Atmospheric Optics

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PS-21 First Fall Institute

Concept 2: Light and Color

September 28, 2012

What can happen to light from the sun???

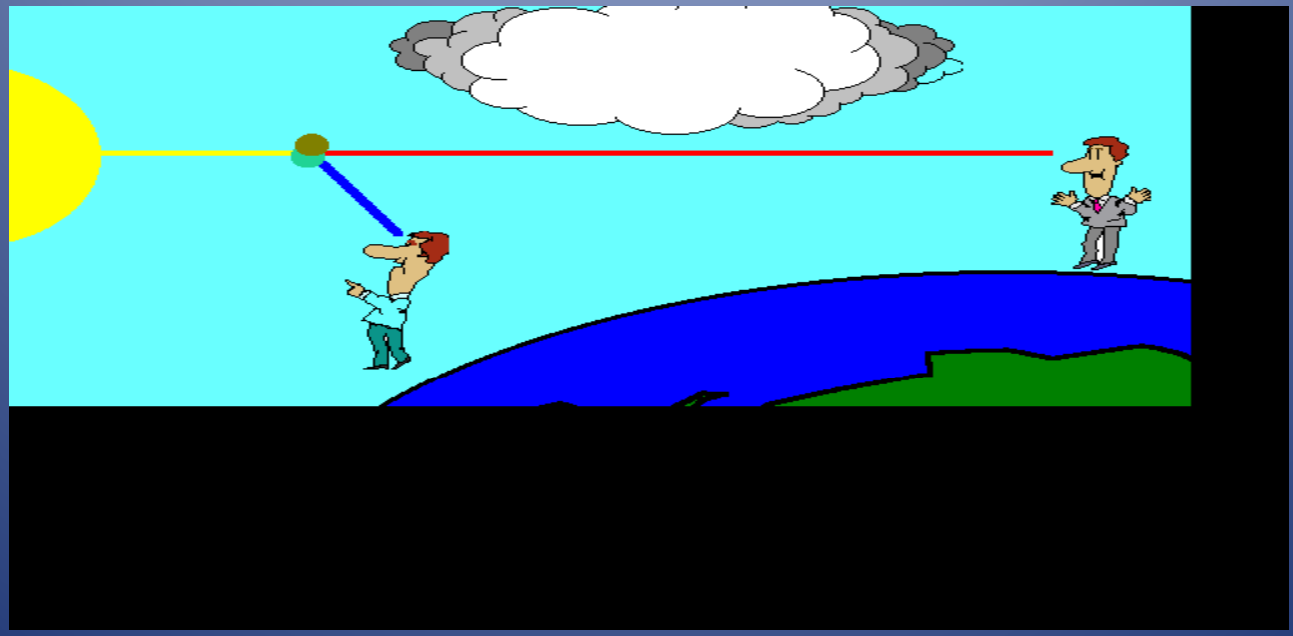
- Scatter (bounce): off of molecules, particles
- Reflection: off drops of water or crystals of ice
- Refraction: water or ice
- Internal reflection: inside water or ice
- Diffraction : around drops or small crystals
- Interference: with other nearby light waves

Colors in the Sky

- I will start with the most basic question:
  - Why is the sky blue?
- And then, why are sunsets red?

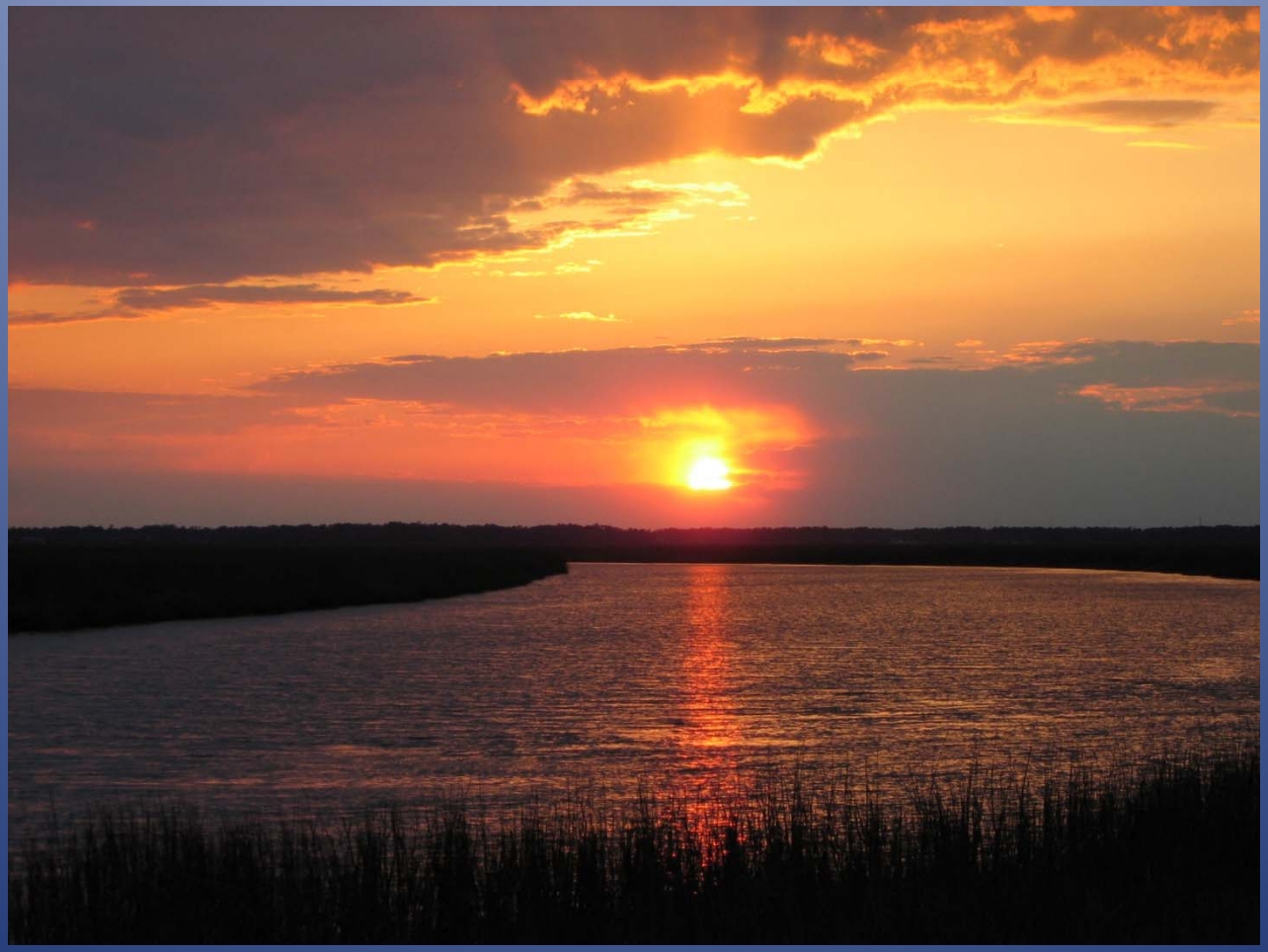
Why the sky is blue, sunsets are red

- Scattering of light off stuff in air
- Blue scatters more than green or red



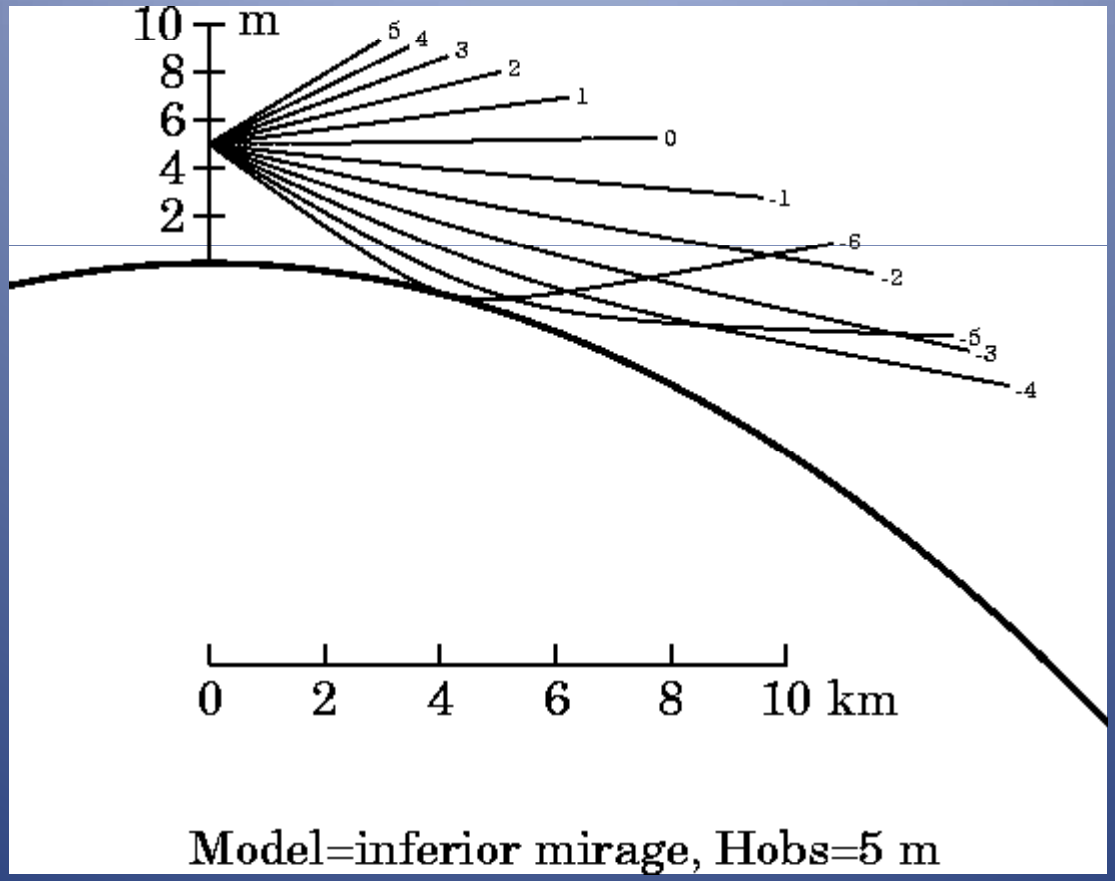
Blue sky, white and pink clouds

Sunset near Savannah



Alberta (CA) sunset after storm

Mirages and the Green Flash



The Green Flash!!

- While we are on the subject of sunsets, here is something I have looked for many times but never seen.
- It helps if you are up high relative to the water, and if the water is warm. This produces a mirage of the sun.

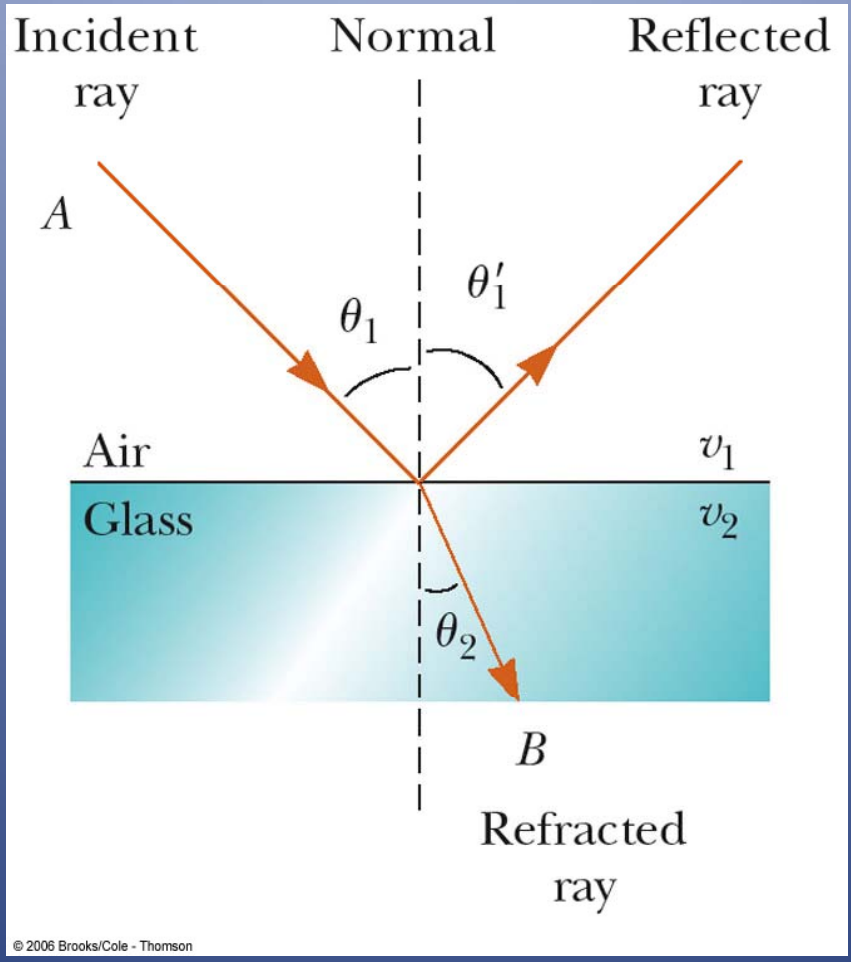
Why Green??

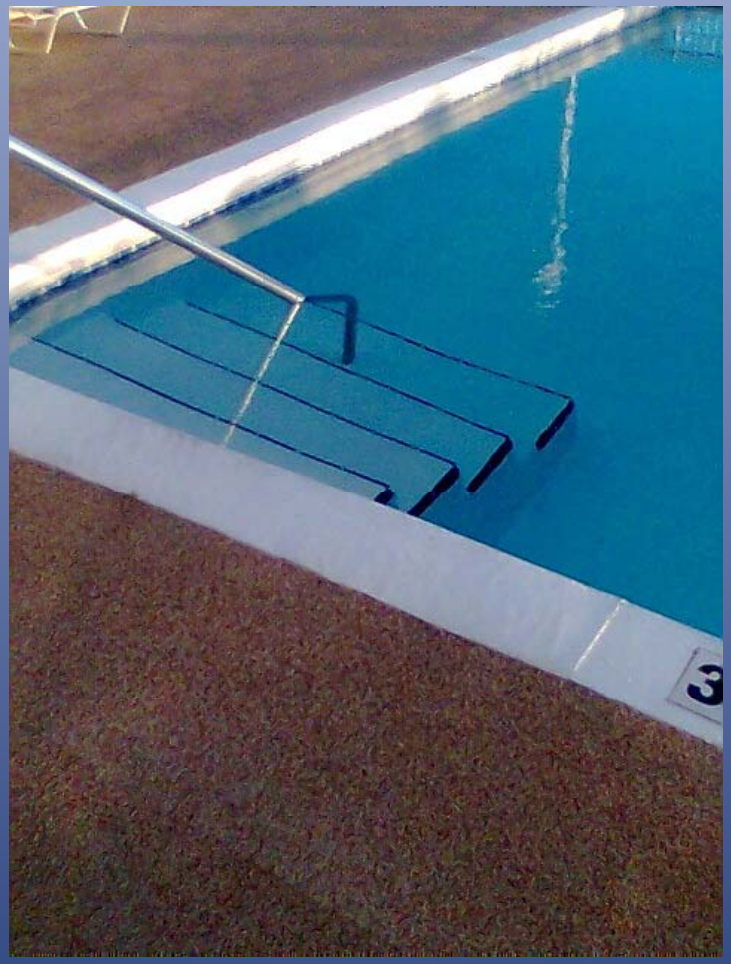
- Green gets refracted more
- So do blue and violet
- But they get scattered (that's why sunset is red…)
- But, sometimes yellow, purple flashes are also seen

Formed by inversion in air temp: “Mock-Mirage”

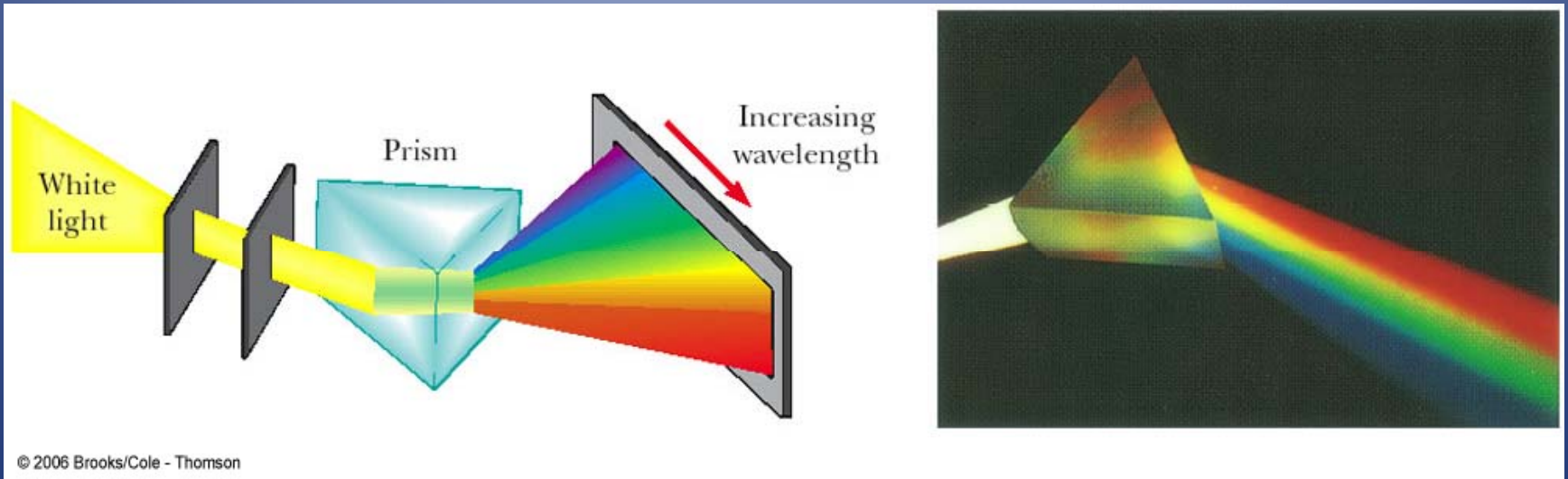
Purple flash

Reflection and Refraction





Dispersion (hands-on)

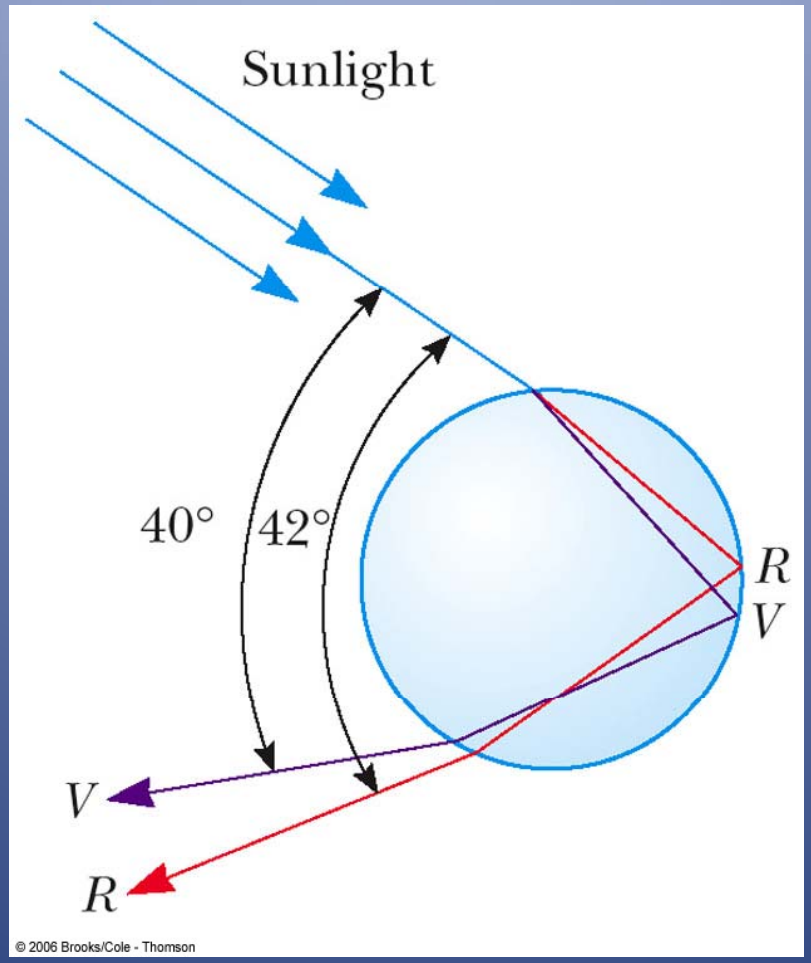


Rainbows

At the Mall

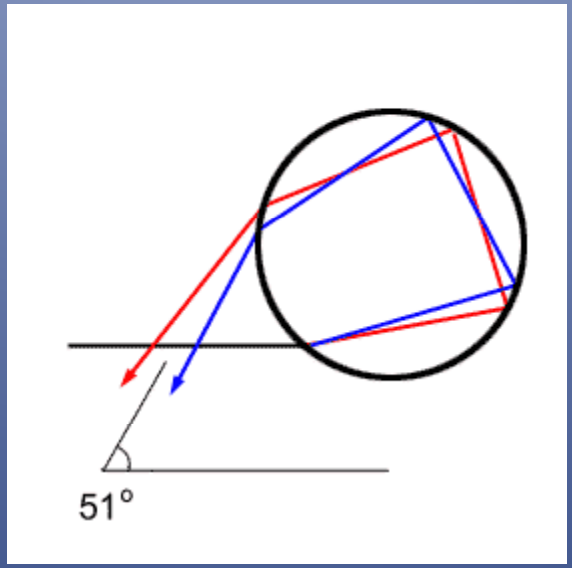
Tennesee

Rainbow formation



Secondary Bow

- http://www.atoptics.co.uk/rainbows/ord2form.htm#

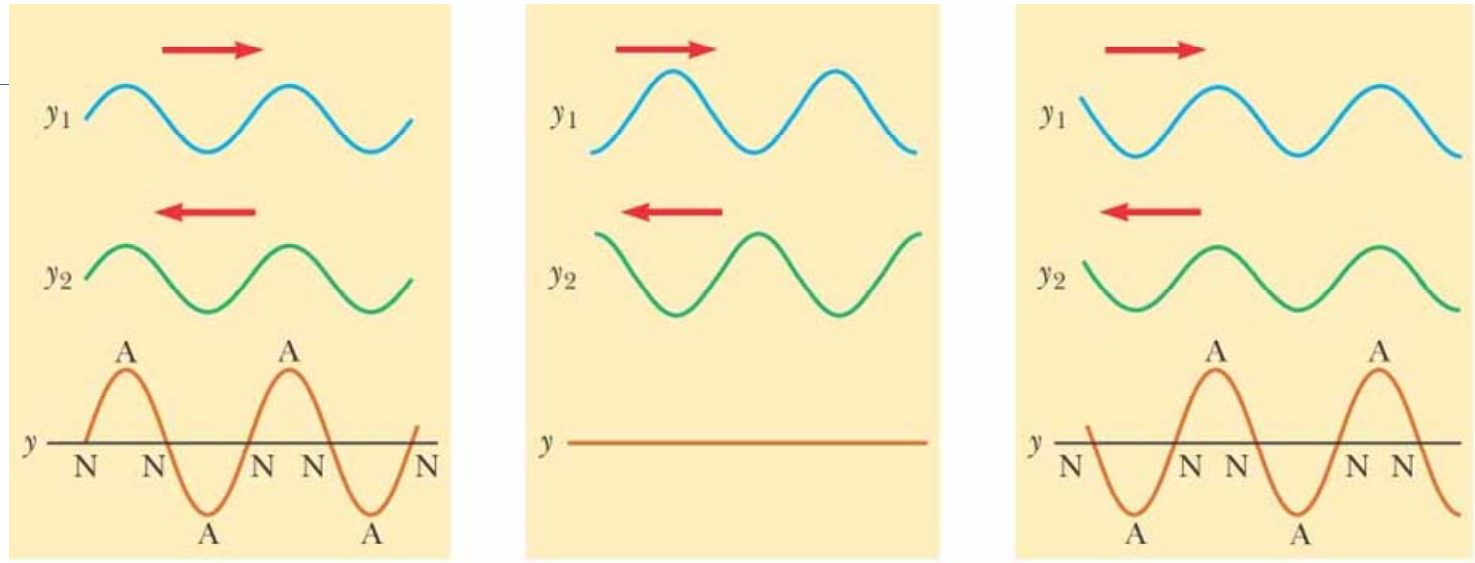



Vivid Rainbow
Oct 3, 2009 - 5:54 p.m.
©2009 - Lauri A. Kangas

A Moonbow

Glassbow

Interference

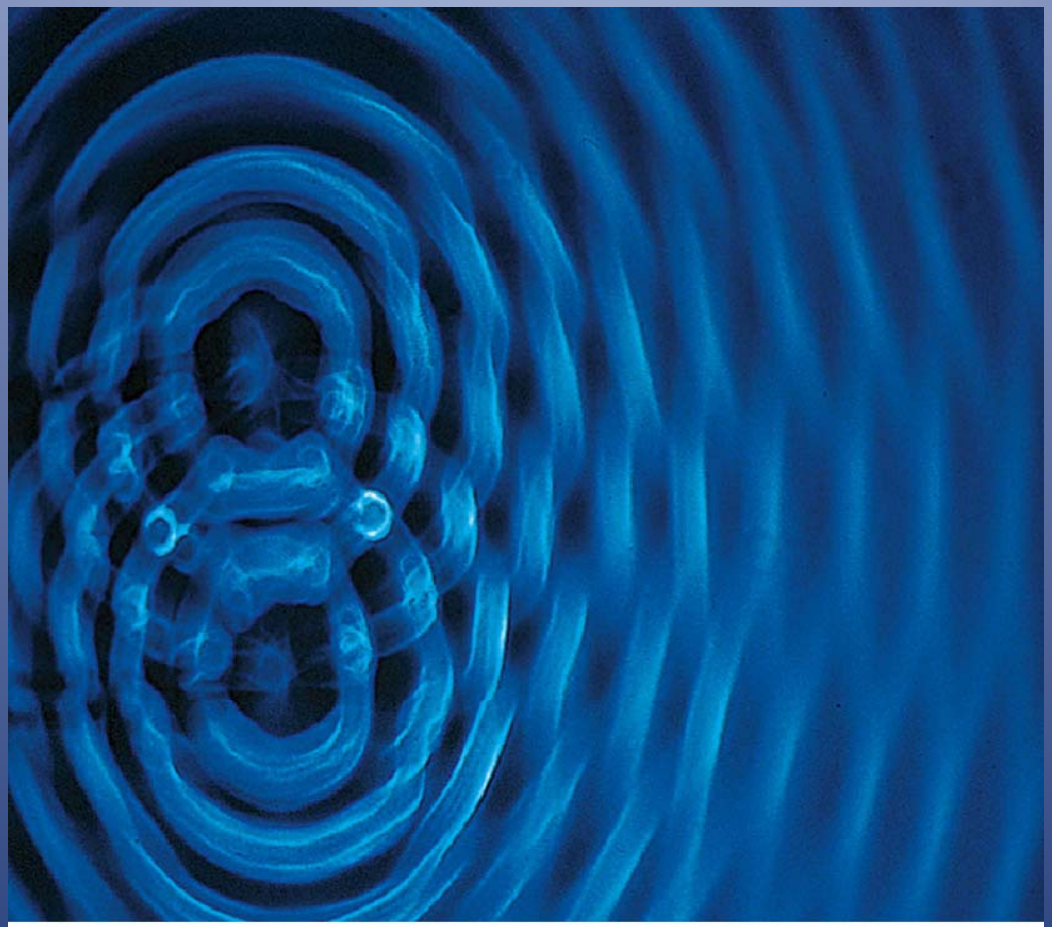


(a) $t = 0$ (b) $t = T/4$ (c) $t = T/2$

© 2004 Thomson/Brooks Cole

Fig. 18.9, p.551

Interference

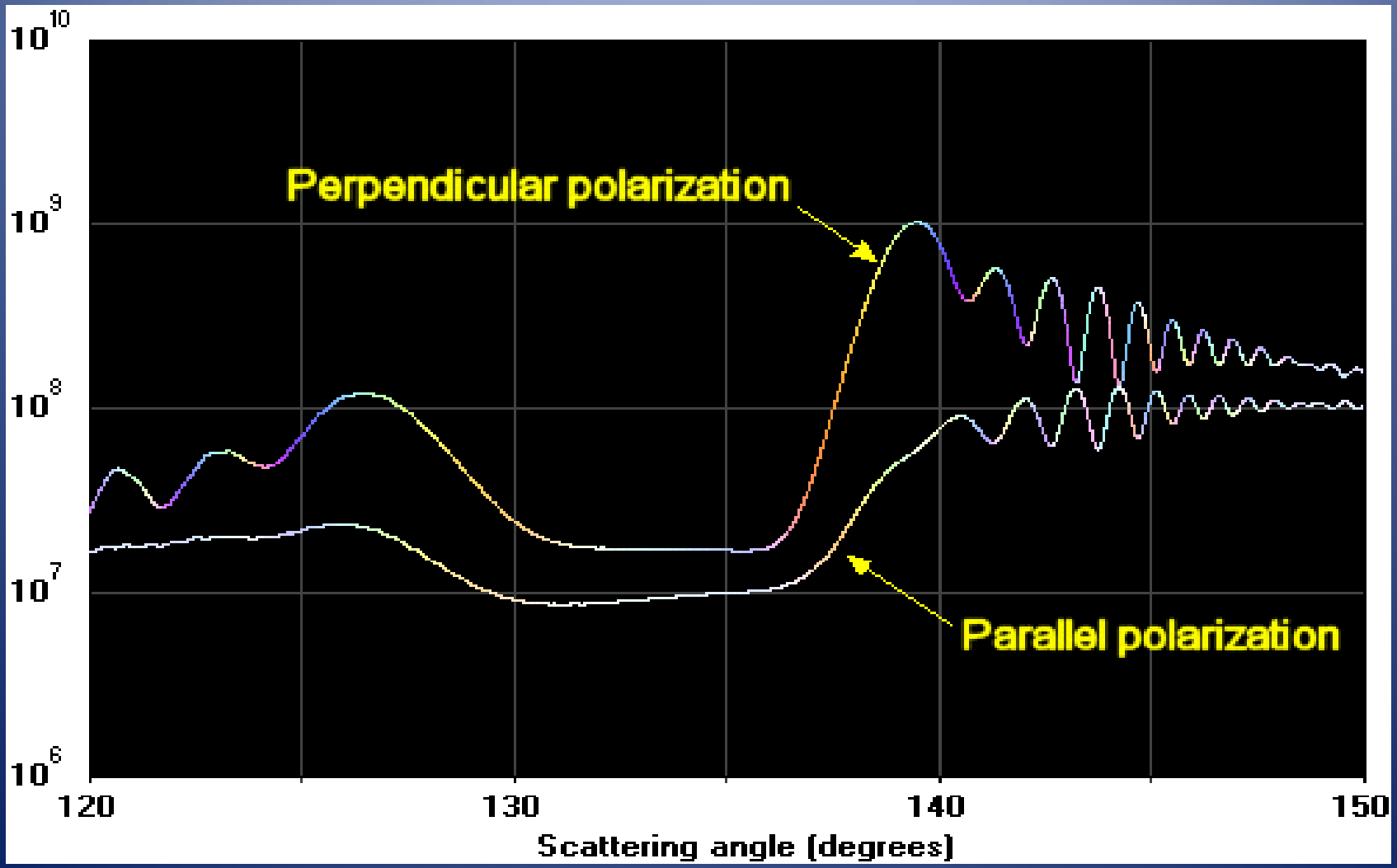


Interference in a soap film

Using a diffraction grating

- Hands on again!

A Model Calculation

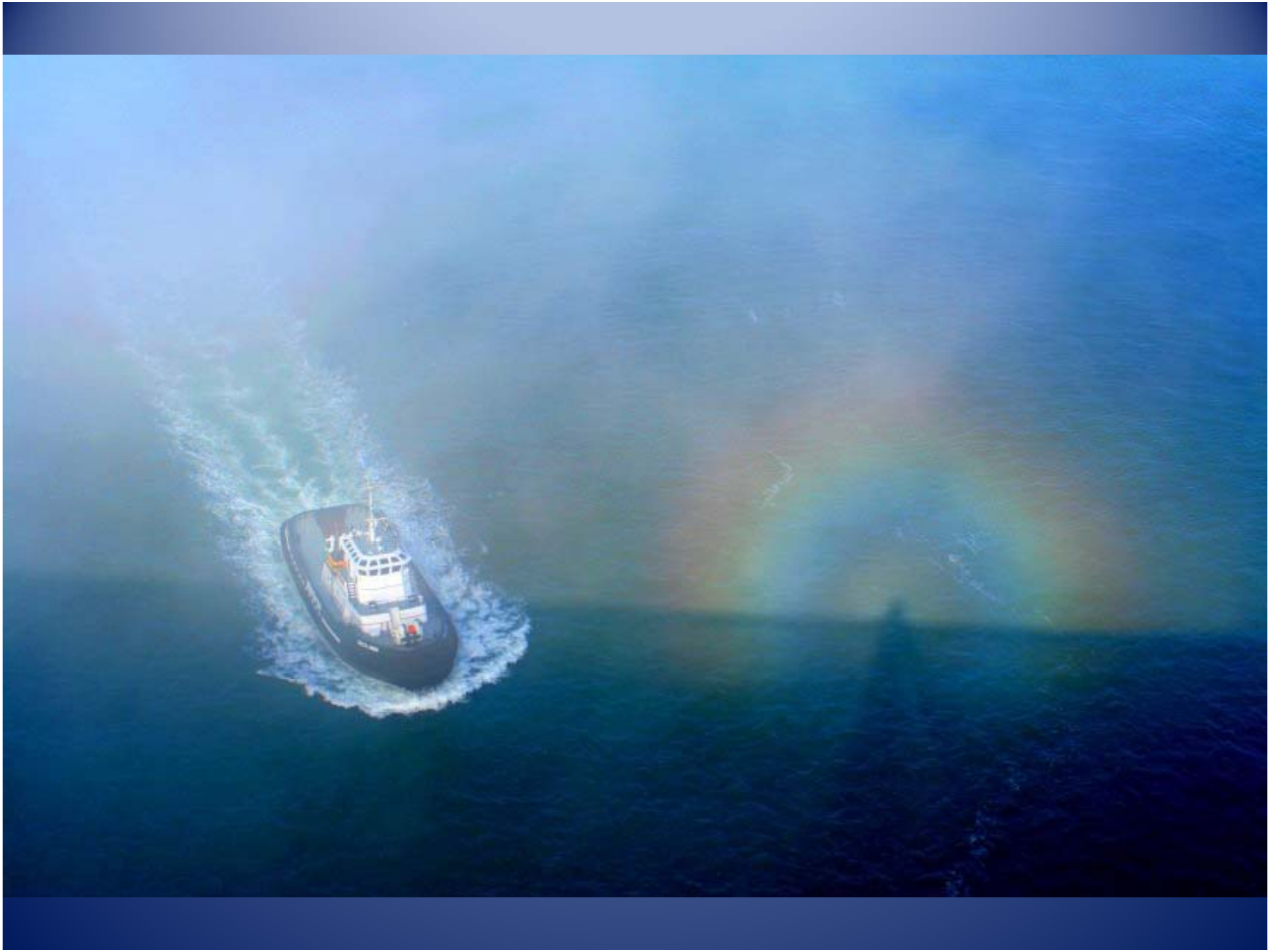


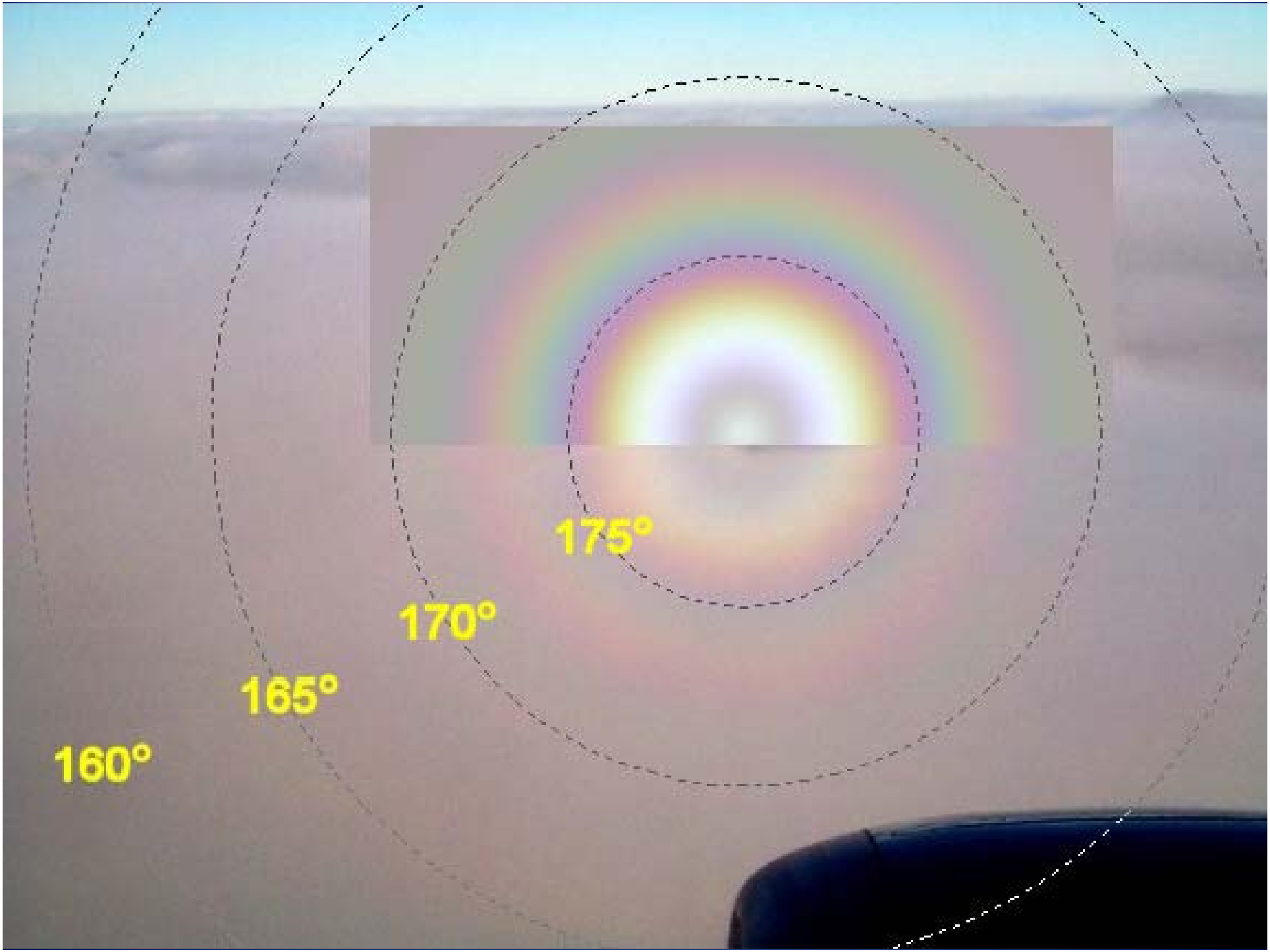
Supernumeraries

Another

The Glory

- This is an interference effect
- Simulations take into account light rays (waves) striking a raindrop on all parts of the surface.
- Variable drop sizes
- Model suggested by Mie in 1920, but requires powerful computers for implementation




175°
170°
165°
160°


© Vincent Lowe 2006

Solar Corona and Aureole

Solar Corona

Iridescent Clouds

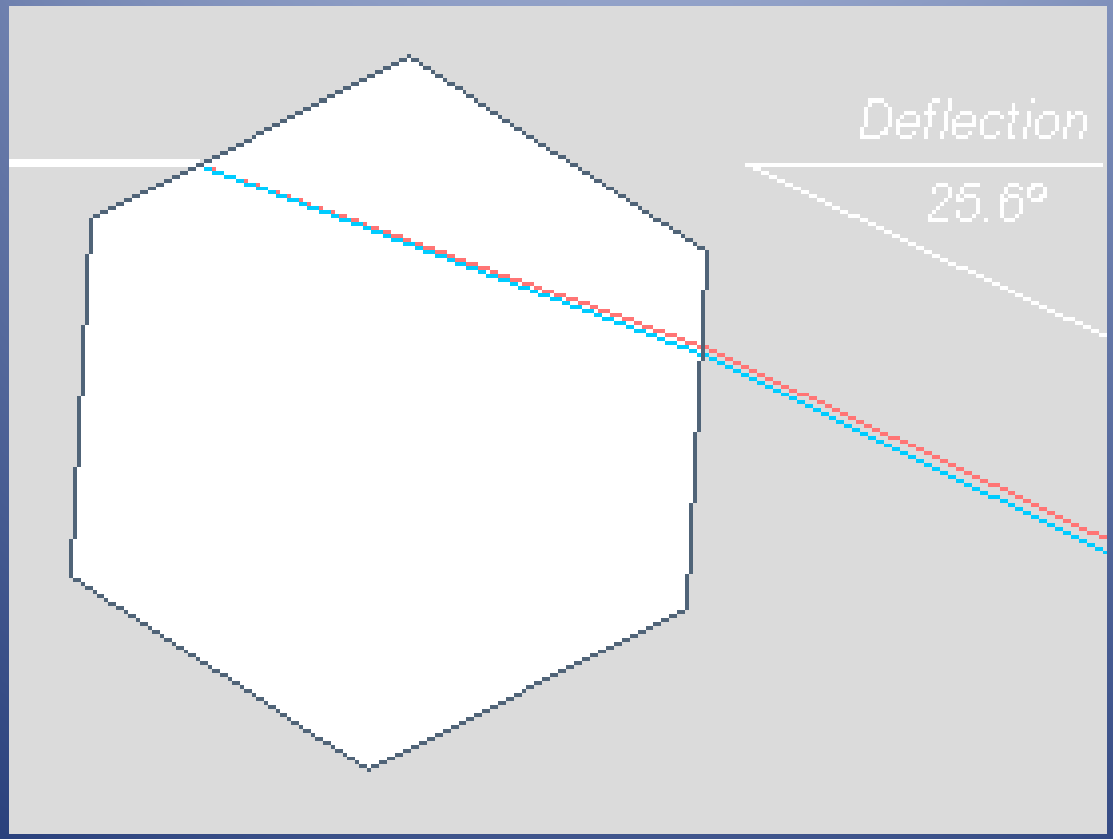
Lunar Corona


©2004 www.photon-echoes.com
Icy Lunar Corona
January 30, 2004 6:44 p.m. EST
-8C with strong winds and fine blowing snow

Heiligenschein

Effects of ice crystals

Refraction through a crystal

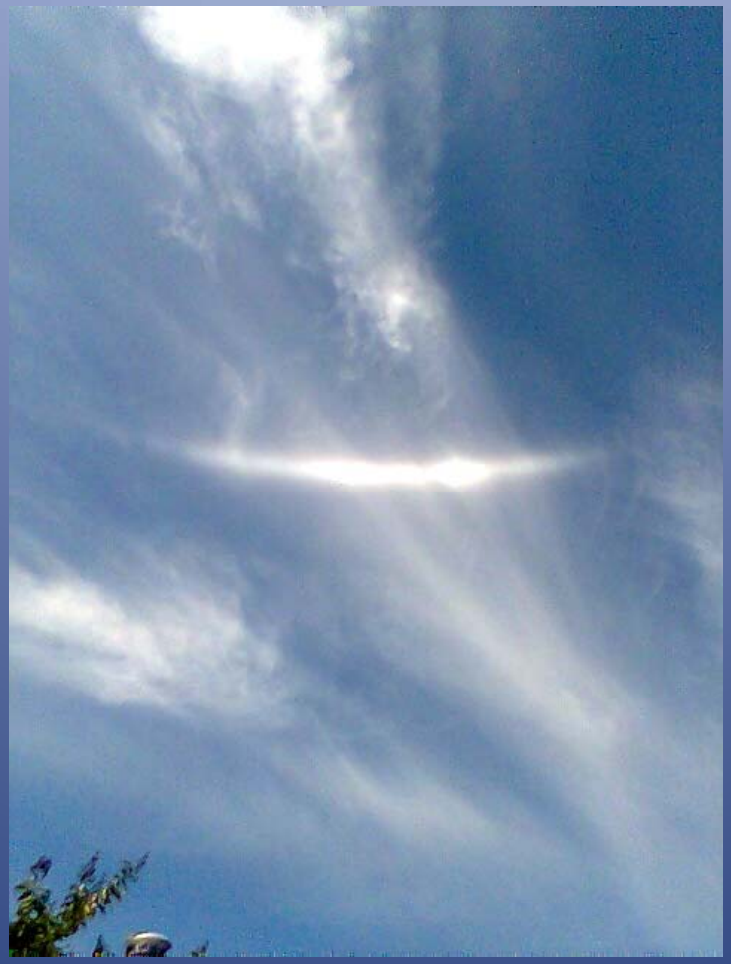


22 degree solar halo

Lunar Halo…and Mars

Parhelic Circle, 22° Halo, Circumscribed arc, and sun dogs over the Dead Sea

Parhelic circle over U of A



Circumzenithal Arc over the golf course

22 Degree Solar Halo

Preview of coming slide

- *The upper part of the circumscribed halo is visible, curving downwards over the fainter 22º halo and intercepting the parhelic circle at the sundogs.*

Several Things Here


©2003 www.photon-echoes.com

Pillar
Reflections off of ice crystals


Sundogs and Sunpillar
Sunrise, February 18, 2005
©2005 Lauri A. Kangas


©2004 www.photon-echoes.com
Brilliant Sundog
November 21, 2004 12:15 p.m. EST

Sundogs Again

- http://www.atoptics.co.uk/

- http://www.photon-echoes.com/atmospheric_optics.htm

In case time allows

- Polarization effects (yet another hands-on!)
- Why clouds are white