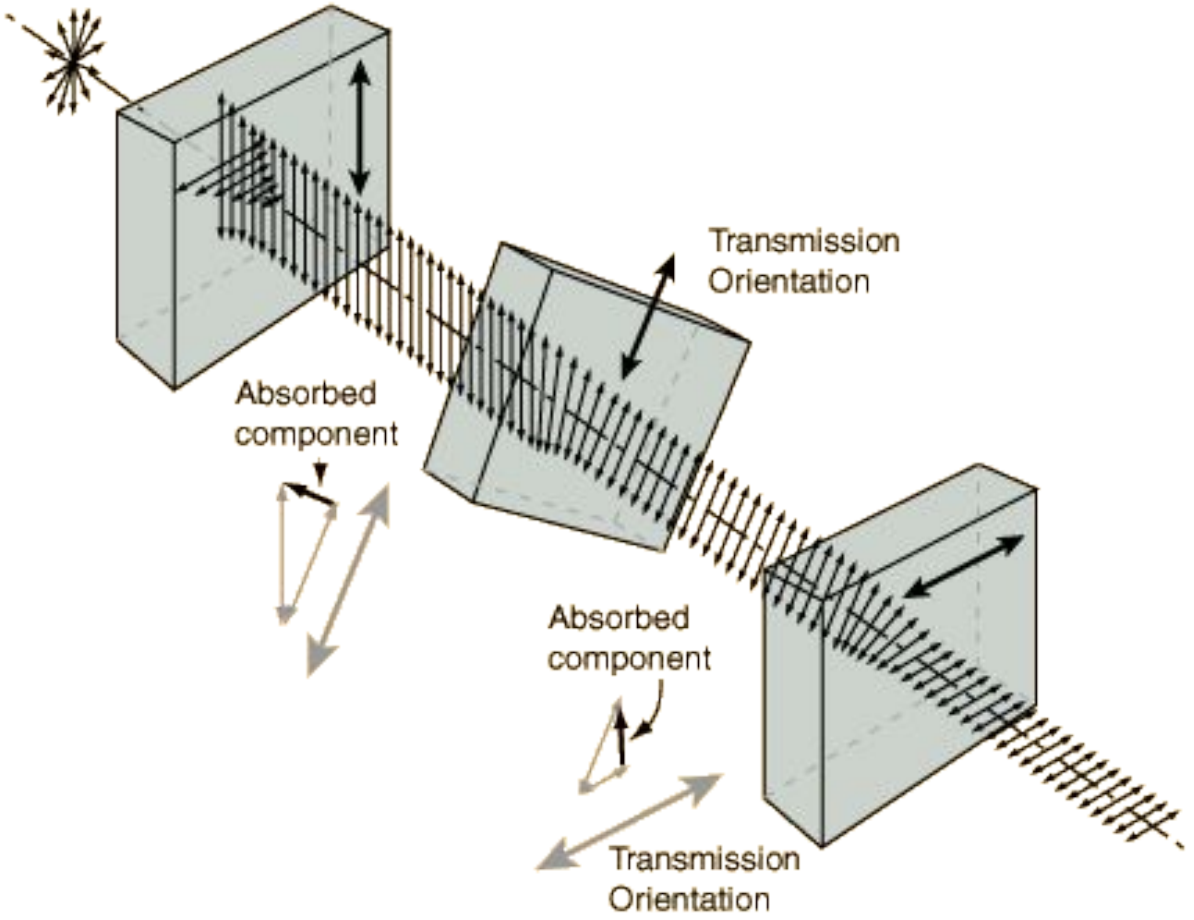
Figure 1

Polarizer Puzzle

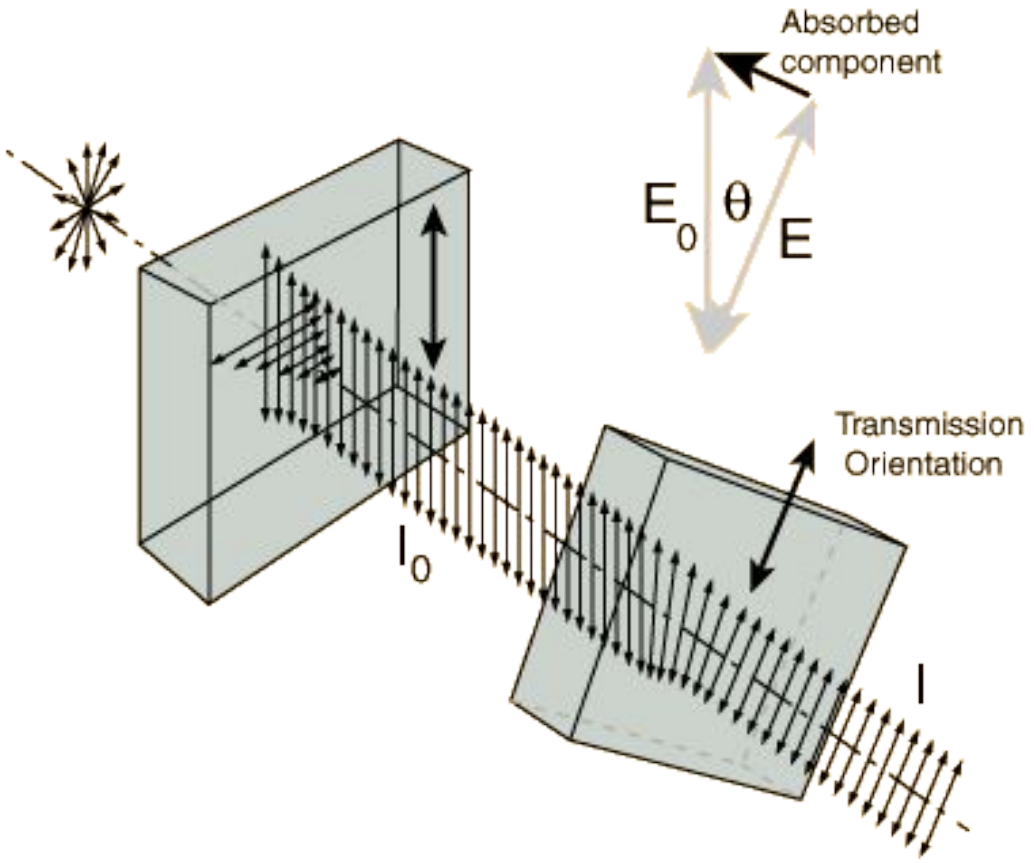
If crossed polarizers block all light, why does putting a third polarizer at 45° between them result in some transmission of light?







Law of Malus



Amplitude:

$$E = E_0 \cos\theta$$

Intensity = Const . (Amplitude)^2

$$I = I_0 \cos^2\theta$$

Law of Malus

Polarized Sunglasses

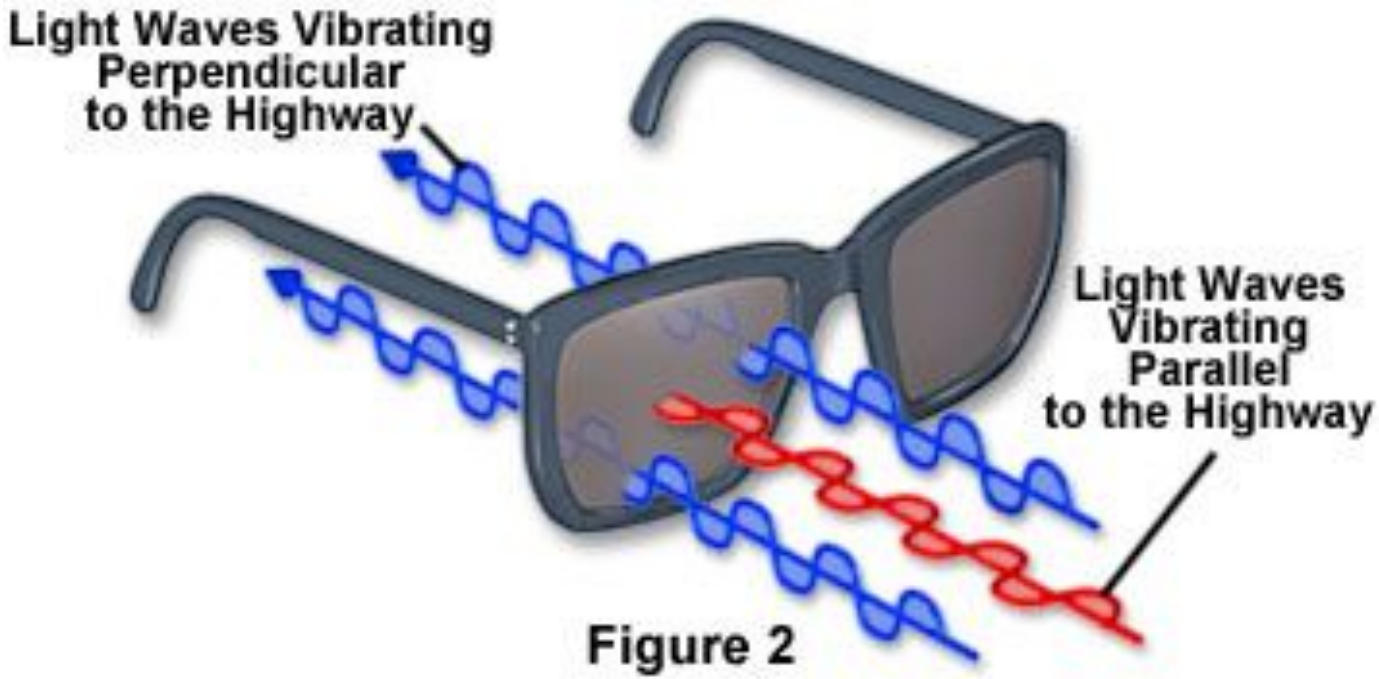


Figure 2

Reduce glare off the roads while driving

NEXT CLASS

Applications of Polarization in Vision

Lecture #18

Thanks to Yoav Schechner, Nayar, Larry Wolff