School of Optricks

Presents Optricks for a Greener World

Donn M. Silberman
The Optics Institute
of Southern California

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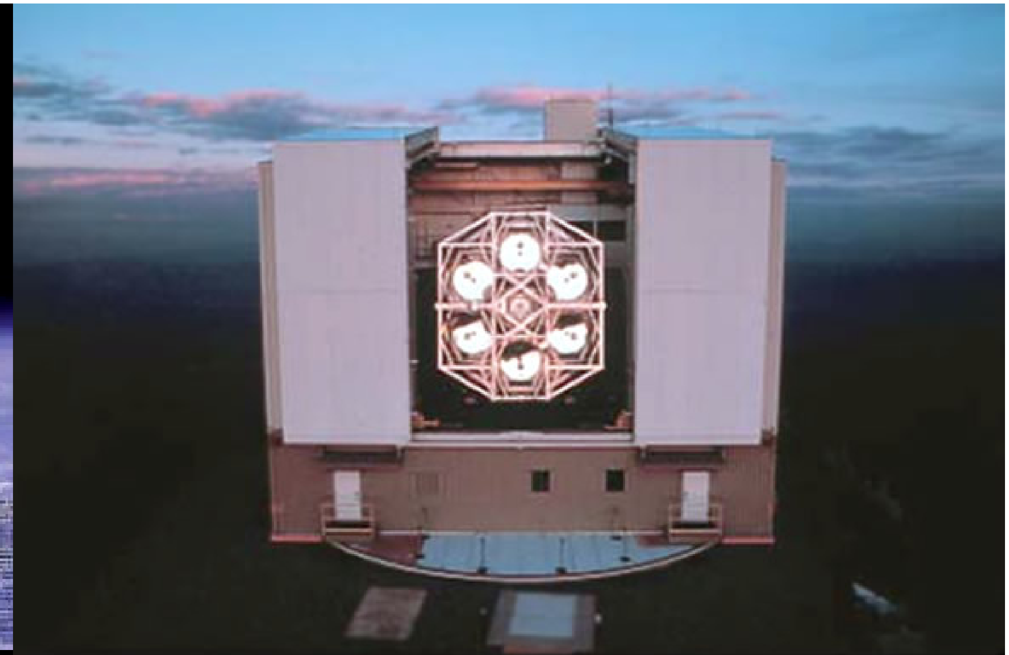
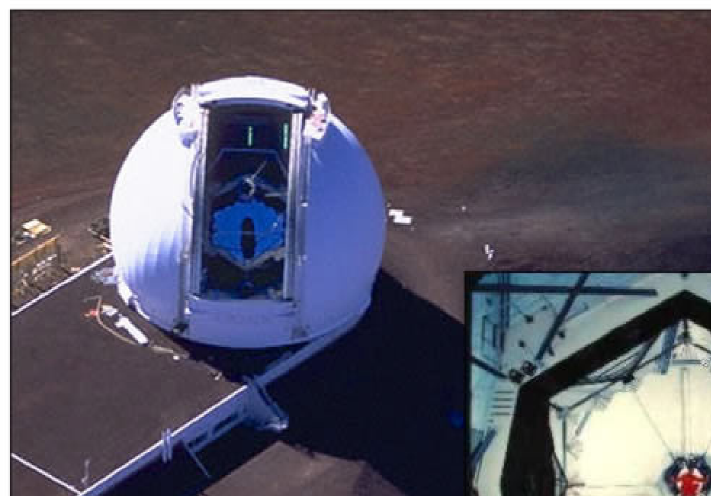
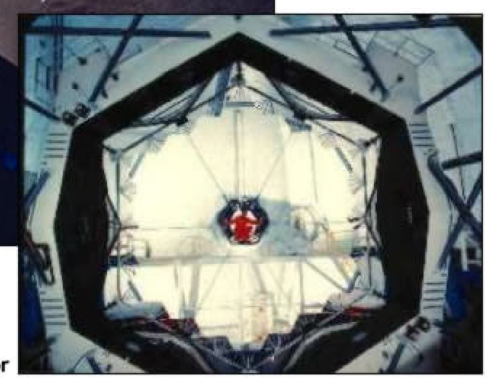
Tyco Brahe’s Observatory ~ 1600’s



Telescopes to look out into space at stars and galaxies.



Keck I exterior

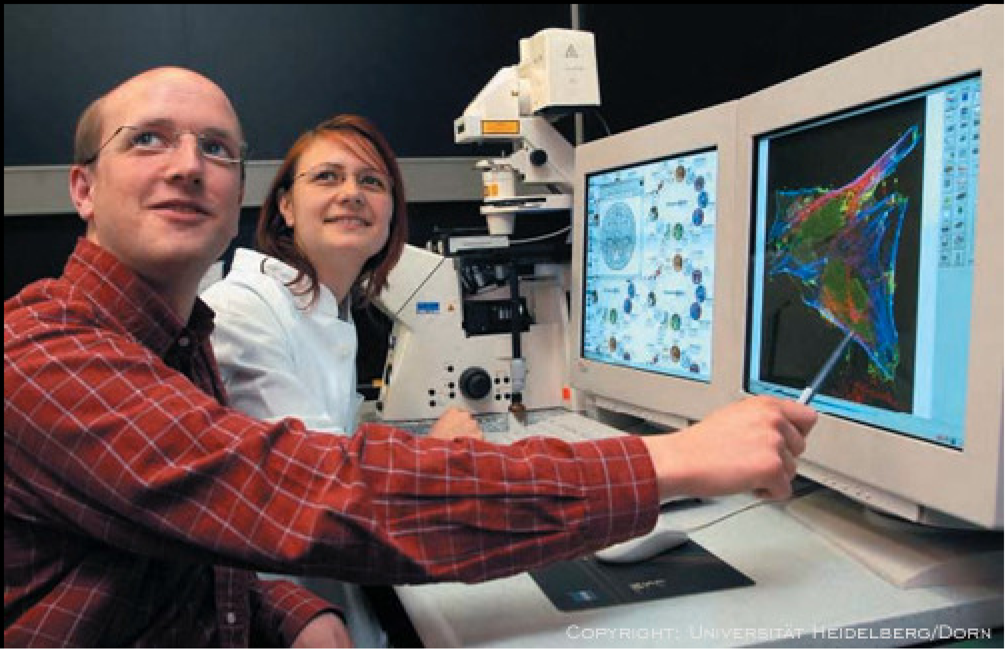


Close-up of primary mirror

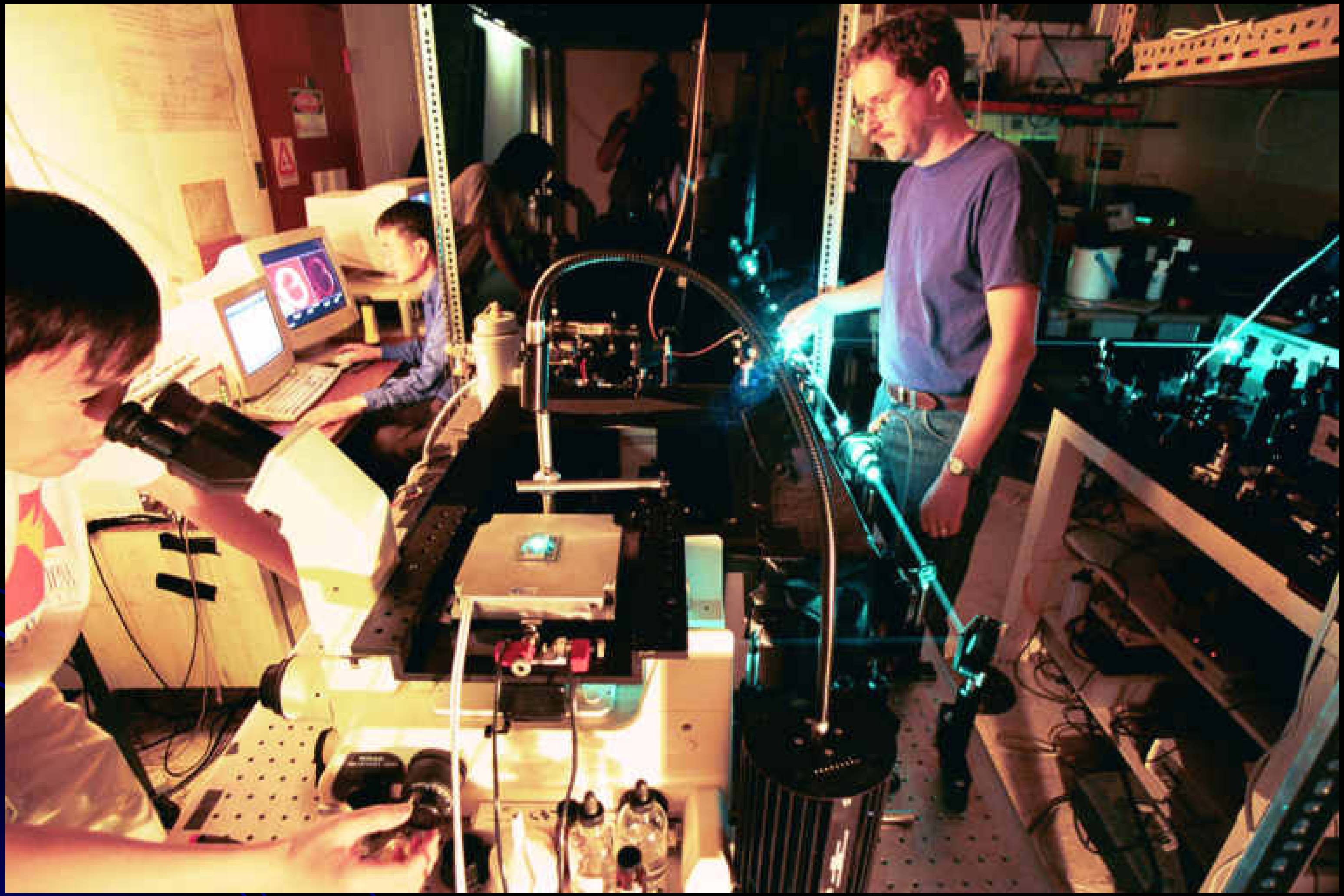
Young students like you
Learning how to use
Microscopes.

Microscopes for looking at small and very small things.

Researchers in a ‘clean room’.



Laser Spectroscopic Microscope in a university research laboratory



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How Do We “See” the World Around Us?

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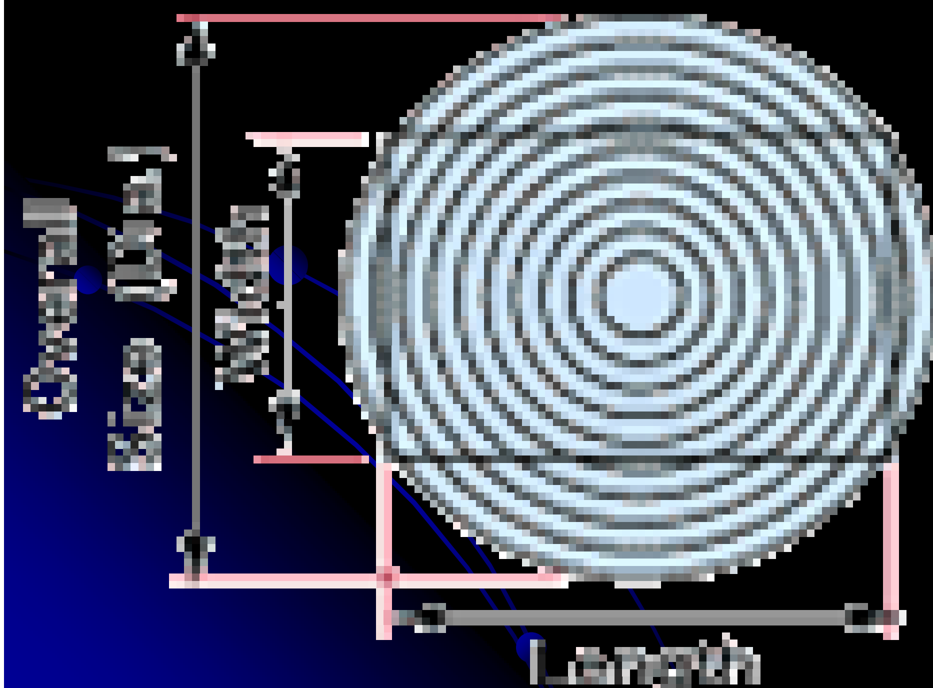
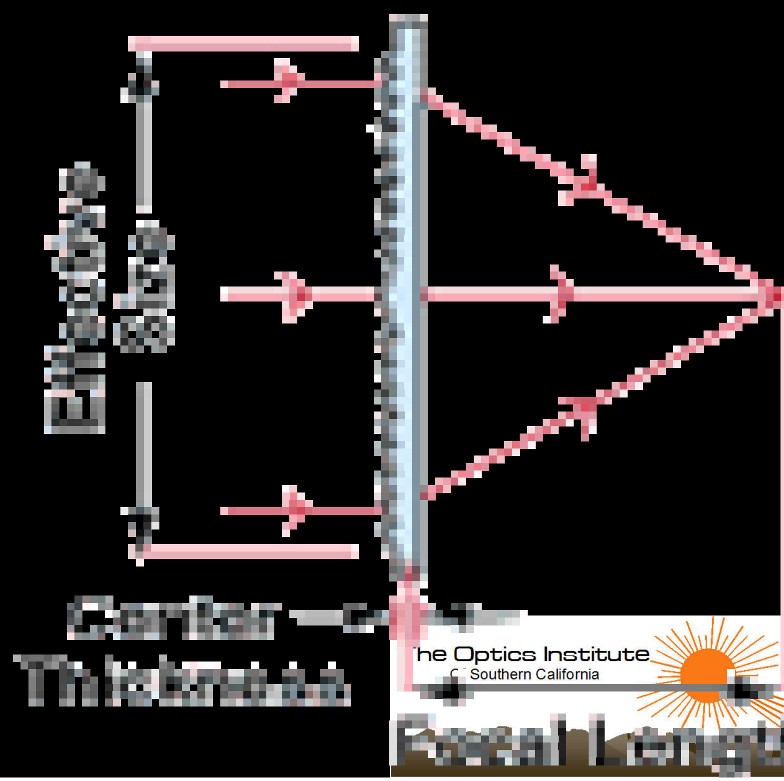
What's a Fresnel Lens Anyway?





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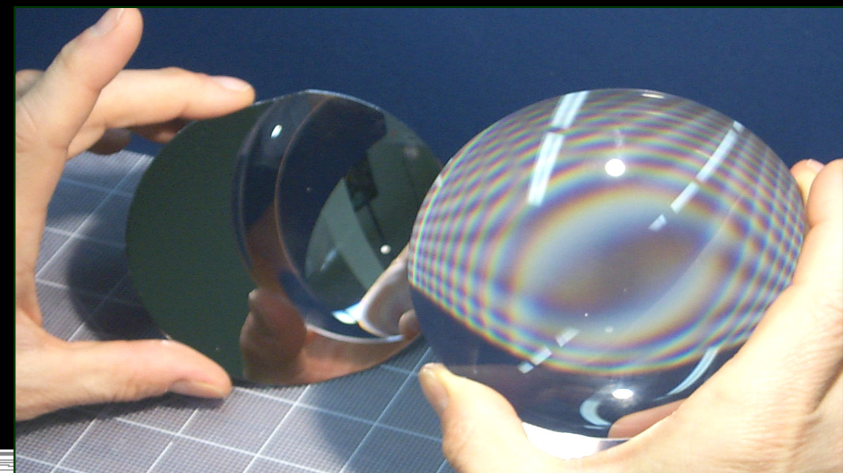
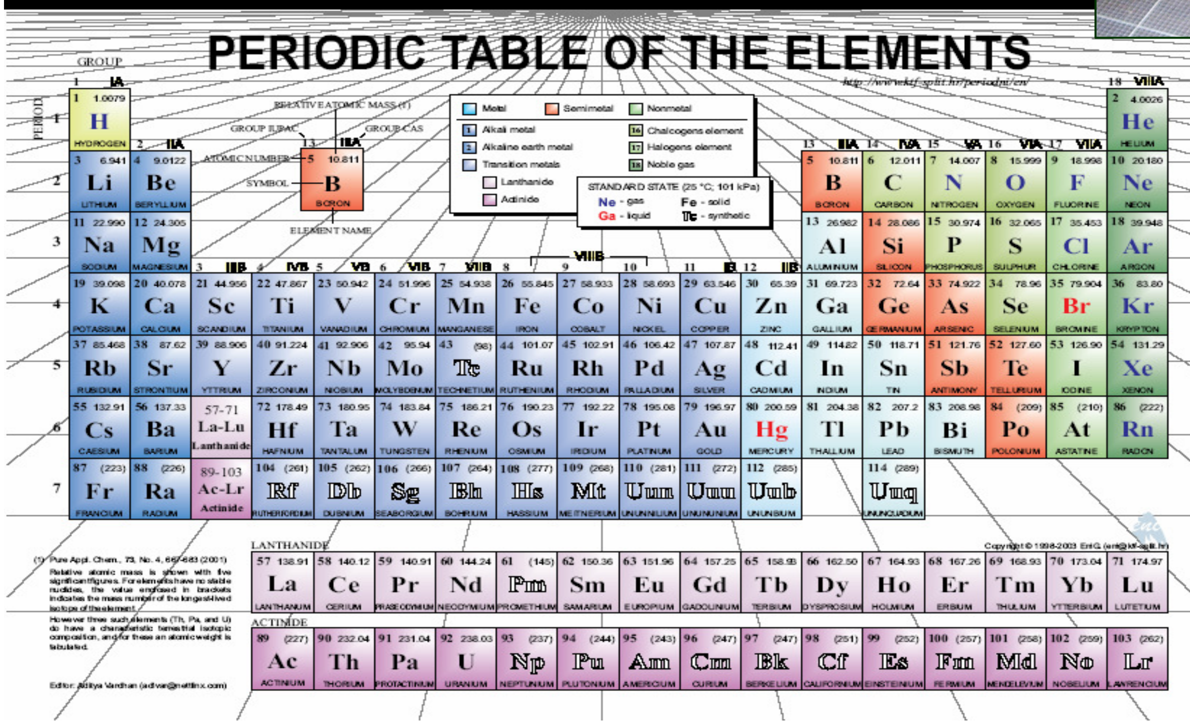
Optical Engineers Work with Materials That Reflect or Transmit Light



Si – polished silicon wafer mirror-like reflector

SiO_2 – clear silica lens focuses light



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What is Light??

Light is Like a Vibrating Wave

- We can make a slinky vibrate like a wave of light.
- A slinky vibrating with one length is like light of one wavelength.
- We can stretch the slinky to make longer wavelengths or different colors of light.
- Light is like pure energy with no rest mass (because it is never at rest!!)

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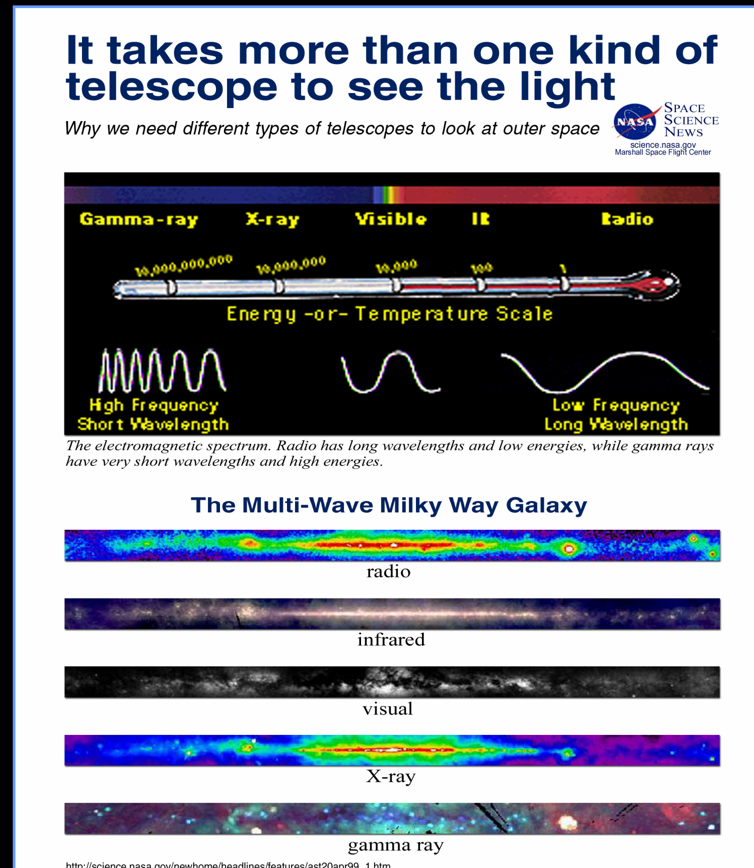
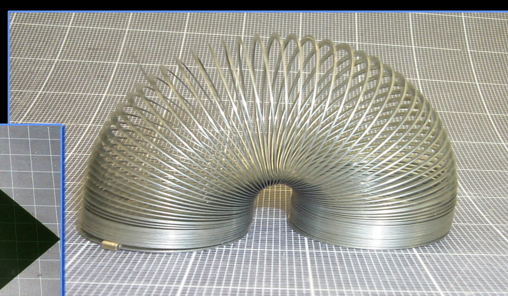
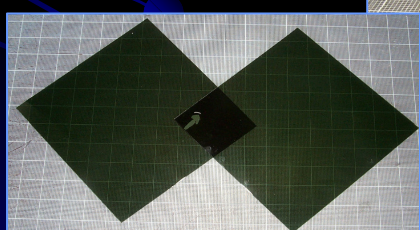
Light is Like a Vibrating Wave

- We can make a slinky vibrate like a wave of light.
- A slinky vibrating in one direction is like “polarized” light.
- Optical engineers use polarizers to make light vibrate in one direction.





Slinky



Polarizers

- Polarizers have a “secret code.”

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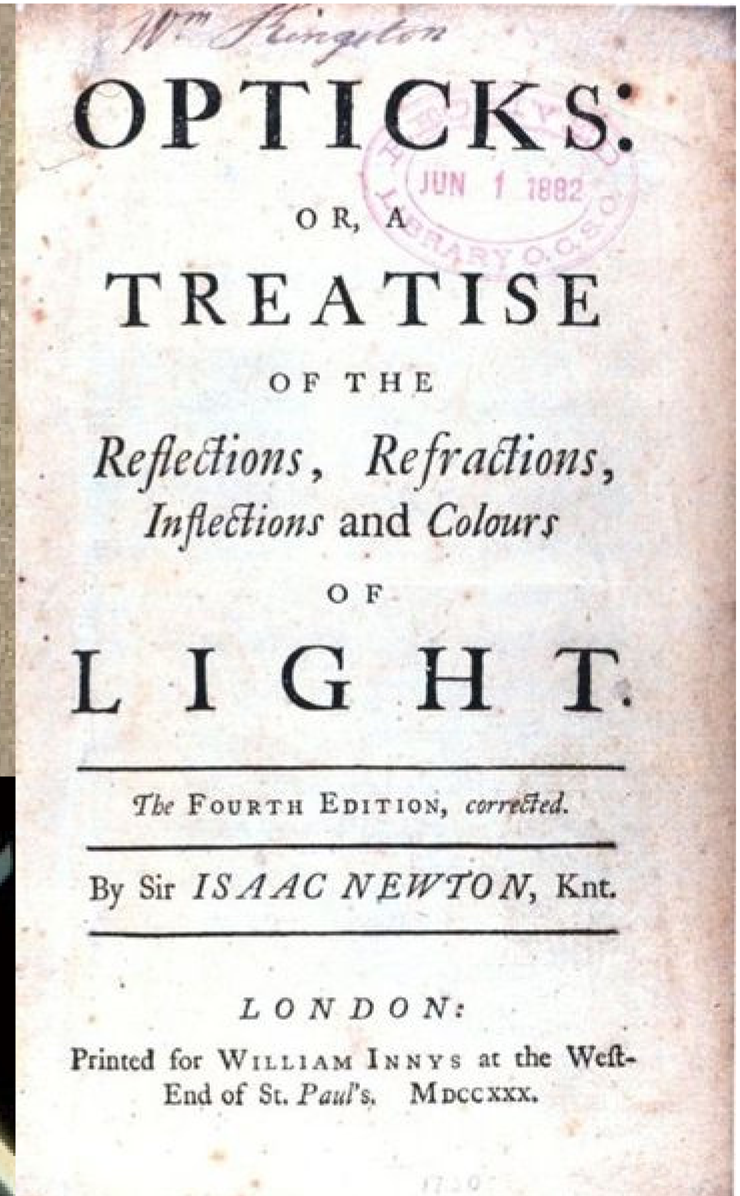

OPTICKS:

OR, A

TREATISE

OF THE

Reflections, *Refractions*,
Inflections and *Colours*

OF

LIGHT.

The FOURTH EDITION, *corrected.*

By Sir *ISAAC NEWTON*, Knt.

LONDON:

Printed for WILLIAM INNYS at the West-End of St. *Paul's*. MDCCXXX.

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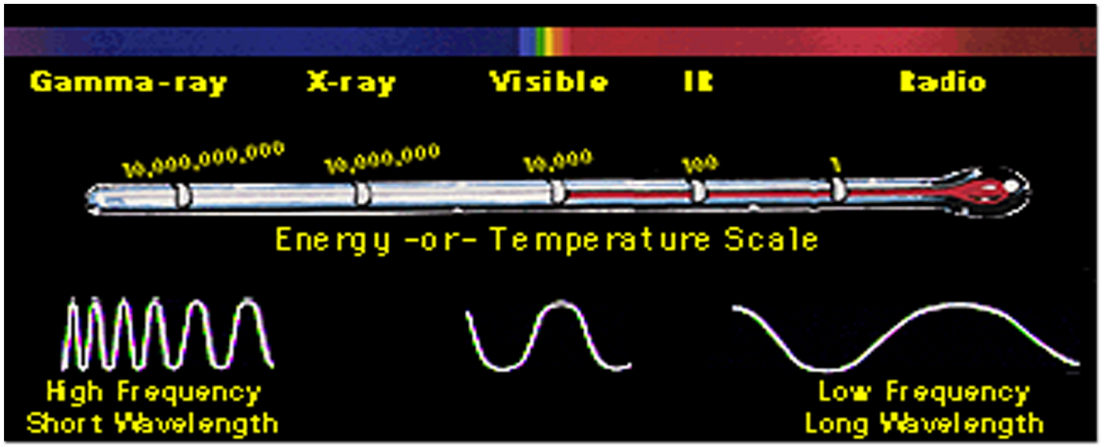
It takes more than one kind of telescope to see the light

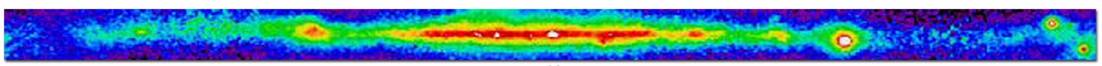
Why we need different types of telescopes to look at outer space

Space Science News
science.nasa.gov
Marshall Space Flight Center

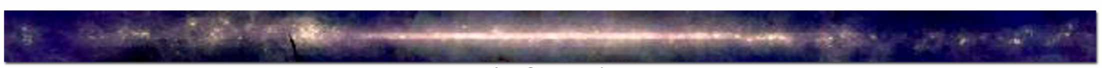


The electromagnetic spectrum. Radio has long wavelengths and low energies, while gamma rays have very short wavelengths and high energies.

The Multi-Wave Milky Way Galaxy

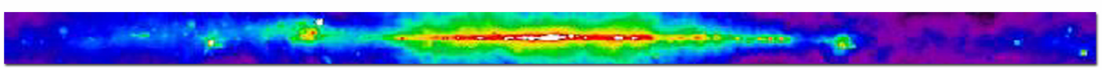


radio



infrared

visual

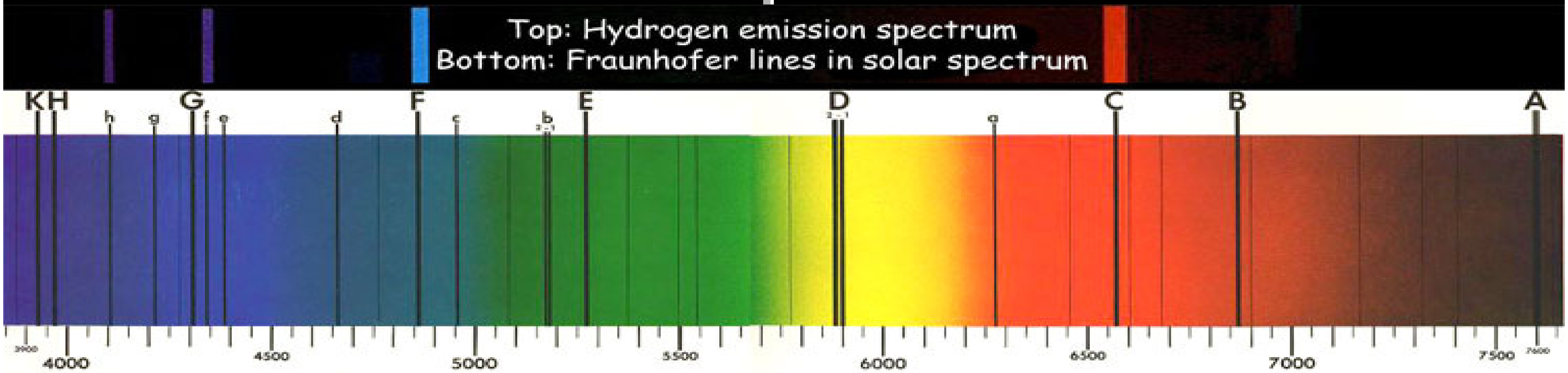


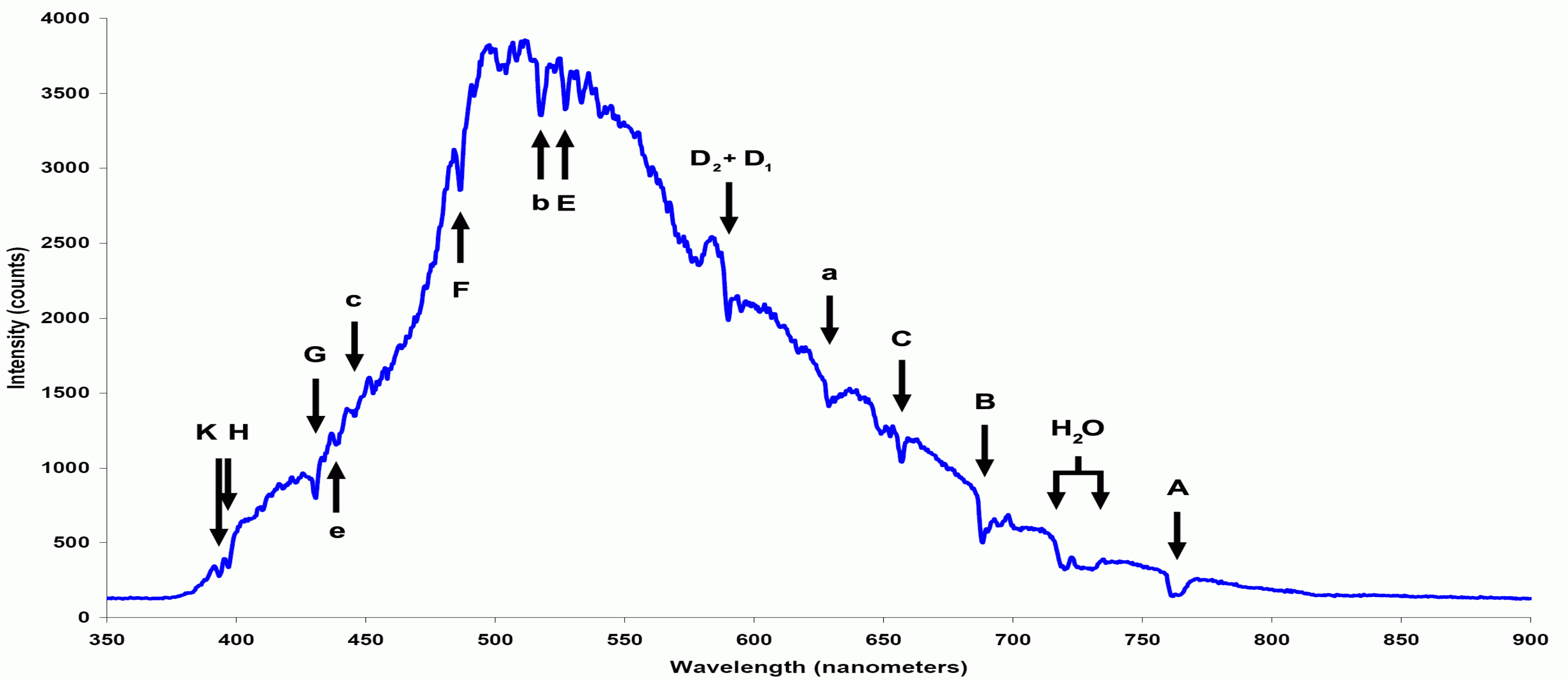
X-ray

gamma ray

http://science.nasa.gov/newhome/headlines/features/ast20apr99_1.htm

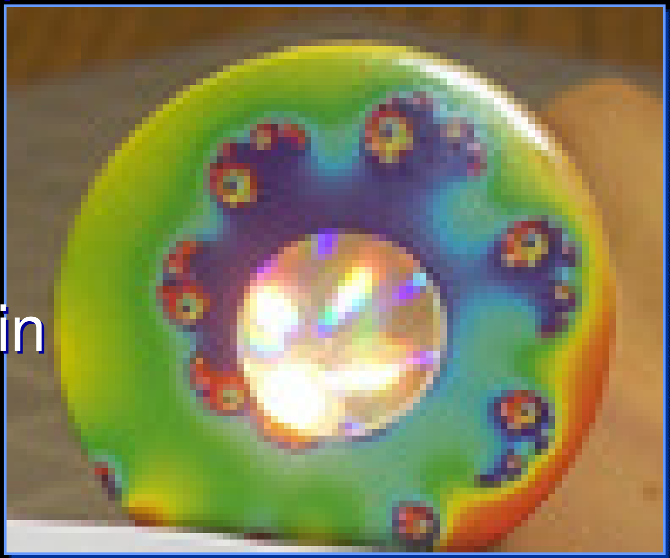
Fraunhofer Spectral Lines





Rainbow Peephole®
Diffraction Gratings

- Light is “redirected” in passing through the plastic peephole to the eye.
- Where do the colors come from?
- Do you see a regular pattern?
- Identify the colors. Are they the same in each spot?
- Does the pattern change if the light is close or far from the peephole? How?
- Do you see colors from the room lights?
- The regular array of bumps on the plastic peephole's surface allows us to see the color in white light through “diffraction.”



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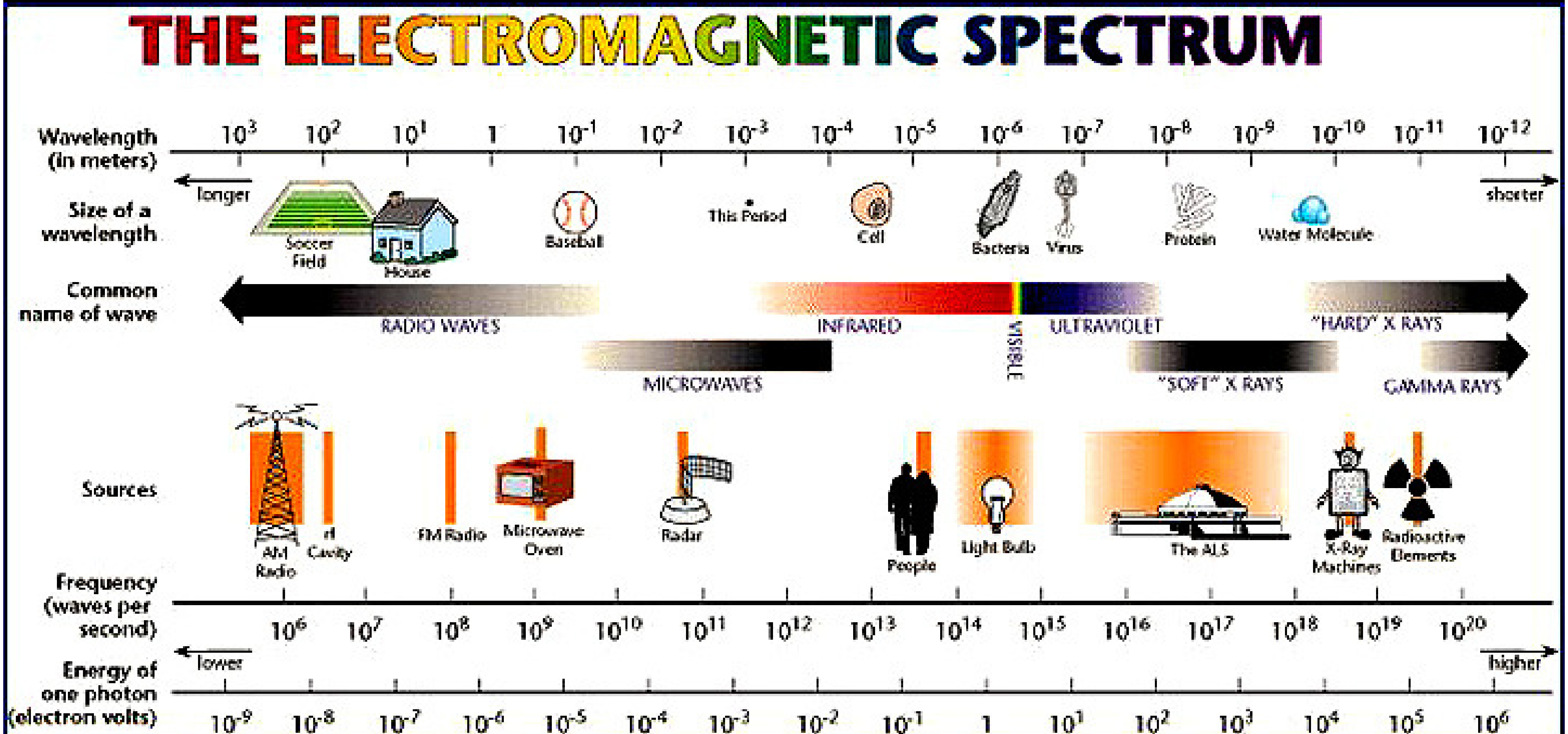
the remote sensing tutorial



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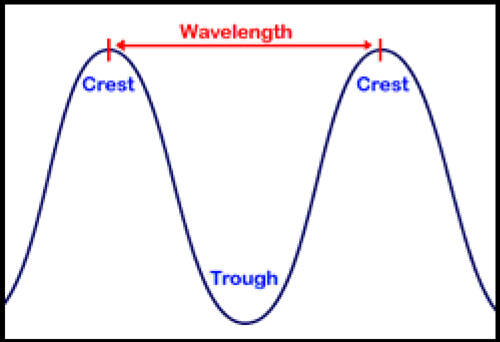
This is a photo of Phoenix, Arizona taken from the Space Shuttle.
What can we learn about the earth from this photo?

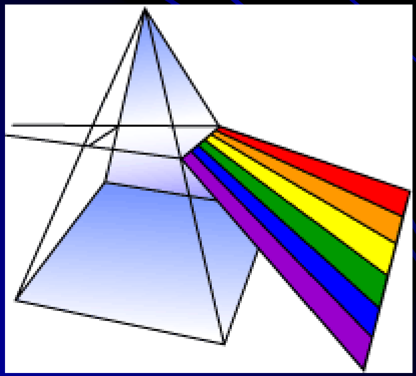


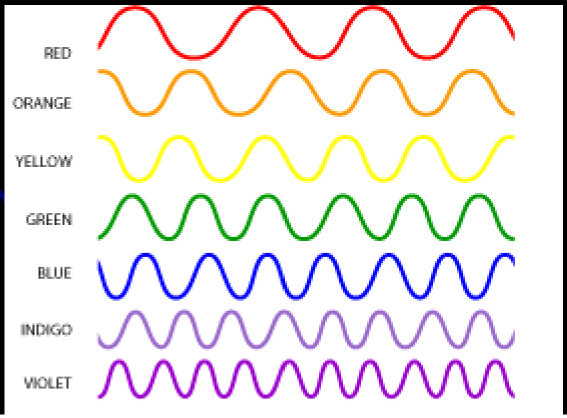
What are waves?

What are electromagnetic waves?

How are they different?

Waves in the electromagnetic spectrum vary in size from very long radio waves the size of buildings, to very short gamma-rays smaller than the size of the nucleus of an atom.





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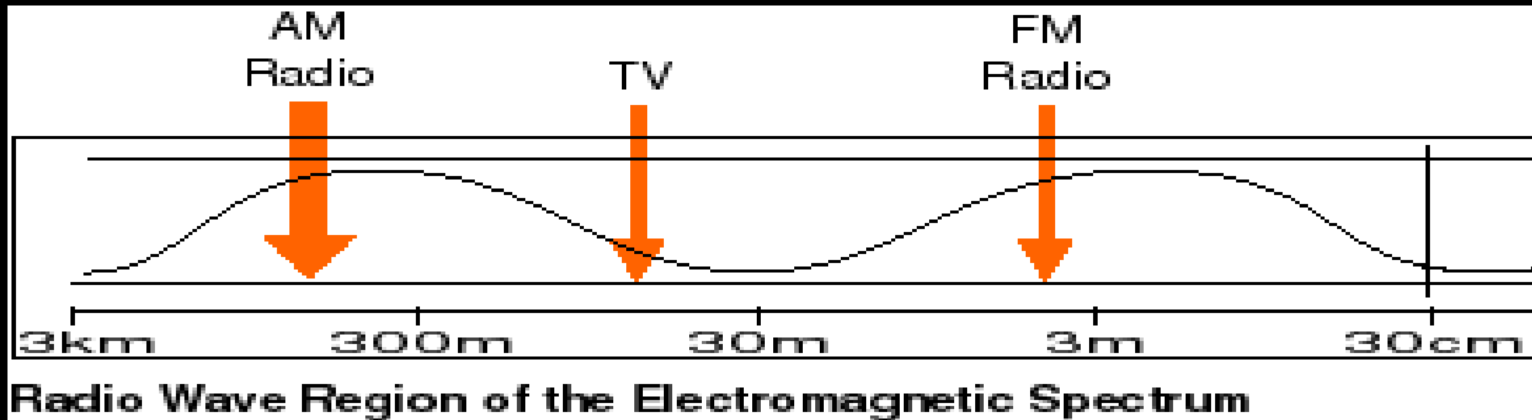
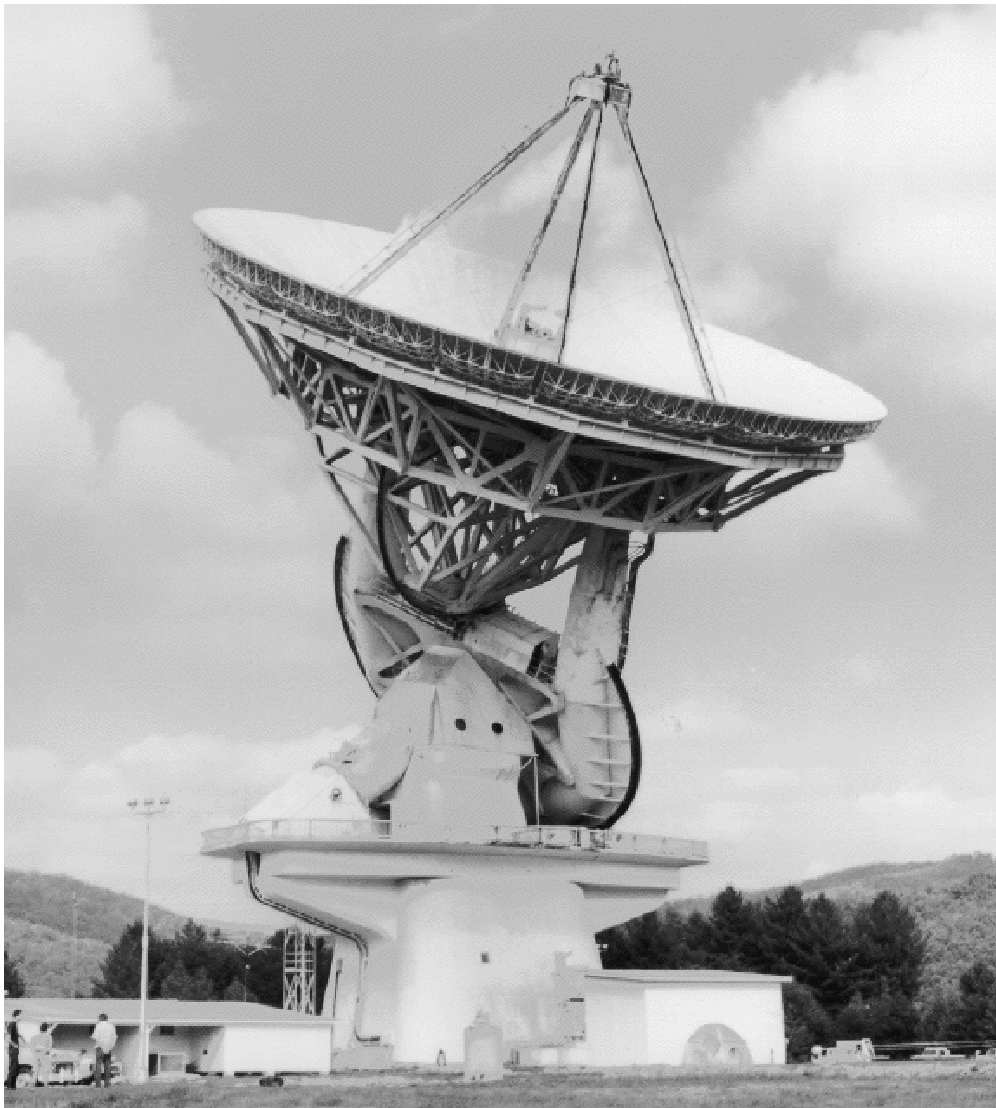
Radio Waves



Why are antennae on cell phones smaller than antennae on your radio?

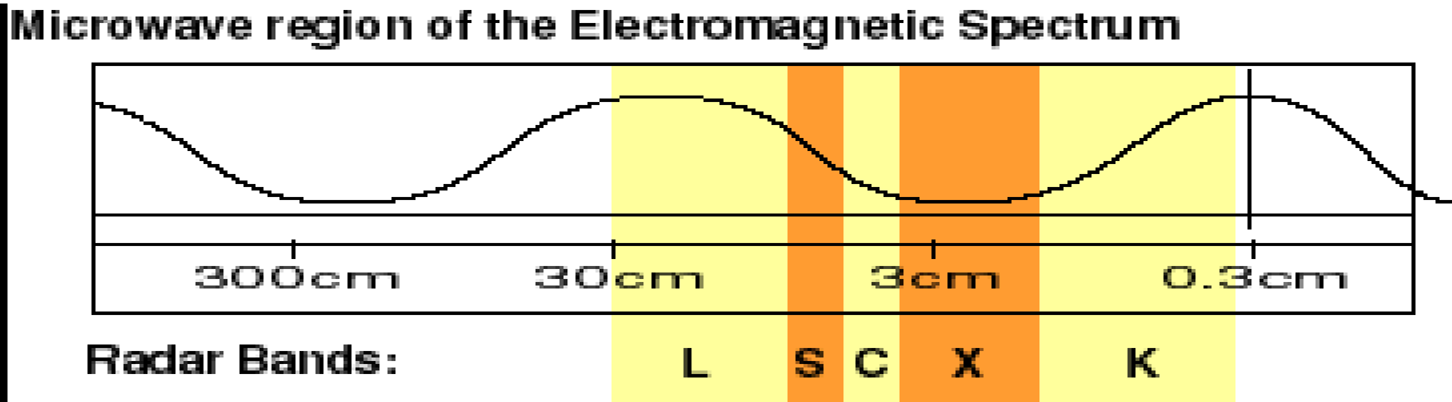


NRAO operates the 140 Foot
Robert C. Byrd Green Bank Radio Telescope

The Arecibo radio telescope is currently the largest single-dish telescope in the world.

VLA as seen from the north

Close-up of antenna

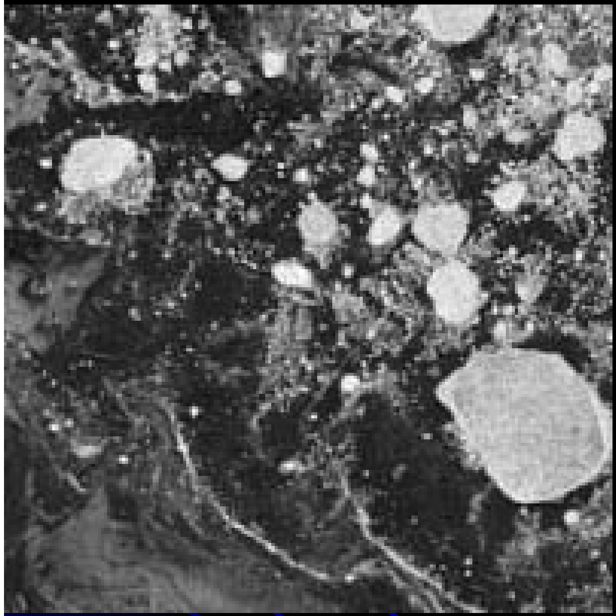


Microwaves have wavelengths that can be measured in centimeters! The longer microwaves, those closer to a foot in length, are the waves which heat our food in a microwave oven.

This microwave tower can transmit information like telephone calls and computer data from one city to another.

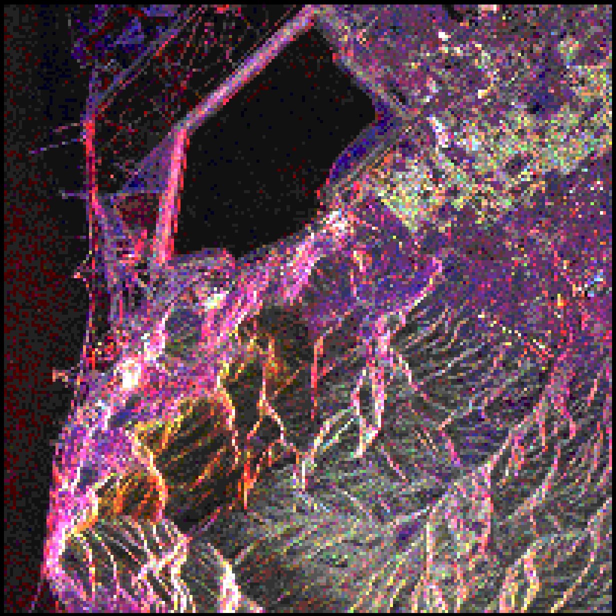
Radar is an acronym for "radio detection and ranging". Radar was developed to detect objects and determine their range (or position) by transmitting short bursts of microwaves. The strength and origin of "echoes" received from objects that were hit by the microwaves is then recorded.

What do Microwaves show us?

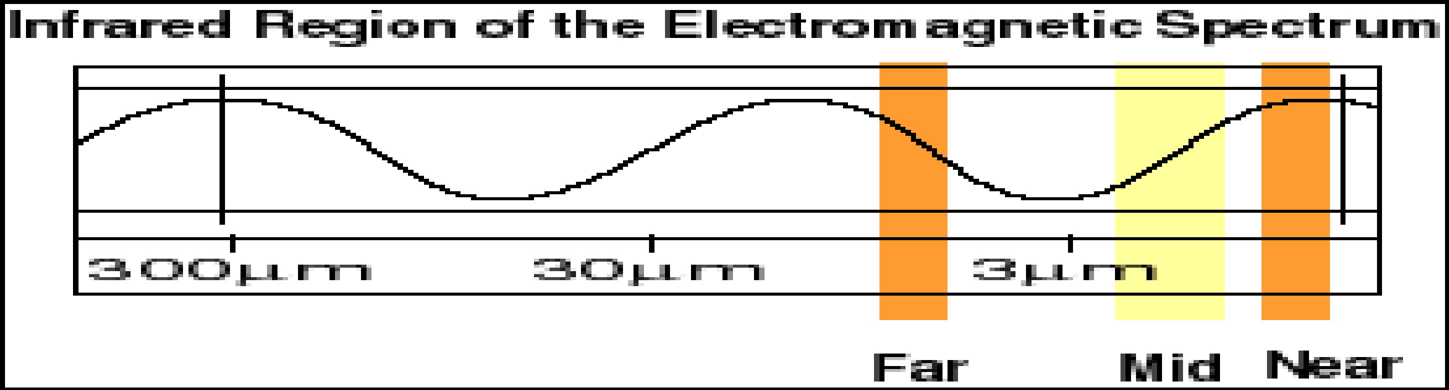


Because microwaves can penetrate haze, light rain and snow, clouds and smoke, these waves are good for viewing the Earth from space.

The JERS satellite uses wavelengths about 20 cm in length (L-band). This is an image of the Amazon River in Brazil.



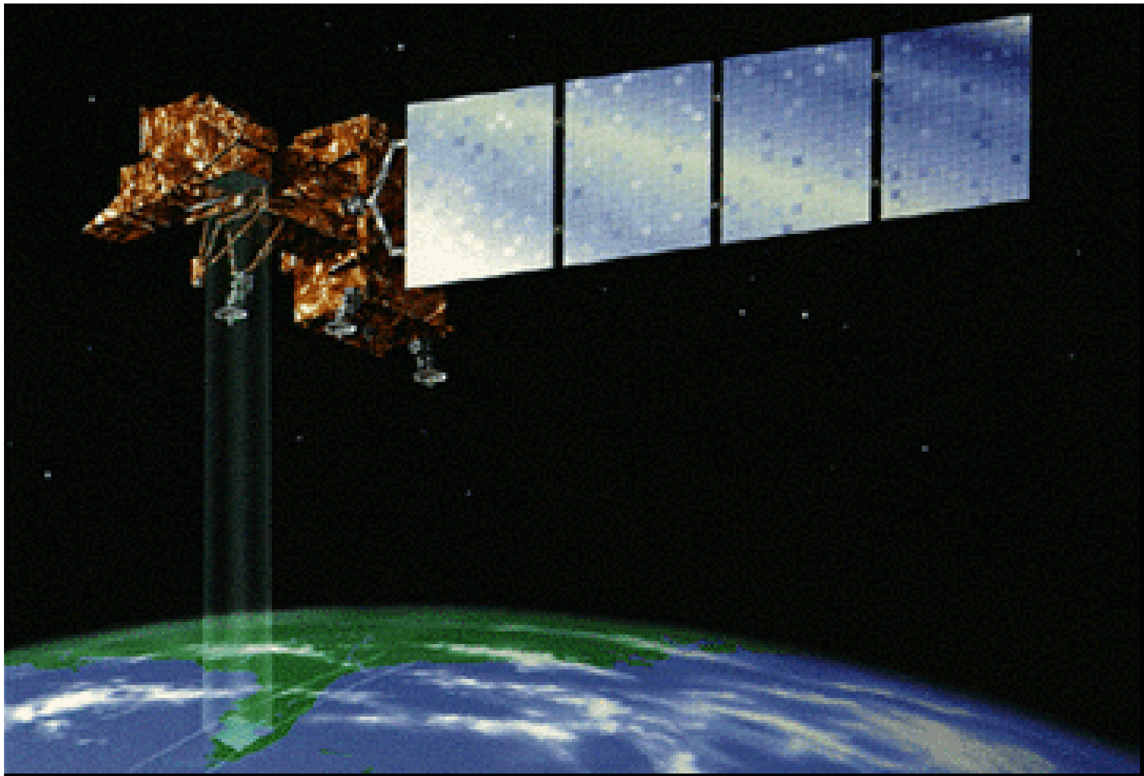
This is a radar image acquired from the Space Shuttle. It also used a wavelength in the L-band of the microwave spectrum. Here we see a computer enhanced radar image of some mountains on the edge of Salt Lake City, Utah.



Far infrared waves are thermal. In other words, we experience this type of infrared radiation every day in the form of heat! The heat that we feel from sunlight, a fire, a radiator or a warm sidewalk is infrared.

Shorter, near infrared waves are not hot at all - in fact you cannot even feel them. These shorter wavelengths are the ones used by your TV's remote control.

Humans, at normal body temperature, radiate most strongly in the infrared at a wavelength of about 10 microns. This image (which is courtesy of the Infrared Processing and Analysis Center at CalTech), shows a man holding up a lighted match!

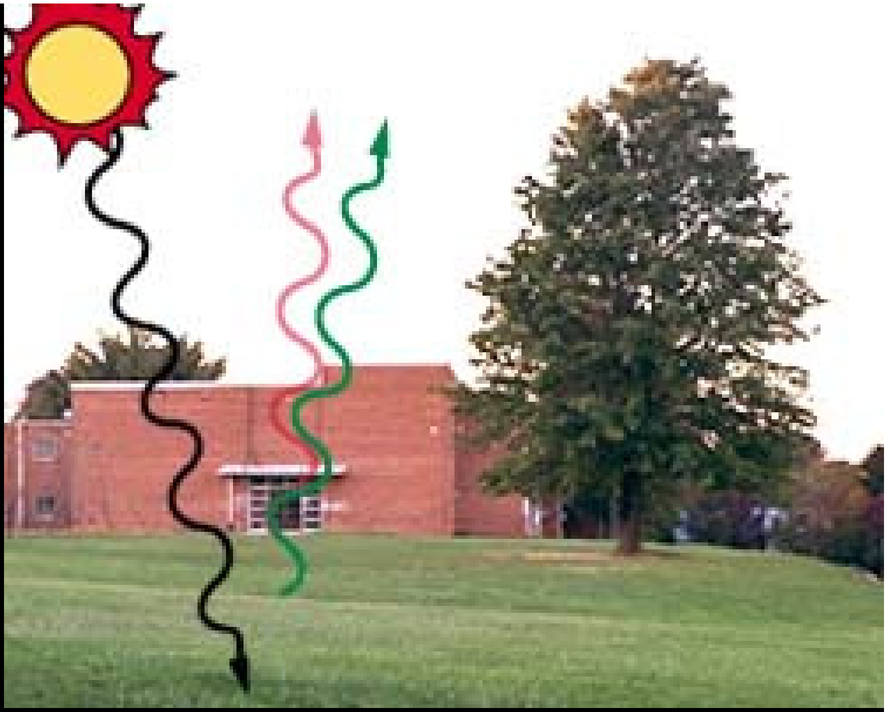


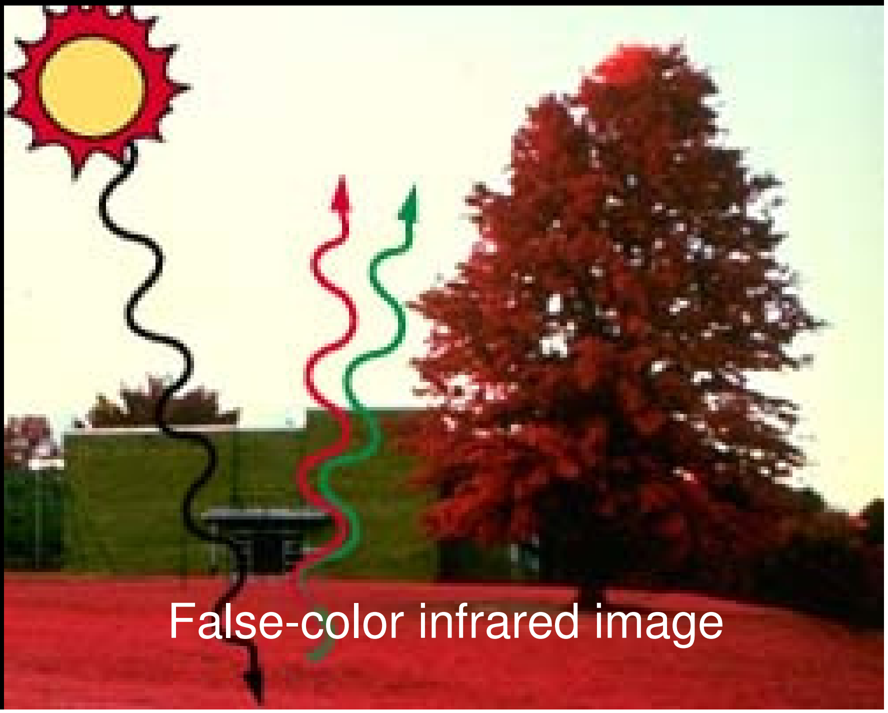
Satellites like GOES 6 and Landsat 7 look at the Earth. Special sensors, like those aboard the Landsat 7 satellite, record data about the amount of infrared light reflected or emitted from the Earth's surface.

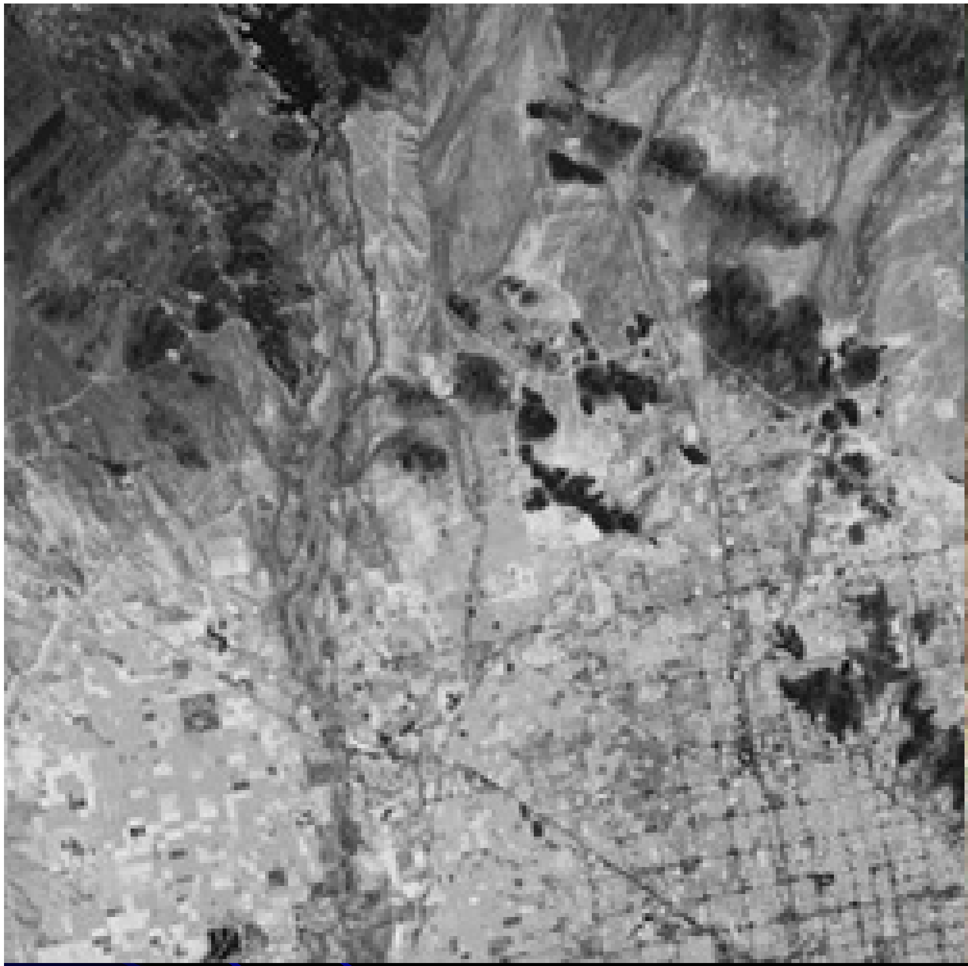
This is an infrared image of the Earth taken by the GOES 6 satellite in 1986. A scientist used temperatures to determine which parts of the image were from clouds and which were land and sea. Based on these temperature differences, he colored each separately using 256 colors, giving the image a realistic appearance.

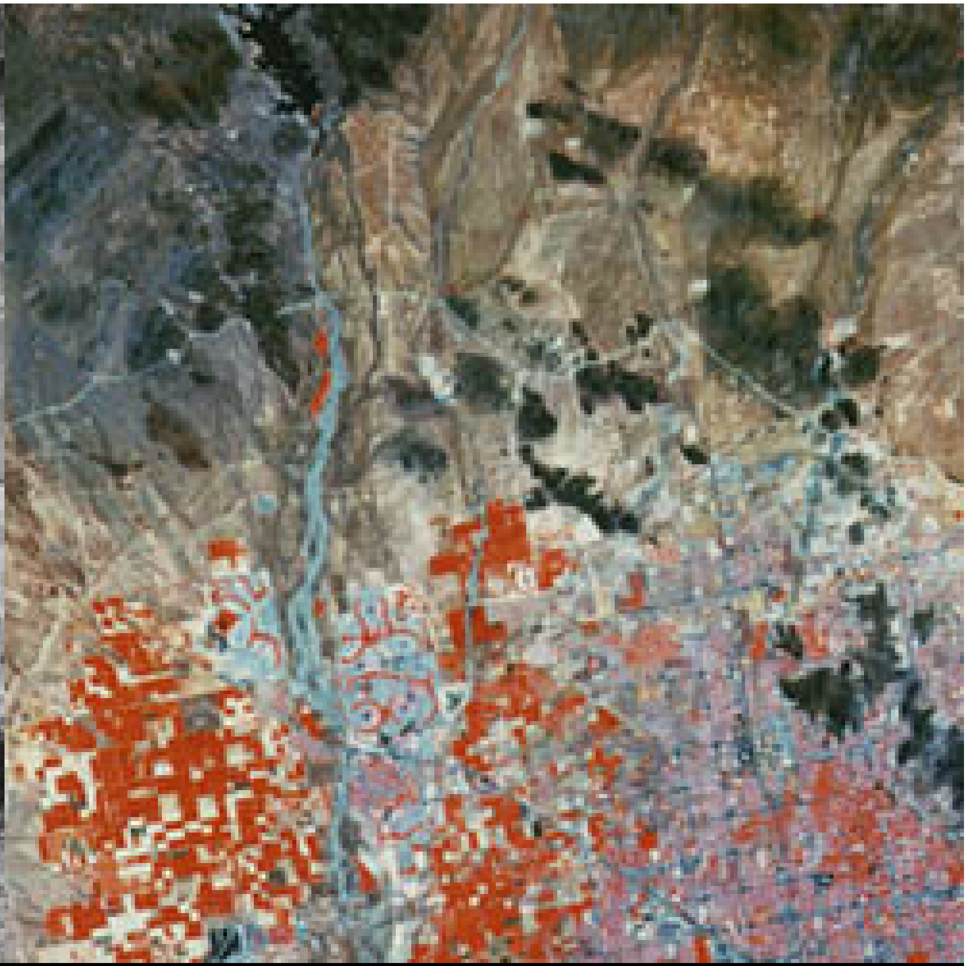
This image of a building with a tree and grass shows how Chlorophyll in plants reflect near infrared waves along with visible light waves. Even though we can't see the infrared waves, they are always there. The visible light waves drawn on this picture are green, and the infrared ones are pale red.

This image was taken with special film that can detect invisible infrared waves. This is a false-color image, just like the one of the cat. False-color infrared images of the Earth frequently use a color scheme like the one shown here, where infrared light is mapped to the visible color of red. This means that everything in this image that appears red is giving off or reflecting infrared light. This makes vegetation like grass and trees appear to be red. The visible light waves drawn on this picture are green, and the infrared ones are darker red.









This is an image of Phoenix, Arizona showing the near infrared data collected by the Landsat 5 satellite. The light areas are areas with high reflectance of near infrared waves. The dark areas show little reflectance. What do you think the black grid lines in the lower right of this image represent?

This image shows the infrared data (appearing as red) composited with visible light data at the blue and green wavelengths. If near infrared is reflected off of healthy vegetation, what do you think the red square shaped areas are in the lower left of the image?

Would you like to help make the World a **Greener** Place?

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Learn about:

- Optics
- Color
- Spectroscopy
- Remote Sensing

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Spend some time at the ….

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Visit us upstairs for:

Telescope Challenge

Spinning Your (color) Wheels

Teen Optricks Benches

Win lots of cool prizes!!!

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