MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Physics Department

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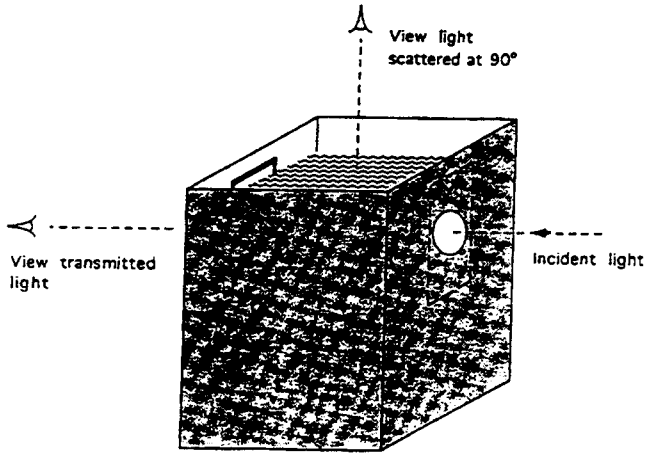
Take-Home Experiment #4

SCATTERING OF LIGHT

Objective In this experiment you will investigate the scattering of light by a collection of independent, isotropic, polarizable particles. You will be able to observe the frequency dependence of the scattering and the polarization of the scattered light. It is just this sort of scattering that produces the color and polarization of sky light, where the polarizable particles are the molecules that make up the atmosphere.

Experiment Obtain a half gallon milk or juice carton with flat, rectangular sides. Either plastic (translucent) or plastic covered cardboard (opaque) will do. Cut the carton off evenly at a height of about 6 inches above its base. Use a penny as a template to cut two circular holes in opposite vertical faces, centered about 2 inches from the top. Use the RTV to cement a microscope slide (oriented vertically) over each hole on the inside of the carton. Use enough RTV to ensure a water tight seal of the glass to the carton, but not so much that it squeezes out and obscures the resulting window. You may find it helpful to hold the slides in place with Scotch tape until the RTV has set (about 24 hours).



Fill the carton with clean, cold water to within about an inch of the top. Adjust the mini-maglite to produce a roughly parallel beam of light. Prop it up so that the beam goes in one window and out the other. Turn out the room lights and look down into the water from above. Apart from stray light at the windows, you should not be able to see the beam traversing the water. (It is possible that floating pieces of dust in the water may

be illuminated and give some indication of the beam path.)

Add a few drops of milk to the water and stir thoroughly. Continue adding milk by this process until you can distinguish the beam path by a faint glow in the water. The glow is caused by scattering of the light by the tiny droplets of milk which range from 1/2 to 2 microns in diameter. The light in the beam is traveling horizontally; the scattered light that reaches your eye is traveling vertically. Look at the scattered light carefully. What color does it appear to be? Look backwards through the exit window at the light which has traversed the water without scattering. What color does it appear to be?

Look at the scattered light thorough a polarizer. In which direction is it polarized? Why? Next put the polarizer in the flashlight beam before it enters the water. What happens to the intensity of the scattered light which you see from above when you rotate the polarizer? Why?

Repeat the above series of observations with higher and higher concentrations of milk. The character of the results should change when the probability becomes appreciable that the light which reaches your eye has been scattered more than once. Can you use the results in this case to explain the difference in color and polarization between clouds and the clear sky?