Polarization

GOALS FOR PLAYING WITH OPTICS LAB
Introduce the students to nomenclature and concepts associated with polarization in the natural light field.

LABORATORY SAFETY ISSUES– ***No hazardous chemicals; general laboratory safety; do not look directly at the sun<http://eclipse.gsfc.nasa.gov/SEhelp/safety2.html>; avoid contact with eyes in the labs with laser pointers*** < the classic laser lab warning sign is "*Do not look at LASER with remaining good eye*"!>

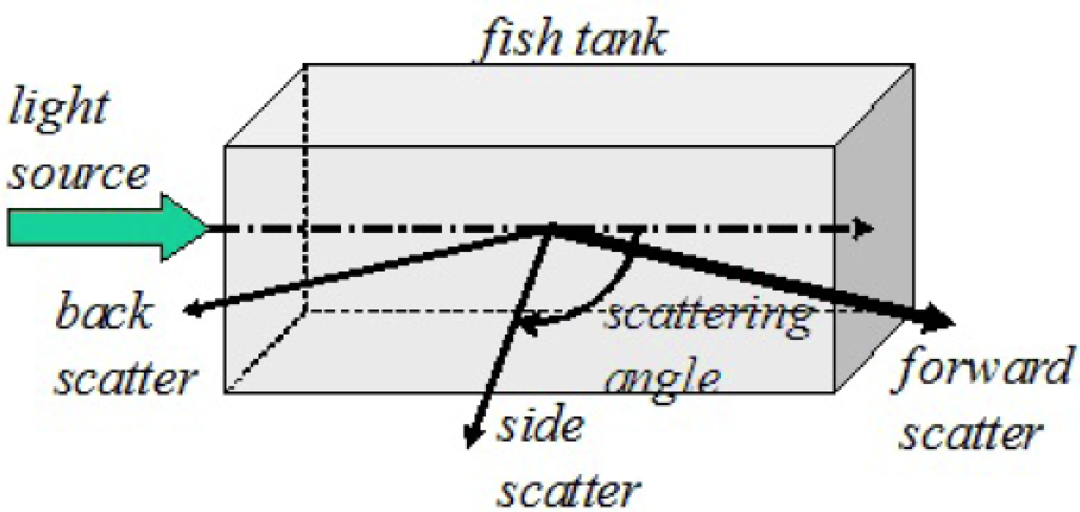
LAB DIRECTIONS:

This is really just an exploration of polarization in the natural light field, and mostly qualitative, not quantitative. It picks up several parts which you might have done before (but hopefully understand more of now), and lets you explore more on your own.

Station 1: Scattering and reflection affect the polarization state of light interacting with matter. Polarization is a relatively new frontier in ocean optics and has been shown to be useful to avoid glare, and help characterize the composition of particulate materials in the ocean.

a. Polarization due to scattering of a light beam

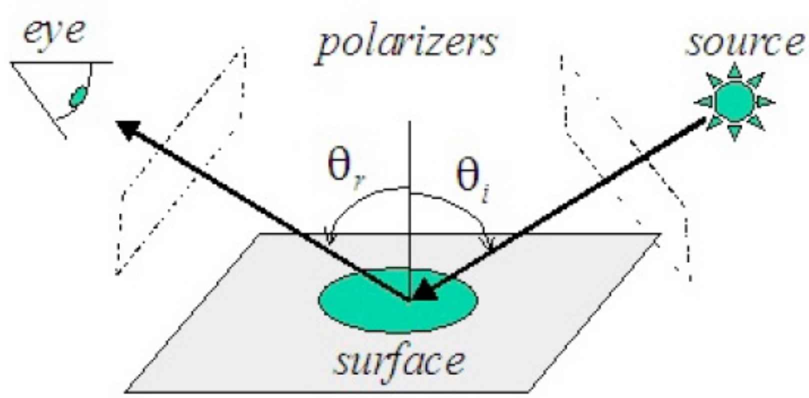
a. Shine a collimated light source through from the sides of an aquarium. Add a few drops of Maalox and observe the intensity of the beam as function scattering angle (relative to the direction of propagation, see diagram) and azimuth angle. How does the intensity change?



b. Holding a linear polarizer, observe the beam at 90° scattering angle and rotate the polarizer on its axis. Does the intensity change with the axis of your polarizer? Now observe the beam from other scattering angles. How does the relative change in intensity (between the two axes of polarization) vary with scattering angle?

c. Do the same experiment but with a laser as a source. Observe the beam through the polarizer from a 90° scattering angle as you rotate the laser on its axis (shining in the same direction). Can you explain the observation given the fact the laser is linearly polarized?

b. Reflection from surfaces



Look at the specular reflection of a collimated unpolarized light from a smooth non-metallic surface (e.g. plastic, wood, or water). View the surface through a linear polarizer.

a. How does the intensity vary with the direction of the polarizer?

b. What if you use a polarizer in front of the source before it interacts with the surface?

c. How different are the result for a metallic surface?

d. View polarized light as it reflects from a depolarizing surface (white diffuser), is it still polarized at all? Vary the polarization of the input light (parallel and perpendicular to surface).

Station 2: Polarization in the natural light field
Scattering due to molecules and aerosols cause skylight to be partially linearly polarized. Even clouds maintain this polarization to some degree (actually interesting patterns there). Reflection from the water surface also will introduce polarization.

Part 1, skylight:
Using your linear polarizer, view the sky with the polarizer at different angles. Where is the skylight most polarized (biggest difference between having the polarizer and not having it)? What is the plane of polarization in different areas of the sky?

Part 2, Water surface:
Find somewhere you can view the water surface (hopefully flat water, but also look in areas of wind ruffled surface to check that out). Look for angles of both the polarizer and your viewing angles which most strongly eliminate the surface reflectance.