SCIENCES EDUCATION FOUNDATION
GENERAL ATOMICS

THE COLOR OF ICE

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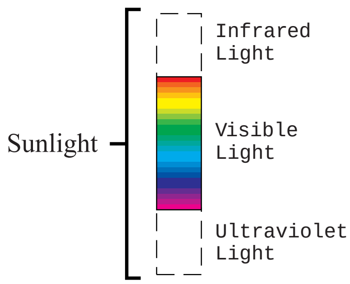
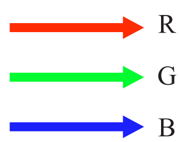
Background

The sun is a source of light, which normally appears uncolored to us (we will call it "white light" below). Sunlight actually consists of many wavelengths of light, corresponding to a continuum of colors from violet to red. When these wavelengths are separated, as when sunlight passes through a prism or when we see a rainbow, our eyes see the shortest wavelength light as violet or blue and the longest wavelength light as red. So sunlight can be separated into all of the colors from red to blue (or violet). To simplify the analysis below, we will make the assumption that sunlight consists of red, green, and blue light. So we will represent the white light from the sun as consisting of rays of red, green, and blue light. (Your computer monitor and your TV produce white light by combining red, green and blue light! - Take a look at your monitor with an 8X magnifier.)



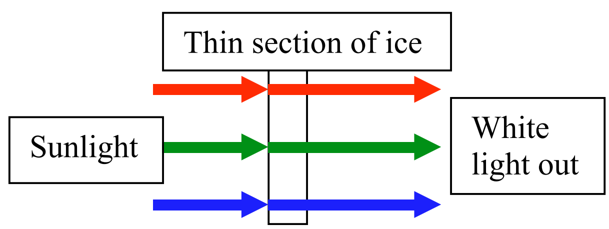


Simplified Model of
Visible Light Spectrum
"White Light"

<u>The color of ice can be understood by considering the following three facts.</u>

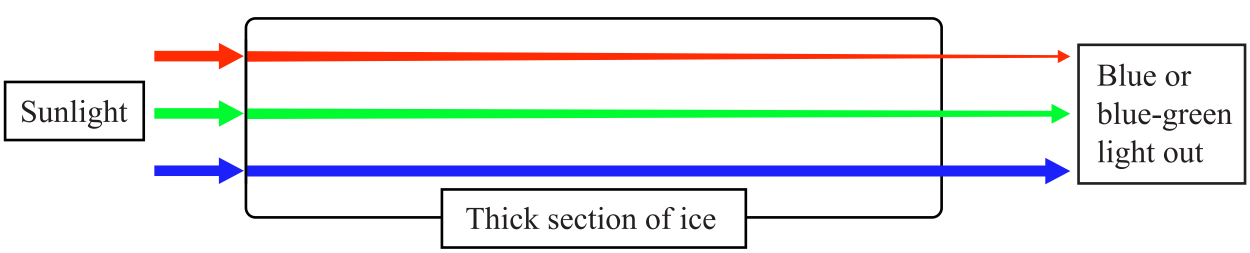
1. **Ice is a very weak absorber of visible light.**

   So light that passes through a thin section of ice is nearly white because almost none of the sunlight is absorbed.

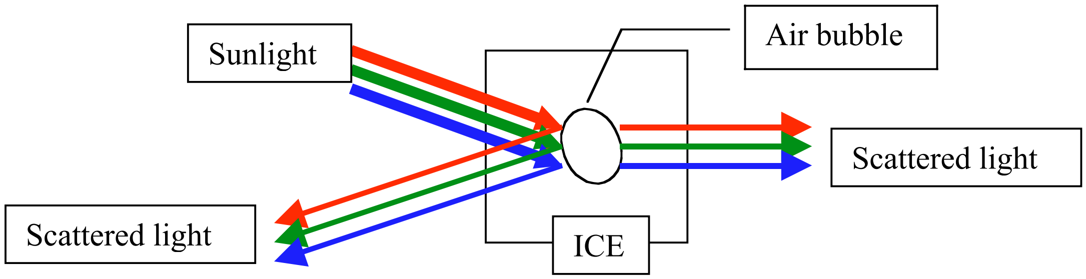


2. **Ice absorbs more strongly as the wavelength of light progresses from the blue to the red end of the visible light spectrum.**

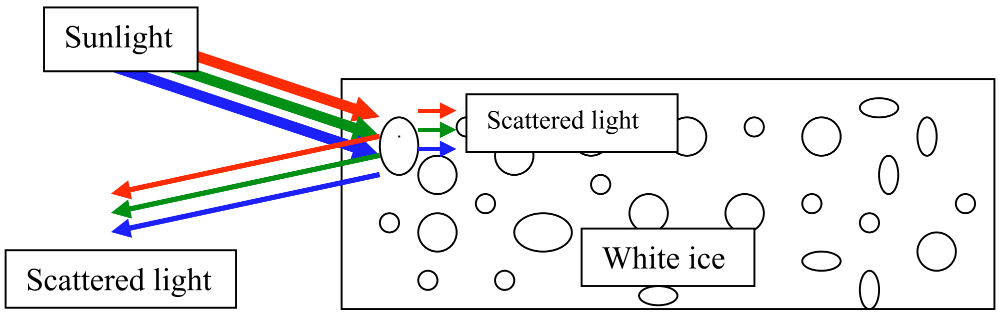
   Light that passes through a thick section of ice appears blue or blue-green because absorption of visible light by ice is gradual as well as selective: greatest at the red end of the spectrum, least at the violet and blue end. This is shown schematically below, where much of the red part, some of the green part, and almost none of the blue part of the visible spectrum of the light is absorbed by the thick section of ice.



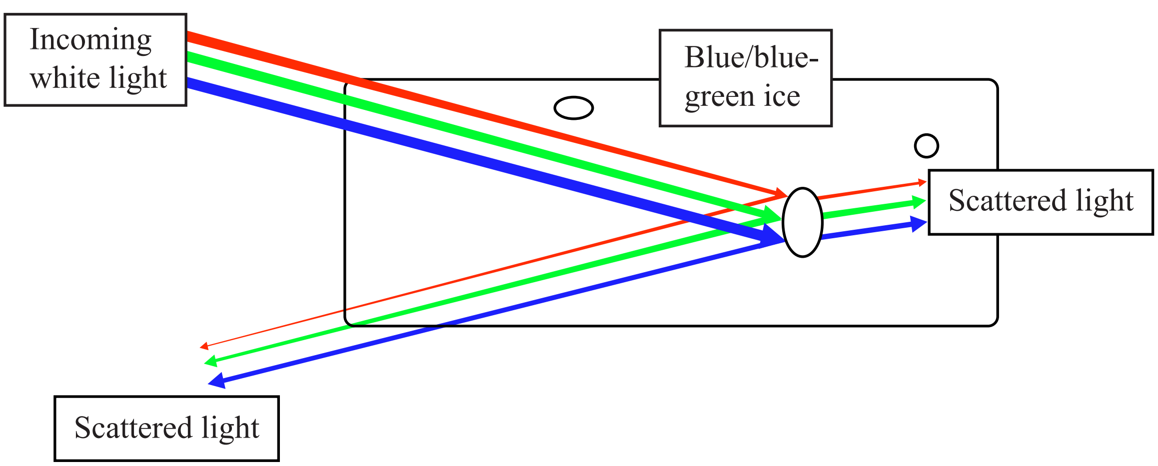
3. Air bubbles in the ice scatter the sunlight into many different directions.



White ice has a high concentration of air bubbles, which scatter the sunlight back out of the ice before the light has passed through a large distance in the ice, so the ice appears opaque. Since little or no light is absorbed by the ice, the light leaving the ice is white.



Blue ice has a much lower concentration of air bubbles than white ice, which allows the sunlight to penetrate a longer distance before it is scattered out, so the ice appears nearly transparent. As the light travels this relatively long distance in the ice, the red part (and to a lesser degree, the green part) of the visible light spectrum is absorbed, causing the light that leaves the ice to be blue or blue-green.



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