

SCHRÖDINGER'S CLUB

AT SAMUELI ACADEMY

Introduction to Quantum Cryptography

with a hands-on polarization laser lab

Today's Agenda:

1. Introduction to light as an electromagnetic wave & polarization
2. Introductory polarization lab
3. Quantum Measurements using polarization
4. Introduction to Quantum Cryptography
5. Quantum Cryptography lab with polarization filters and lasers

Donn Silberman
Mentor



Light is an Electromagnetic Wave

- **Amplitude** → Size of each vibration
- **Direction** → Path of each vibration
- **Length** → Separation between vibrations

Scientists study the properties of things.

Properties of waves include:

Amplitude, Direction, Length

Light is an Electromagnetic Wave

- **Amplitude** → Size of each vibration → *Power*
- **Direction** → Path of each vibration
- **Length** → Separation between vibrations



dim light
small vibrations

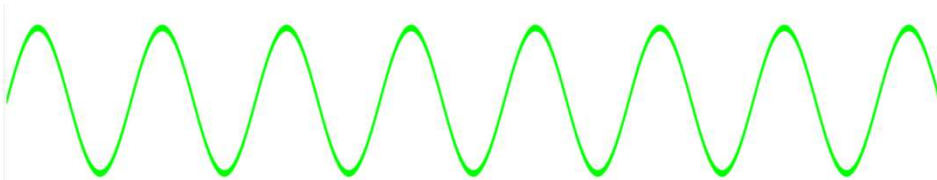


Bright Light
LARGE VIBRATIONS

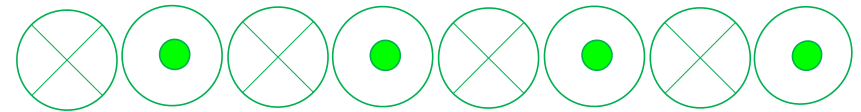
Images courtesy Brian Monacelli

Light is an Electromagnetic Wave

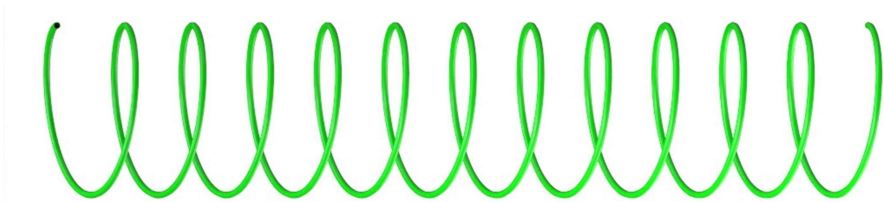
- **Amplitude** → Size of each vibration → *Power*
- **Direction** → Path of each vibration → *Polarization*
- **Length** → Separation between vibrations



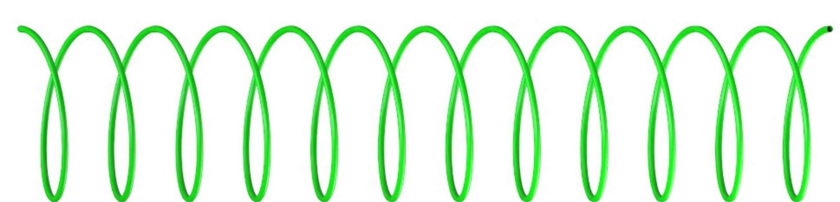
Vertical Linear Polarization



Horizontal Linear Polarization



Left Circular Polarization



Right Circular Polarization

Unpolarized (or Randomly Polarized) Light

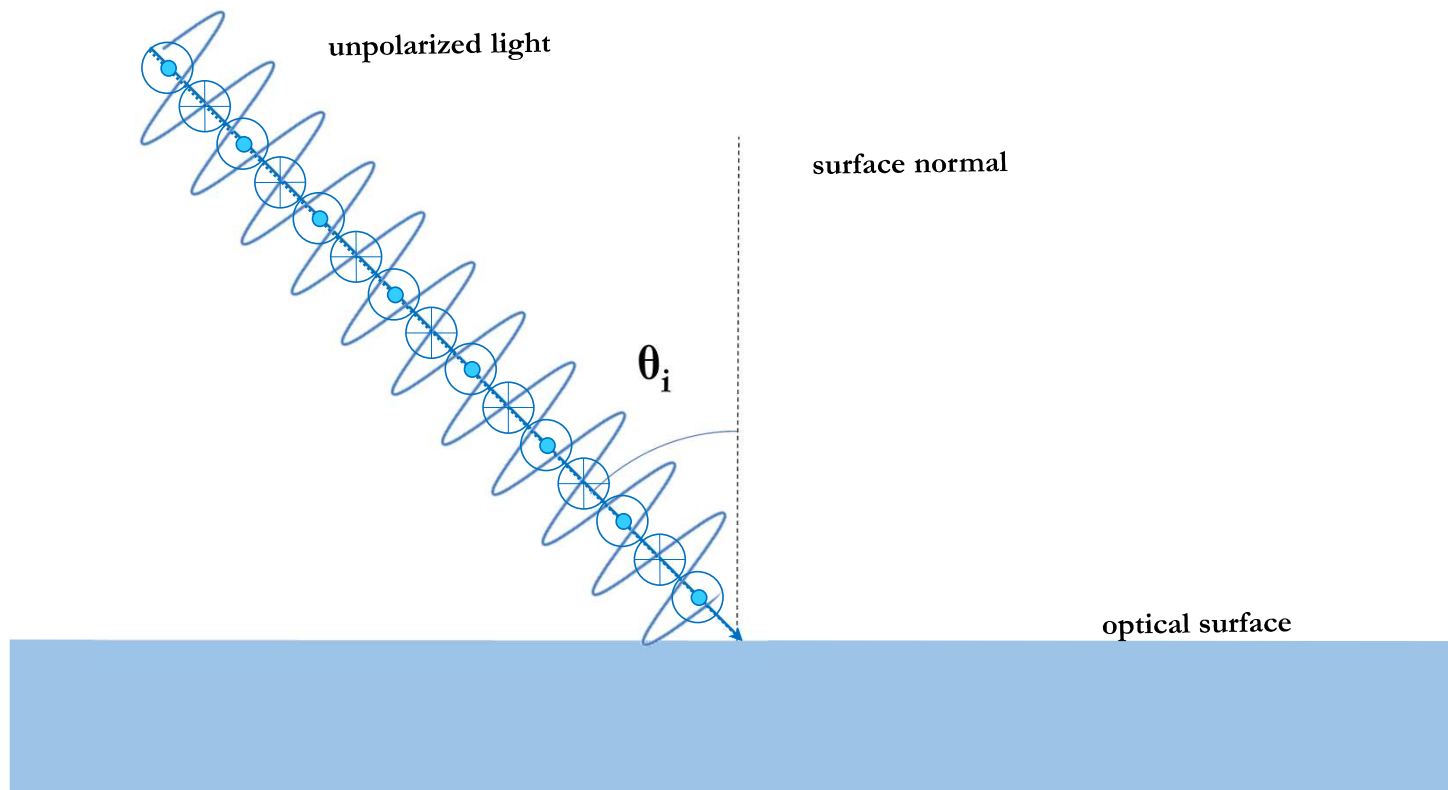


Figure courtesy Brian Monacelli

Linear p-polarized Light

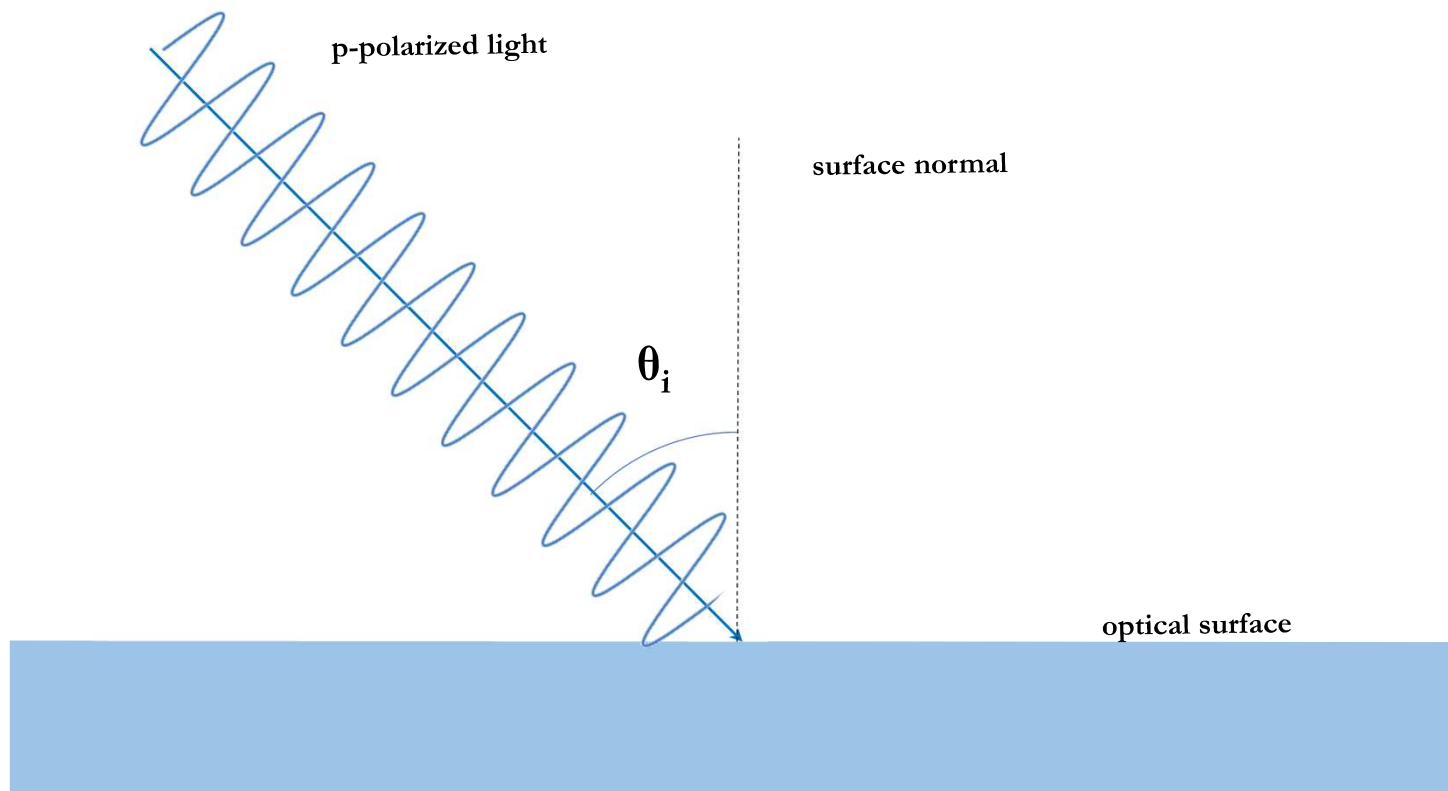


Figure courtesy Brian Monacelli

Linear s-polarized Light

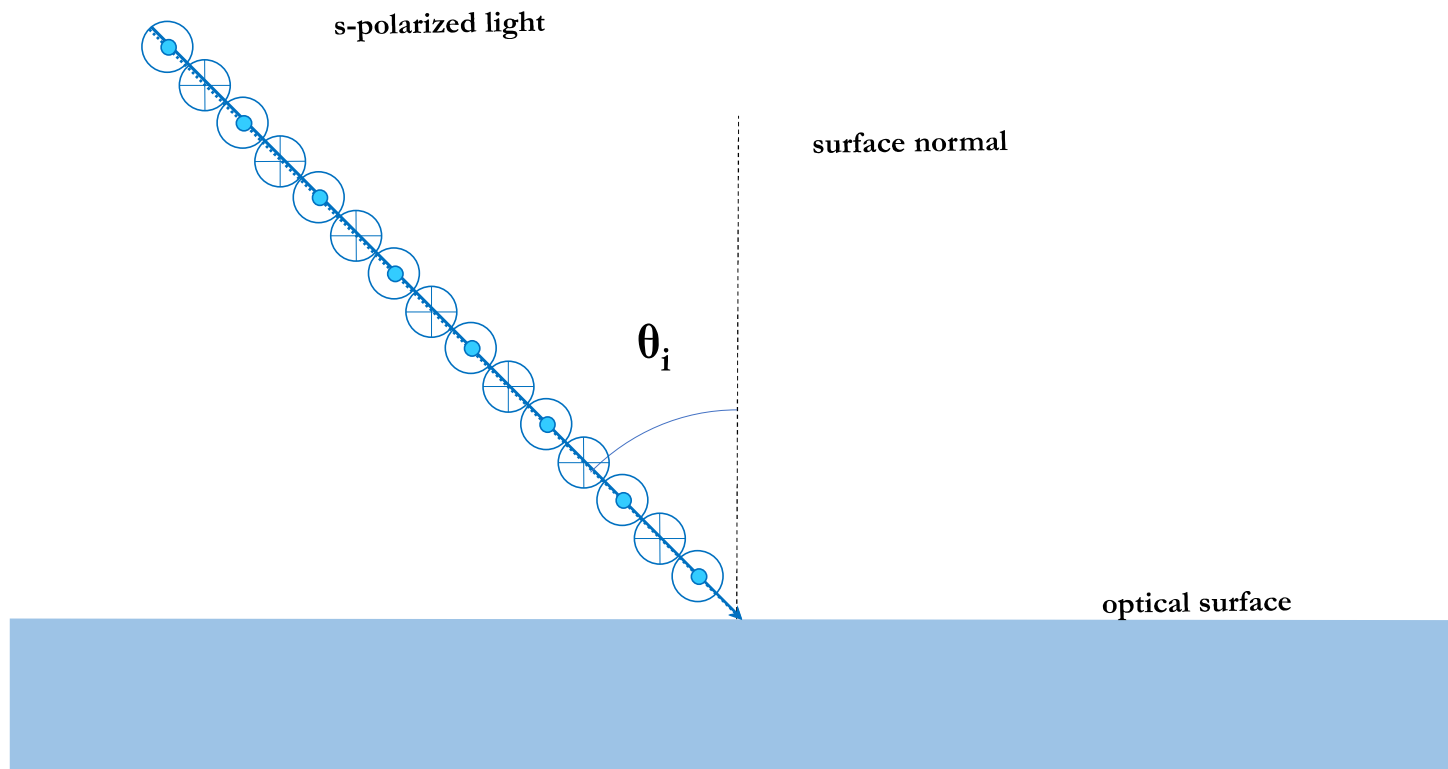


Figure courtesy Brian Monacelli

Linear Polarizers

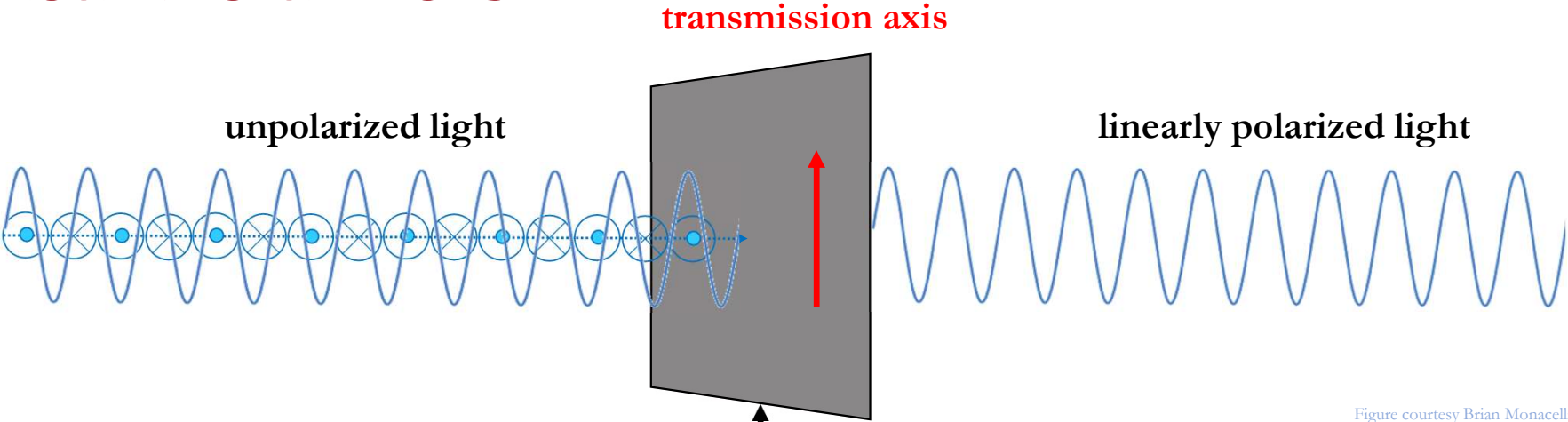
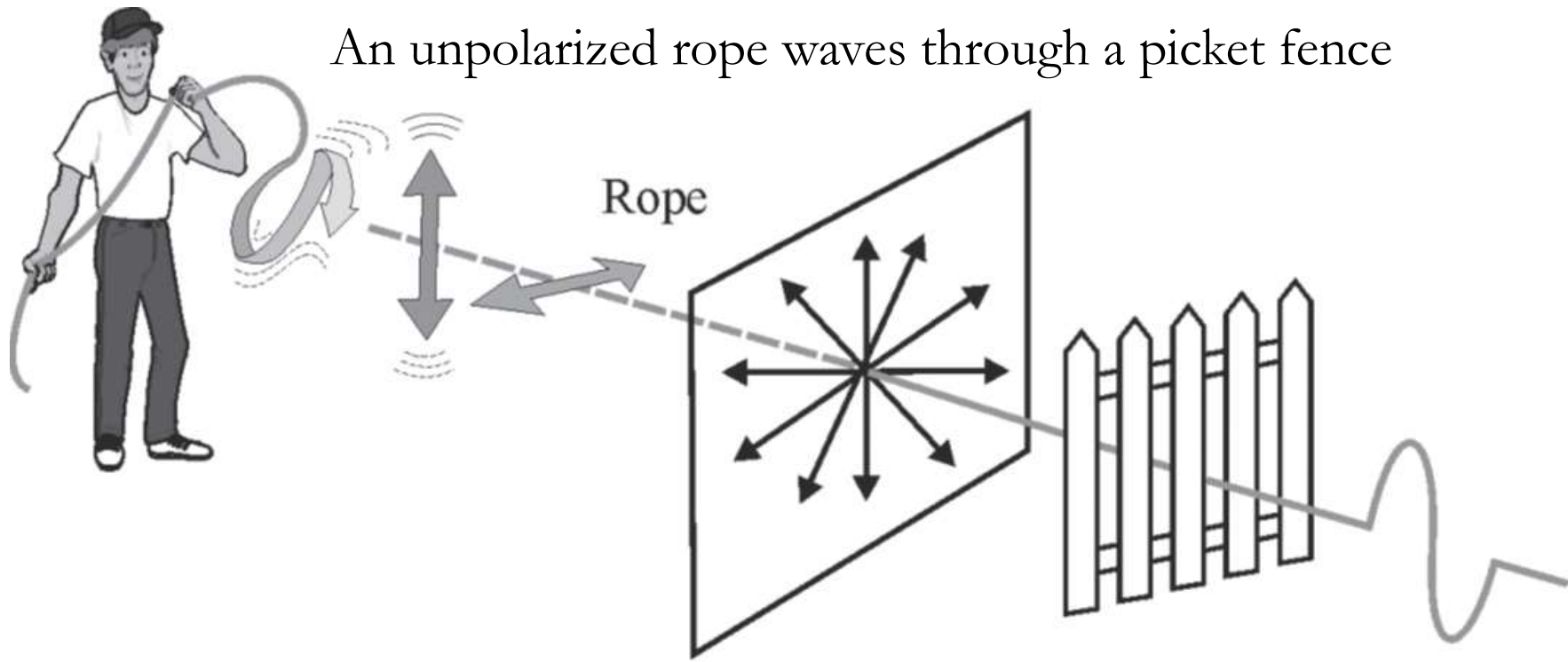


Figure courtesy Brian Monacelli



Image courtesy Erin Monacelli

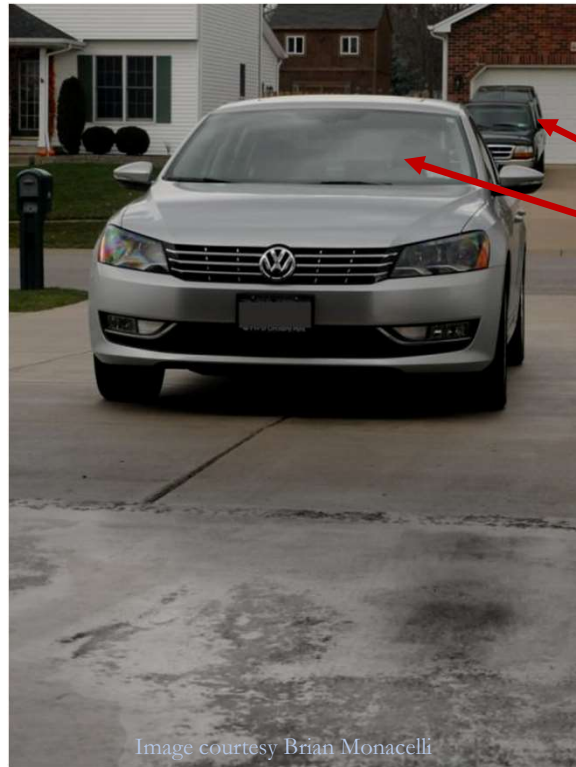
Polarization Analogy



On the other side of the picket fence, the rope's motion is polarized along the slats

Polarized Sunglasses Block Glare

without polarized sunglasses

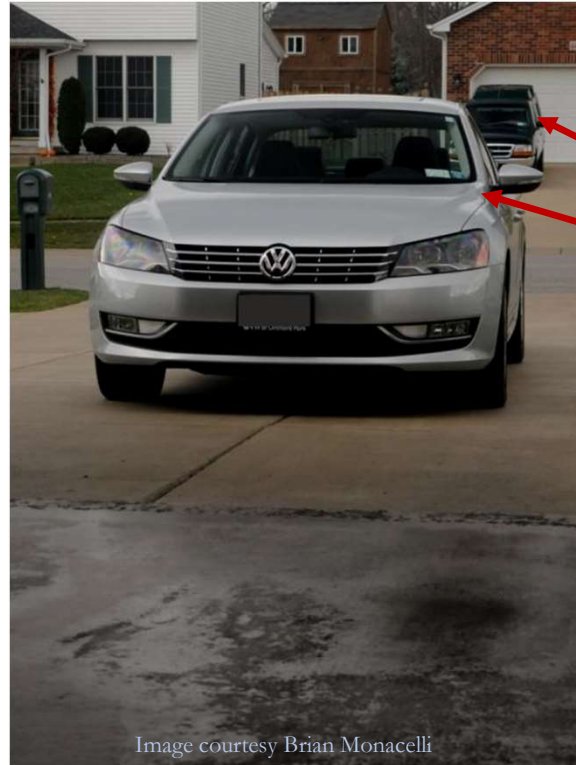


Watch the car windshields and hood

Polarizers block horizontally s-polarized light, and transmit vertically p-polarized light

Polarized Sunglasses Block Glare

with polarized sunglasses



Watch the car windshields and hood

Image courtesy Brian Monacelli

Light reflecting off the ground is horizontally s-polarized

Polarized Sunglasses Block Glare

without polarized sunglasses

Watch the reflected images of the pictures on the wall in the glass tabletop.



Polarizers block horizontally s-polarized light, and transmit vertically p-polarized light

Polarized Sunglasses Block Glare

with polarized sunglasses

Watch the reflected images of the pictures on the wall in the glass tabletop.



Light reflecting off the glass is horizontally s-polarized