How do scientists understand the chemical composition of our universe, study its age and determine the reactive processes constantly taking place at temperatures reaching many million Kelvin?

The answer is Spectroscopy.

Spectroscopy is the measurement of the response of matter as it interacts with light, and its many uses extend beyond space science, to weather monitoring, medical diagnostics such as MRI, household conveniences like the microwave oven and countless other facets of everyday life.

This documentary examines the critical role spectroscopy plays in studying the nature, composition, history and future of the Universe.

PHOTO CREDIT: NASA/SOFIA AND USRA

The Stratospheric Observatory for Infrared Astronomy (SOFIA)

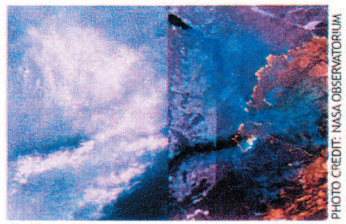

PHOTO CREDIT: NASA OBSERVATORIUM

Yellowstone National Park, 1998. Only smoke appears in the photo at left, but the thermal infrared image at right clearly shows the fire in red, and its leading edge near the image center.

www.scienceofspectroscopy.info

MICHAEL A. ROOKE, SUNDEEP R. MUPPIDI AND STEWART L. MADER PRESENT

SEEING THE SCIENTIFIC LIGHT

NARRATED BY C. WELDON MATHEWS PH.D., SCRIPT BY STEWART L. MADER

DIRECTED BY SUNDEEP R. MUPPIDI AND STEWART L. MADER

Running Time: 60 Minutes

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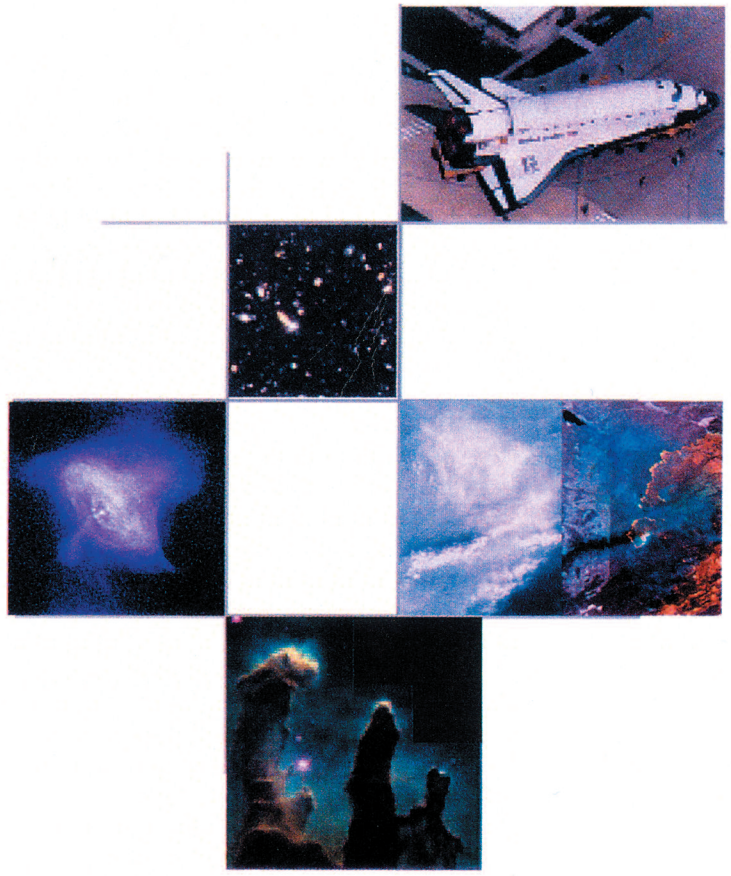
SEEING THE SCIENTIFIC LIGHT



KS207DVD

TERMINOLOGY

ELECTROMAGNETIC (EM) SPECTRUM
The name given to a group of different types of radiation, including visible light which we can see, radio waves which allow for communication, microwaves, infrared light, ultraviolet(UV), x-rays and gamma rays.

GAMMA RAY RADIATION
Electromagnetic radiation having shortest wavelength and highest radiation. Gamma rays have so much energy that they can ionize atoms by removing electrons, which can, in turn, destroy cells and cause cancer.

INFRARED RADIATION
Electromagnetic radiation with wavelengths shorter than visible light but longer than microwave radiation.

HST
Hubble Space Telescope
<http://hubble.stsci.edu>
<http://hubble.gsfc.nasa.gov>

JWST
James Webb Space Telescope
<http://www.jwst.nasa.gov>
<http://www.stsci.edu/jwst/>

NGST
Next Generation Space Telescope. On 10 September 2002, NGST was renamed the James Webb Space Telescope in honor of NASA's second Administrator.
<http://www.jwst.nasa.gov>

PHOTON
The smallest unit/particle of electromagnetic radiation(light). The photon is regarded as a particle with zero mass and no electric charge.

SOFIA
Stratospheric Observatory for Infrared Astronomy
<http://sofia.arc.nasa.gov>

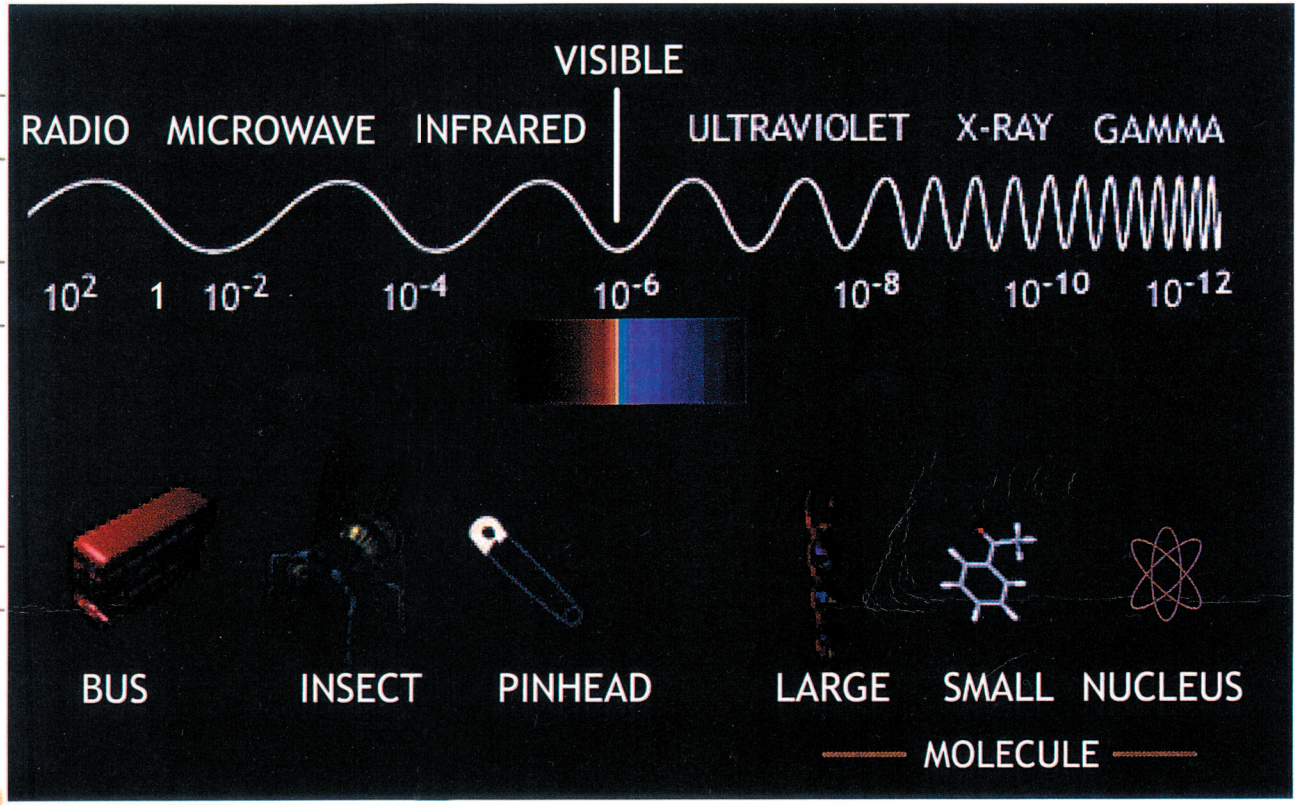
SPECTROSCOPY
The measurement of the response of matter as it interacts with light. Spectroscopy is employed in chemical and biological analysis, medical diagnosis, space science and even in your own home! For example, your microwave oven uses microwave radiation to stimulate water molecules in food, causing them to spin rapidly and generate friction which heats and cooks the food.

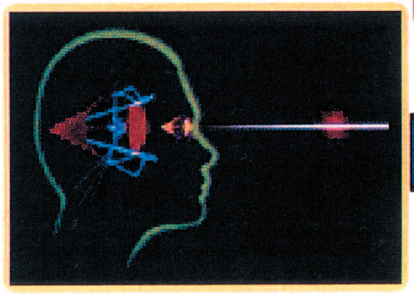
ULTRAVIOLET RADIATION
Ultraviolet (UV) radiation has shorter wavelength and higher energy than visible light. Earth's atmosphere blocks virtually all ultraviolet light, although the radiation which does reach earth is responsible for sunburn.

VISIBLE LIGHT
Visible Light is the region of the Electromagnetic Spectrum which the human eye can see without external aid. Visible light has enough energy to cause electrons in the absorbing material to be promoted to higher energy levels, which is why some materials appear colored when they absorb certain frequencies of visible light.

X-RAY RADIATION
X-Rays have shorter wavelength than Ultraviolet radiation, but longer than Gamma, and have enough energy to travel through the human body, which makes them especially useful for medical imaging techniques, such as Computed Axial Tomography (CT or "CAT Scan") and X-Ray imaging. X-Ray radiation can damage the body by ionizing atoms (completely removing electrons) so caution must be taken to limit direct exposure.

WAVELENGTH
The distance between adjacent peaks in a series of waves. Wavelength indirectly proportional to energy, that is, light with longer wavelength contains less energy.





THE ELECTROMAGNETIC SPECTRUM

SOFIA

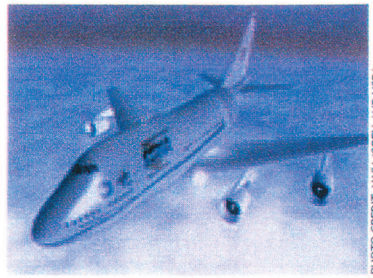


PHOTO CREDIT: NASA/SOFIA AND USRA

Soaring far above ground-based telescopes, but well below instruments like Hubble, the airborne observatory provides a third major vantage point for extraterrestrial observation.

The Stratospheric Observatory for Infrared Astronomy, or SOFIA, is being readied for flight with the modification of a Boeing 747SP to accommodate a 2.5 meter infrared telescope.

NASA DLR
SOFIA
Stratospheric Observatory For Infrared Astronomy

PHOTO CREDIT: NASA/SOFIA AND USRA

The airborne observatory has distinct advantages in that it can quickly travel anywhere around the globe to observe an event, such as a solar eclipse, from the best vantage point. Its agility allows it to observe scarcely seen, little-known celestial events and gather abundant data for astronomers.

Throughout its career, SOFIA will employ a variety of detection instruments which can be rapidly interchanged between observation flights depending on the type of analysis needed. This combination of instrument versatility and mobility sets the airborne observatory apart form its ground- and space-based counterparts.

The airborne observatory's greatest advantage may be its elevation from the ground. Astronomers today analyze light in every region of the electromagnetic spectrum when studying the Universe. The Earth's atmosphere, however, absorbs infrared, ultraviolet, gamma and x-rays, which is fortunate, as we need to be protected from the potentially harmful effects of those rays, but severely limits the information astronomers can gather.

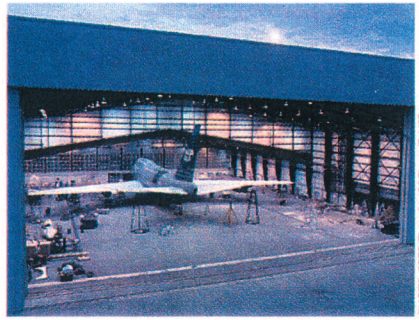


PHOTO CREDIT: NASA/SOFIA AND USRA

Above 40,000 feet, however, these regions of light are not yet absorbed, and airborne observatories are capable of flying at altitudes reaching 45,000 feet, so the Stratosphere is an optimal place to gather astronomical data.

http://sofia.arc.nasa.gov

JAMES WEBB SPACE TELESCOPE

NGST is a collaborative project being developed by NASA, the European Space Agency and the Canadian Space Agency and builds on the astounding gains of the Hubble era. Its chief goal will be to answer several critical questions about the Universe's age, geography and future - questions like:

- When did light begin to illuminate the dark universe?
- How did galaxies form?
- Did black holes play a role in the formation of galaxies?

http://www.stsci.edu/jwst
http://www.jwst.nasa.gov

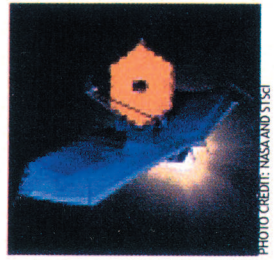


PHOTO CREDIT: NASA AND STSCI

HUBBLE SPACE TELESCOPE

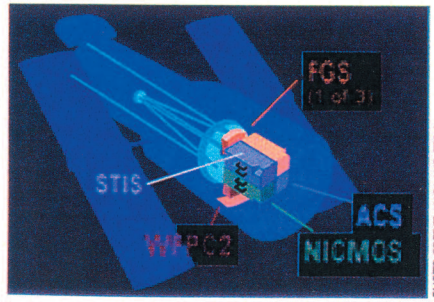


PHOTO CREDIT: NASA AND STSCI

In 1990, NASA and the European Space Agency launched a breakthrough in astronomical observation, called the Hubble Space Telescope.

Without interference from Earth's atmosphere, the ability to distinguish fine detail at great distances, or resolution, of Hubble's instruments is 10 times greater than even the most sophisticated ground-based telescopes.

http://hubble.stsci.edu
http://hubble.gsfc.nasa.gov