

Basic Principles of Light Polarization

Polarization Photography

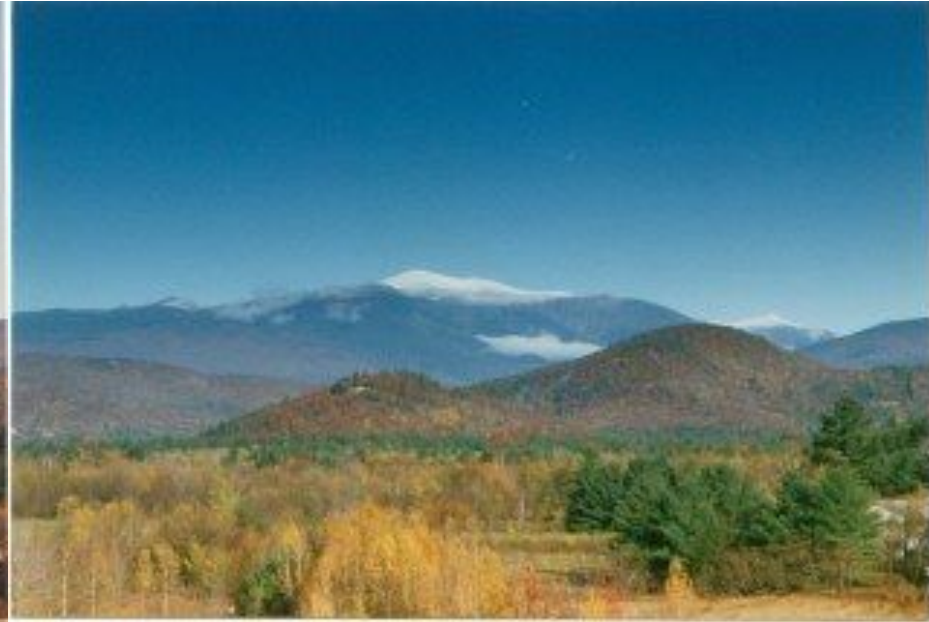


Reduce Sun Glare
Reduce Reflections
Darkens Sky
Increase Color Saturation
Reduce Haze

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



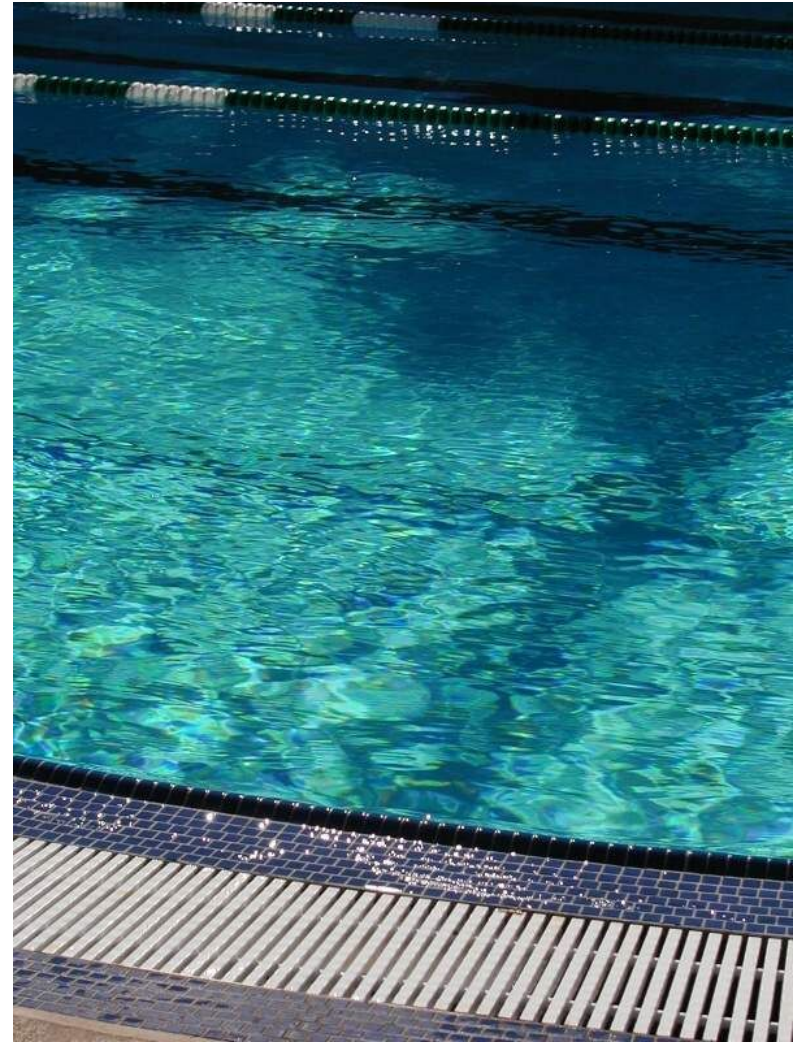
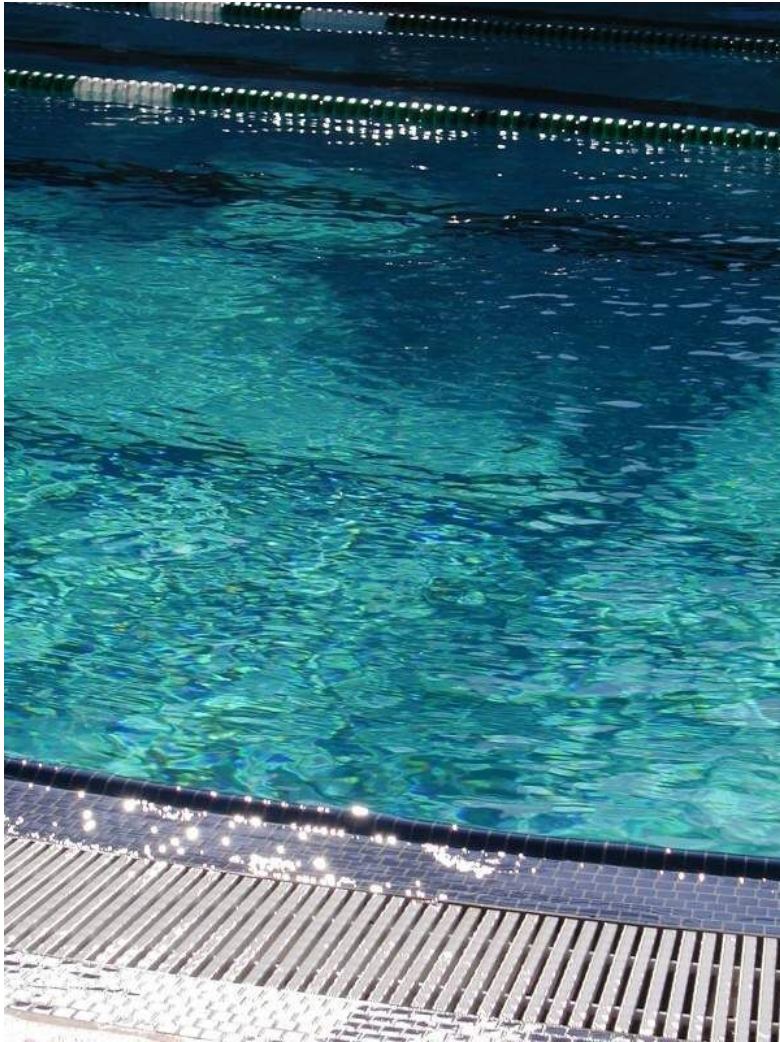
Reduce Reflections

Polarization Photography : Reflections



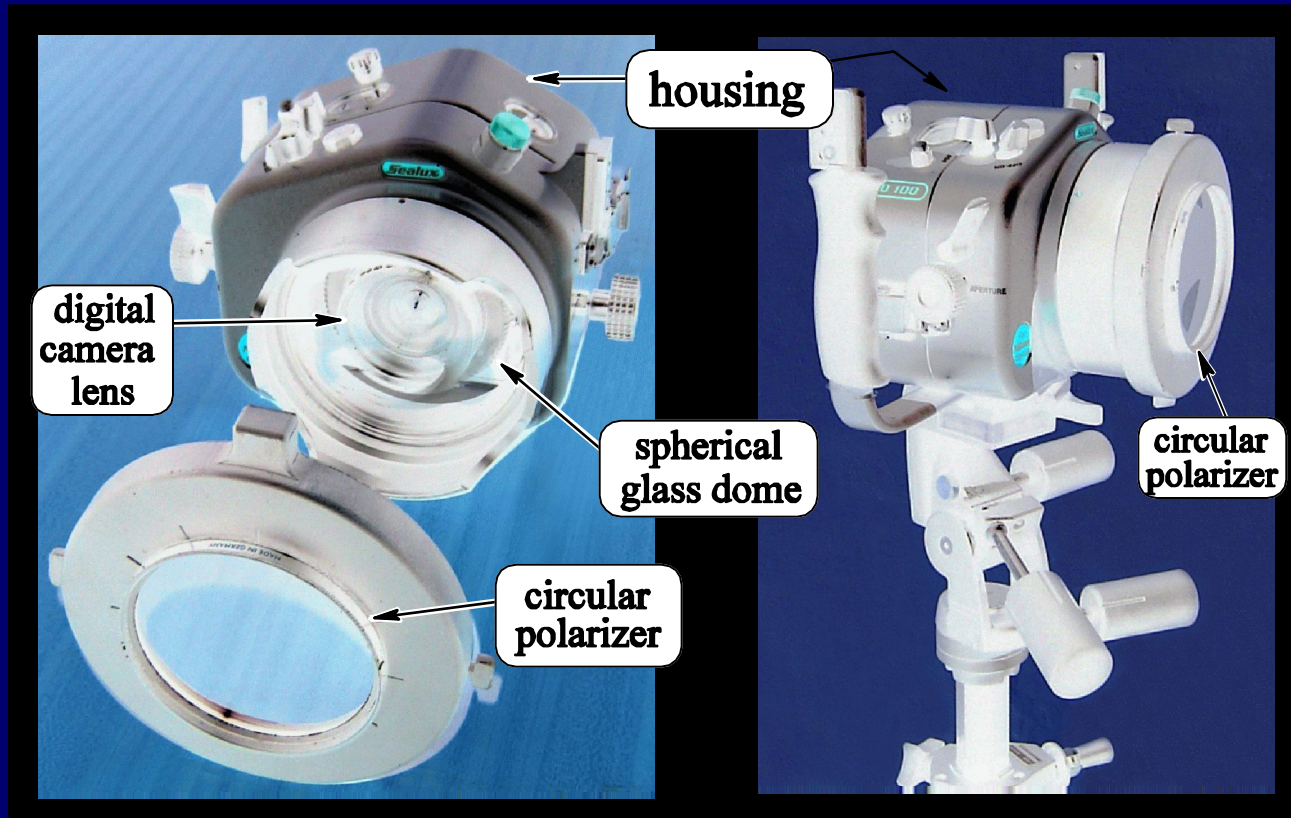
Reduce Reflections

Polarization Photography : Reflections

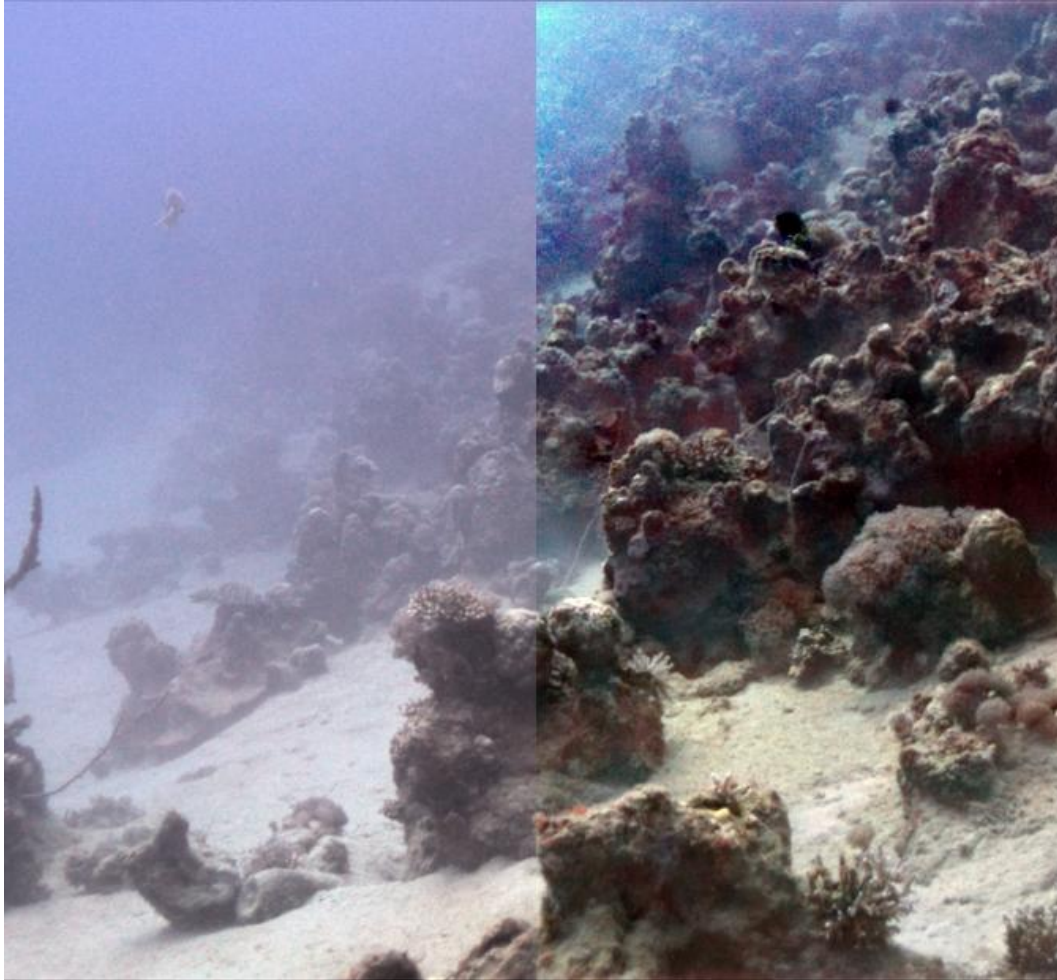


Many titled planes

Aqua-polaricam

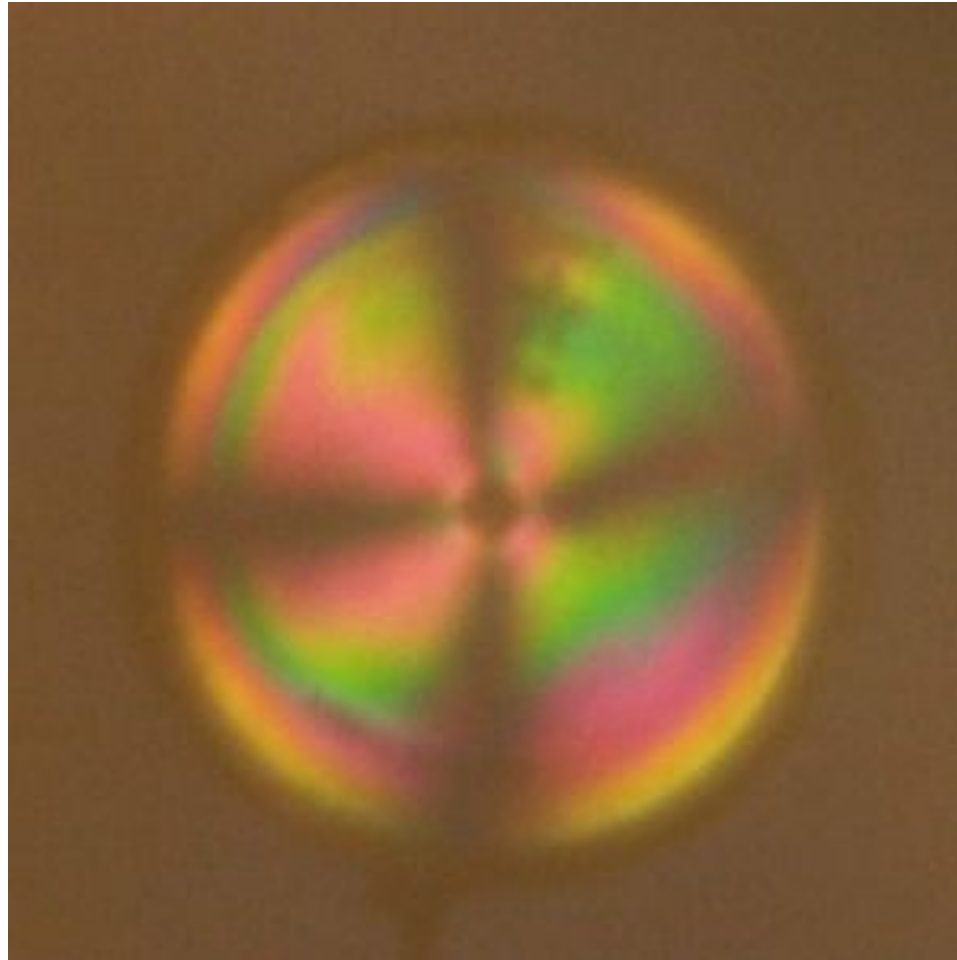


Polarization Photography : Underwater



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

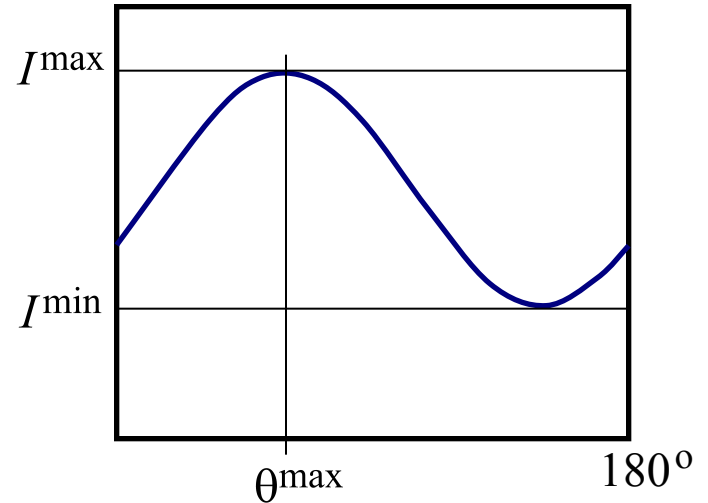
Birefringence



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.

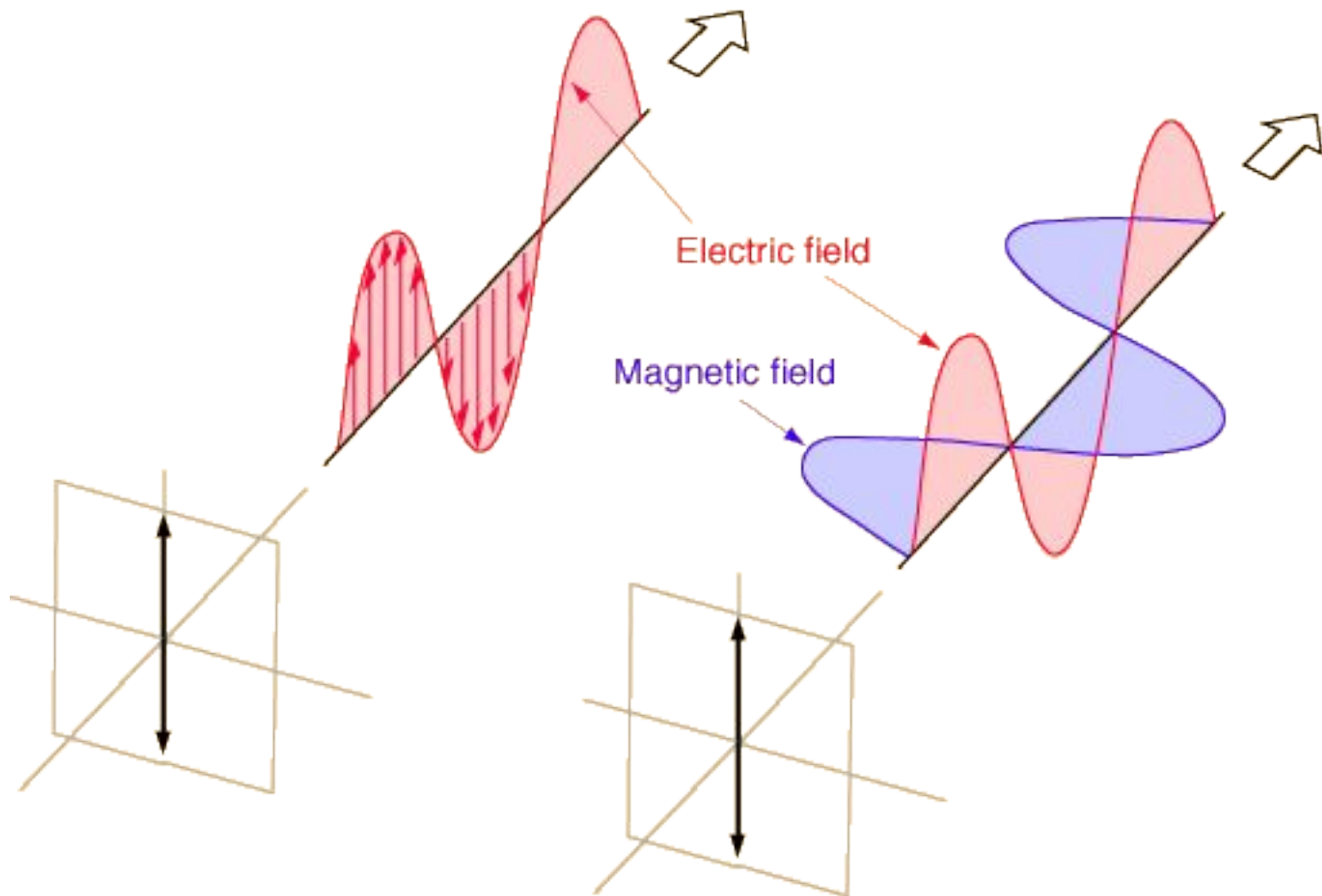
Classification of Polarization

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

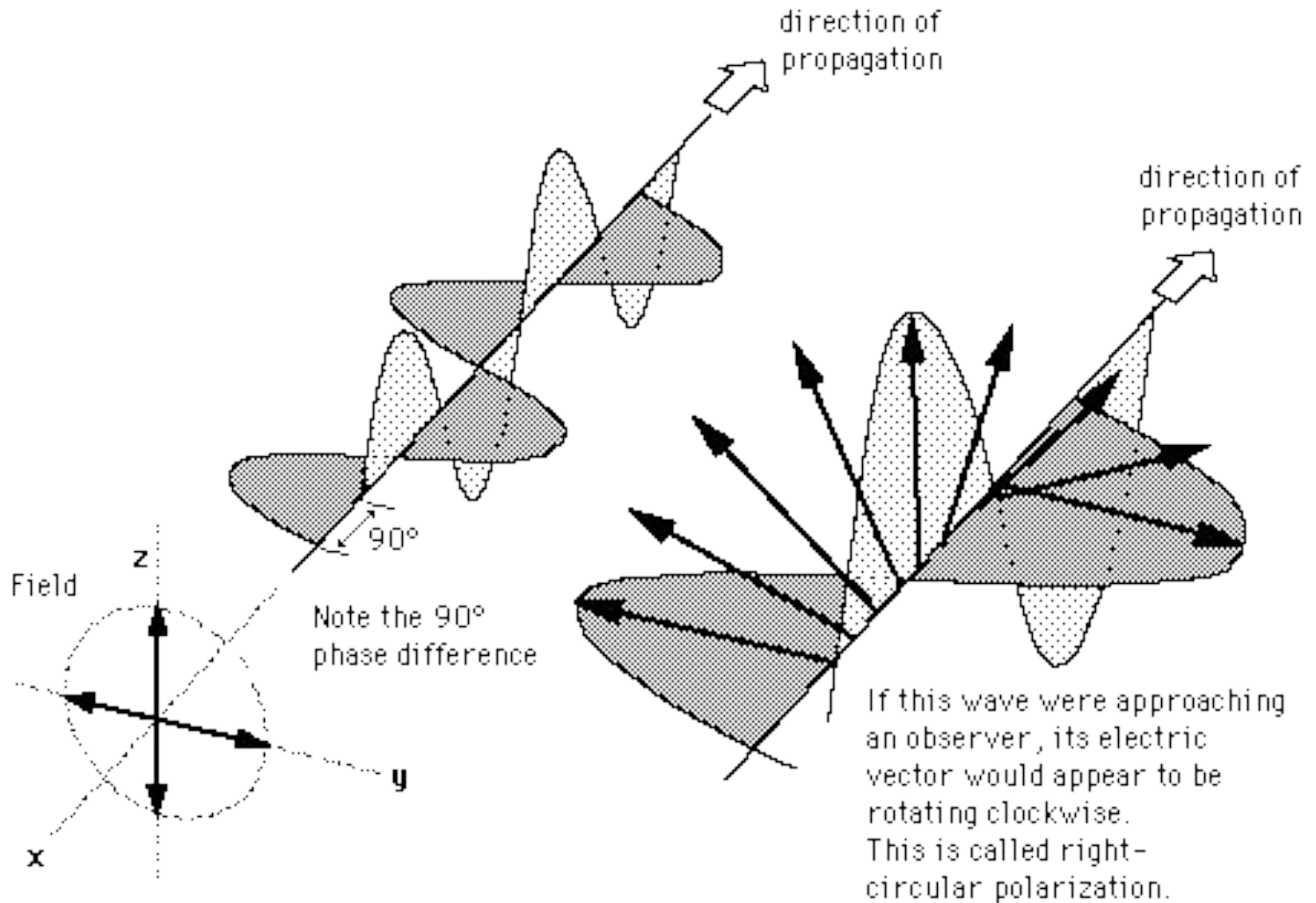
Circular: Two orthogonal plane waves with 90 deg phase shift but same amplitudes.

Elliptical: Possibly any degree phase shift with different amplitudes.

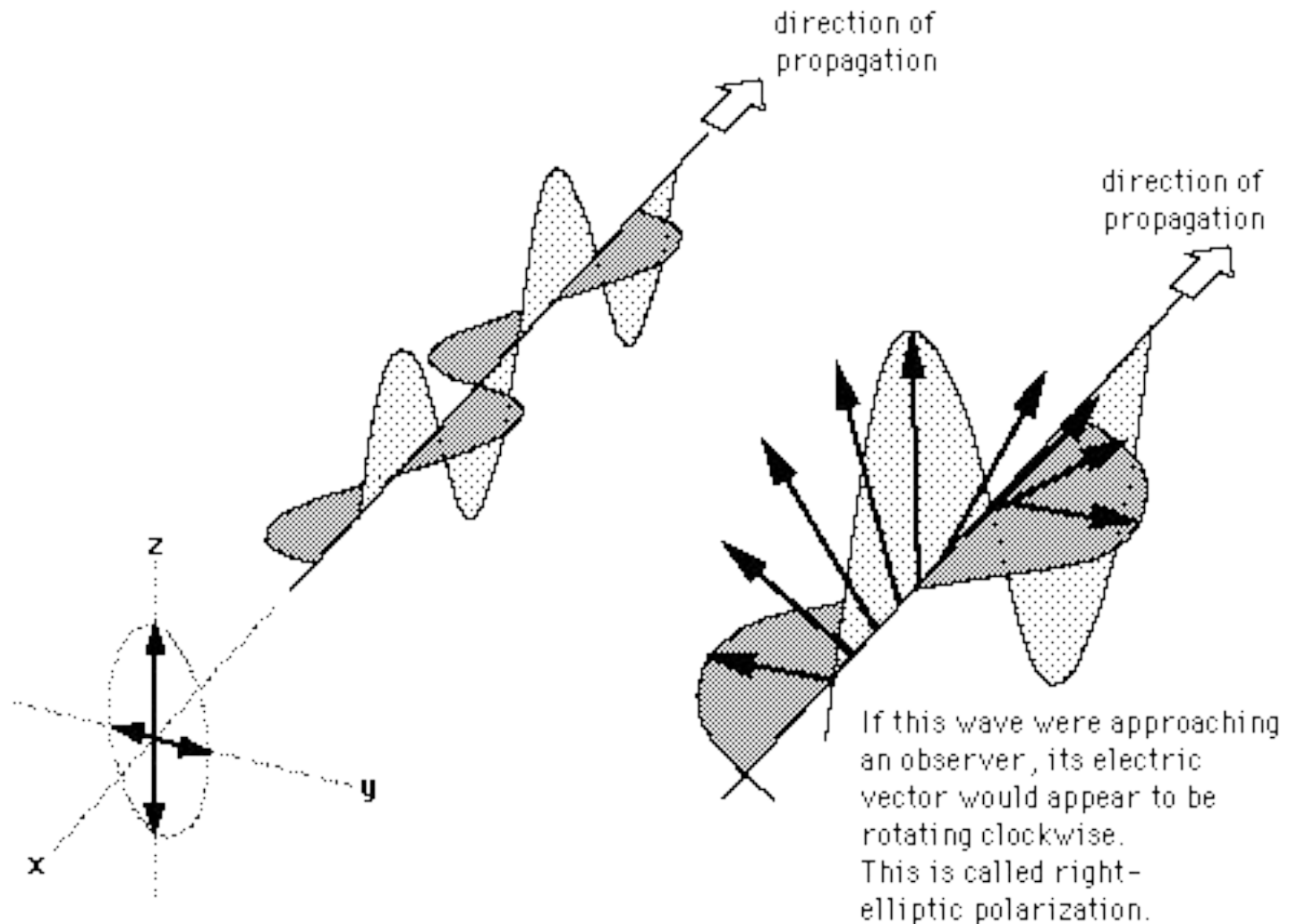
Linear Polarization



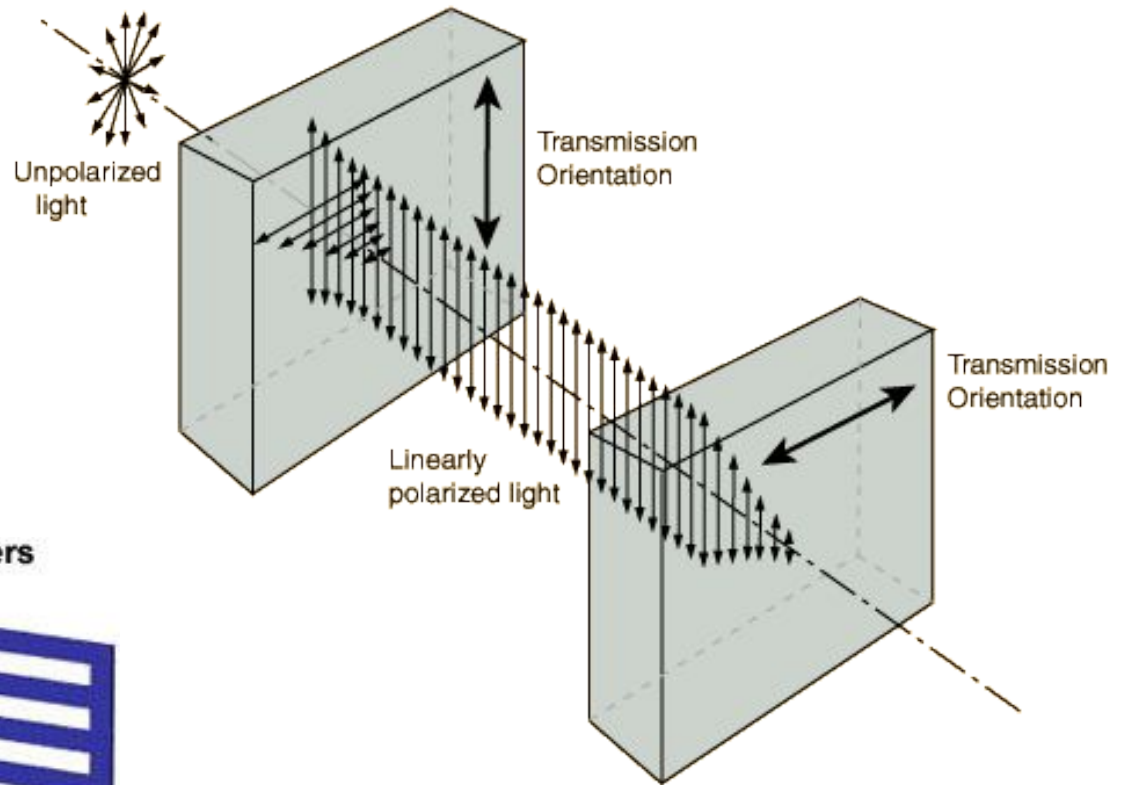
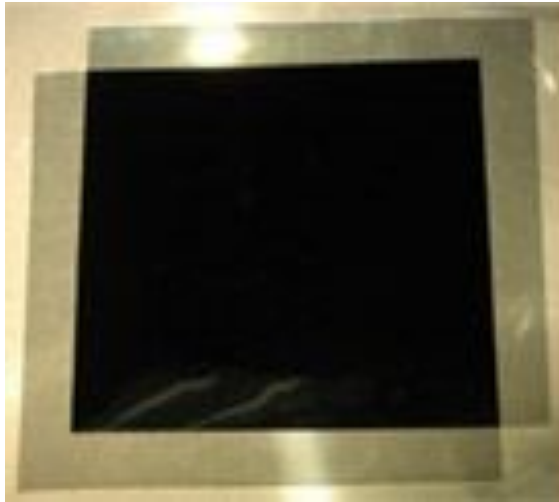
Circular Polarization



Elliptical Polarization



Crossed Polarizers



Light Passing Through Crossed Polarizers

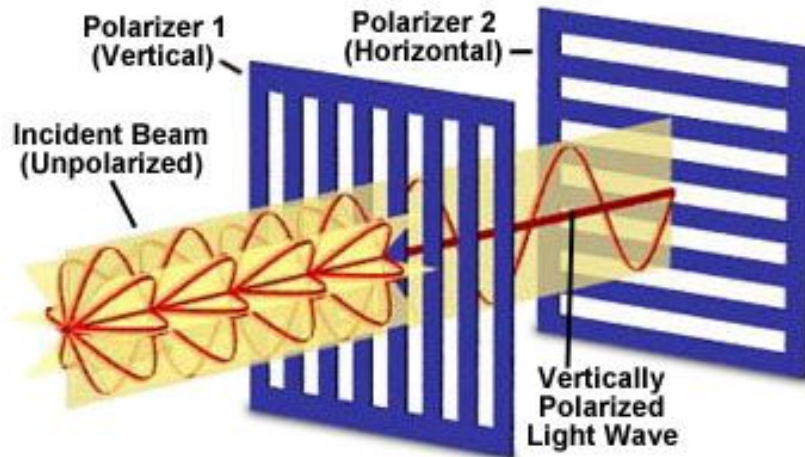
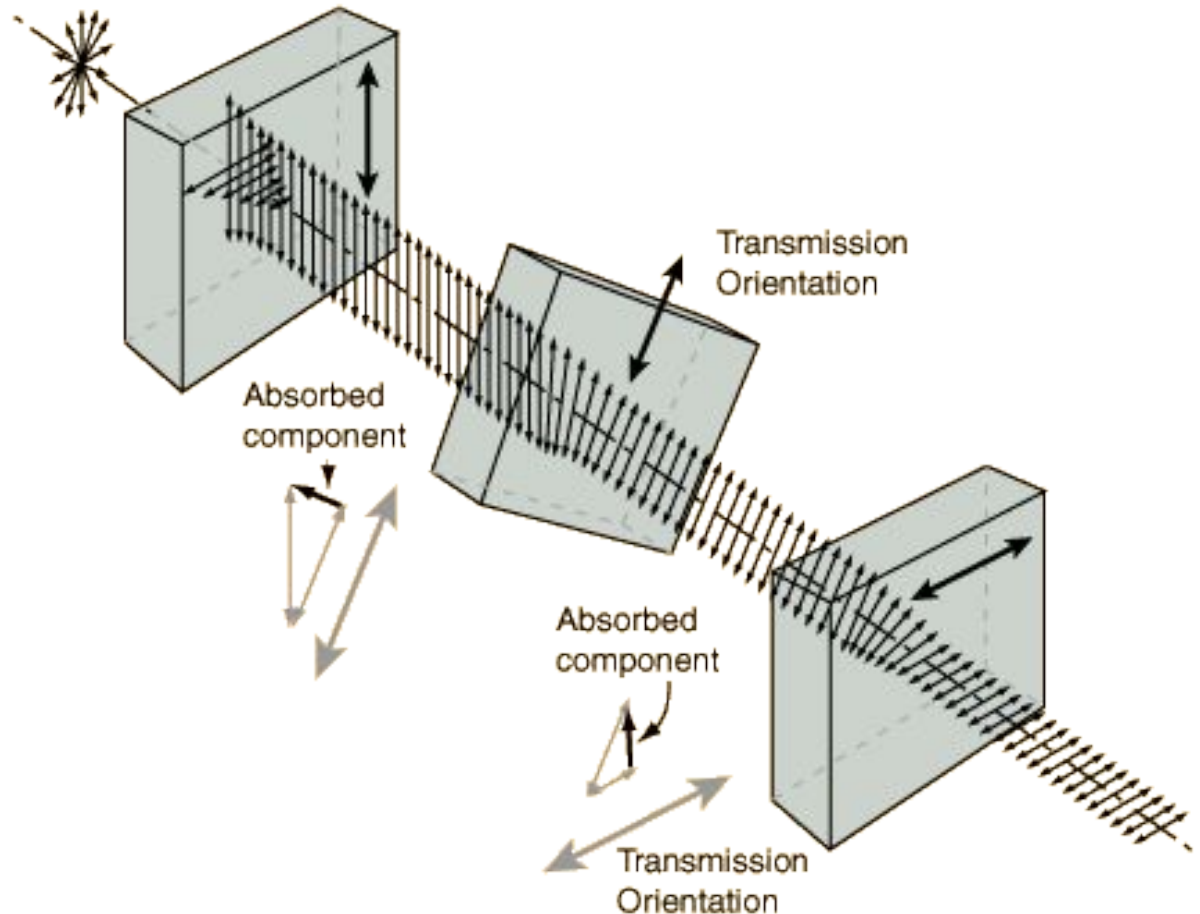
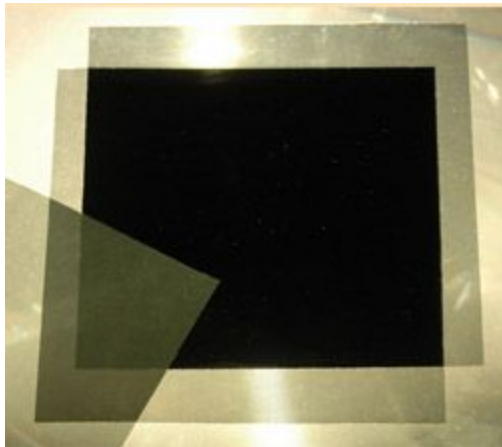
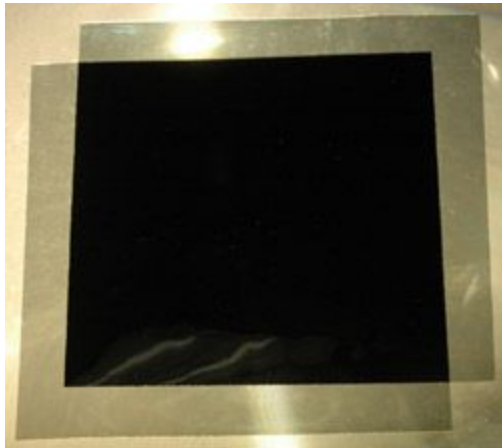


Figure 1

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

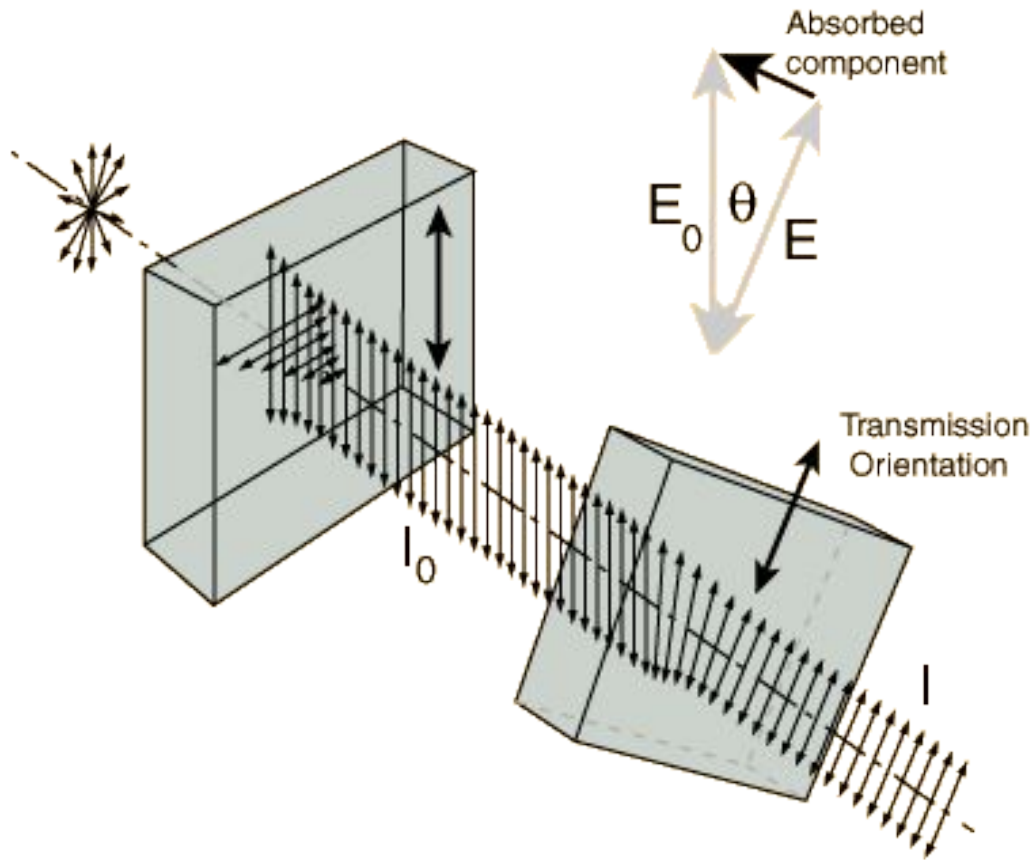
Amplitude:

$$E = E_0 \cos \theta$$

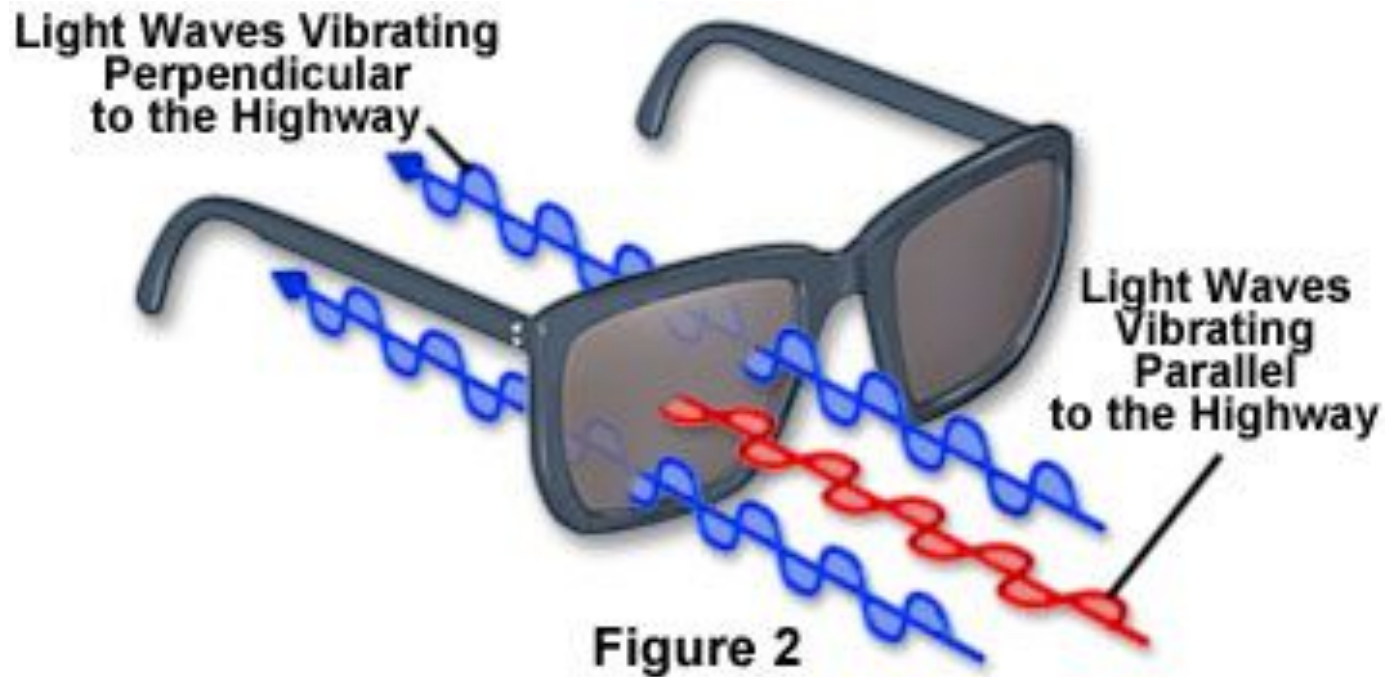
Intensity = Const . (Amplitude)²

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

Law of Malus



Polarized Sunglasses



Reduce glare off the roads while driving

NEXT CLASS

Applications of Polarization in Vision

Lecture #18

Thanks to Yoav Schechner, Nayar, Larry Wolff