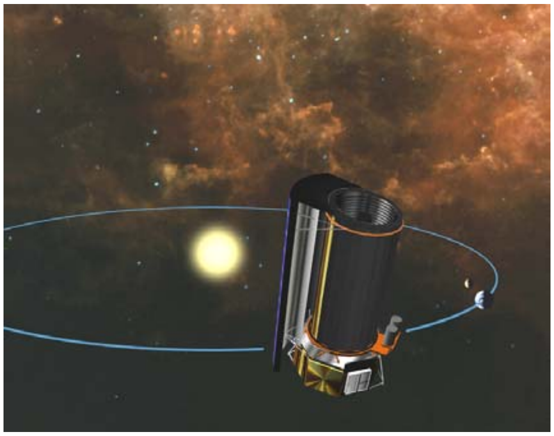
Originally published in The Technology Teacher*, November 2001, by the International Technology Education Association*

Taking a Cold, Clear Look at the Universe



Space Infrared Telescope Facility, NASA's next Great Space Observatory

Compton Gamma Ray Observatory

Hubble Space Telescope

Chandra X-ray Telescope

Early in 2003, NASA will launch the fourth in its current program of great space observatories. You may have heard of one or more of the first three—the Hubble Space Telescope, the Chandra X-ray Observatory, and the Compton Gamma-ray Observatory. This next one, now known by the boring name of Space Infrared Telescope Facility, or SIRTF, desperately needs a snappier, more memorable name before joining its team-mates in the sky. NASA asked for your help in its SIRTF naming contest, which closed in December 2001. The new name selected will be announced in late 2002.

Why So Many Space Telescopes?

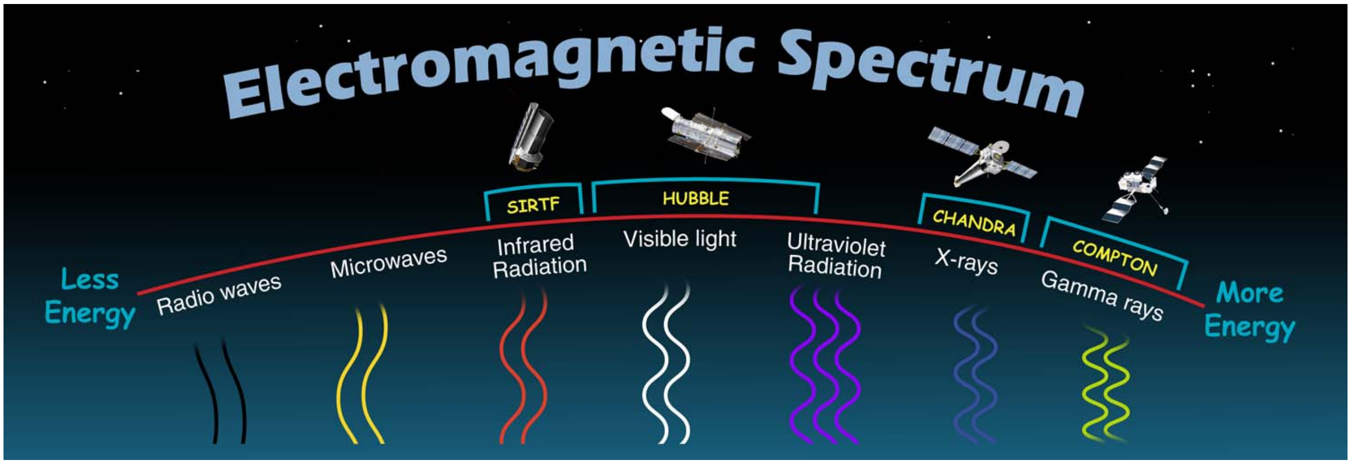
If you are lucky enough to live where the night skies are clear and dark, you can see hundreds or even thousands of stars at night with your unaided eyes. If you look through a telescope, you can see many more stars—maybe even galaxies and planetary nebulae (clouds of gas from exploded stars).

With all this night time splendor laid out before your eyes, you may be surprised to learn that you are still practically blind!

Your eyes, even with the aid of the strongest optical telescope, are seeing only a very tiny part of the "light" that reaches us from all points in the Universe. Besides the light that we can see, enormous amounts of other light we can't see is washing over and around us all the time. This "invisible" light is both more and less "energetic" than visible light, and it comes from planets, stars, galaxies, black holes, pulsars, quasars, nebulae, and all kinds of other astronomical objects. All these kinds of light are really different forms of the same kind of energy—*electromagnetic radiation*.

Like energy passing through the ocean, electromagnetic radiation travels in waves. The only difference between radio waves, x-rays, infrared radiation, ultraviolet radiation, and visible light is the distance between their waves, called their *wavelength*.

Another way to think of wavelength is *frequency*. Frequency means how many of these waves pass by a certain point in a certain time. The longer wavelengths (for example, radio waves), have lower (or slower) frequencies, since it takes longer for one wave to pass by. The shorter wavelengths (for example, x-rays), have



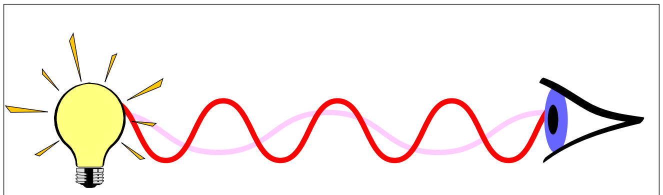
Different space observatories are needed to study different parts of the electromagnetic spectrum.

higher (or faster) frequencies, and these waves zip by very fast. The shorter the wavelength, the more energy the electromagnetic radiation carries. X-rays are so full of energy they pretty much pass right through your body. That is why doctors find them useful for making images of our insides.

Who in the Sky Does What?

Some astronomical objects emit energy mostly in the infrared range, others mostly in the visible range, others mostly ultraviolet, and so on. The most important property of objects (whether they be stars or light bulbs) that determines the radiation they emit is their *temperature.*

There are huge differences in the amounts of energy contained in these different wavelengths of light. To give you an idea, one radio wave (like the kind that carries a signal for AM radio) might be 1 kilometer (over a half-mile) long, while one x-ray wave is the size of a single atom! You can imagine that it will take very different kinds of instruments and technologies to detect these



A light bulb emits both visible and infrared light, but our eyes detect only the visible.

different levels of energy. So scientists and engineers build one kind of telescope to detect radio waves, another to detect infrared, and use still different technologies to detect visible light, x-rays, and gamma rays.

No wonder our poor little eyes need help to see them all!

The Challenge of Infrared

The new SIRTF telescope has a very special problem to solve and here is why.

Some bodies in space, whether they be the tiniest interstellar dust grains or giant planets, are in the temperature range where most of the energy they give off is in the infrared range of wavelengths. These objects, such as dusty interstellar clouds where stars are forming and the icy surfaces of planetary satellites and asteroids, are very cool compared to a lot of other objects in space. It is very helpful to be able to observe them in the infrared range, because we can separate them out from the other objects that are emitting both more and less energetic radiation. Also, cosmic dust grains often make parts of the Universe invisible to our optical (visible light) telescopes. A telescope that could see infrared light could look right through this dusty stuff.

But here is the problem. The temperature of Earth and any telescope on Earth, or even any telescope in space near Earth, is going to be about the same (relatively speaking) as the temperature of the bodies the telescope is observing. Thus the telescope itself would be emitting a lot infrared radiation (after having been warmed up by light and other wavelengths of radiation from the Sun). How can a telescope be made that will be sensitive to the infrared radiation coming from, say, a distant planet, and not react to the infrared radiation coming from its own outer walls, computer, solar panels, propulsion system, and other instruments?

The answer? Make the telescope itself so cold that any infrared radiation it detects has to be coming from outside itself. A big part of SIRTF is its *cryostat*. The cryostat is the system that keeps the instruments cold by venting helium vapor from a liquid helium tank. Yes, this helium is the very same element you put in party balloons to make them float in the air. But when it is very, very cold, helium becomes a liquid. Special coolers on the spacecraft cool the liquid helium to below *minus* 450 ° F (remember, that's *below* zero ° F, and water freezes at 32 ° F *above* zero!) This super cold liquid helium is then used to cool the telescope and other infrared imaging instruments.

This cutaway drawing shows SIRTF's cryostat, with its helium tank, and the telescope mounted above.

Although the helium tank holds about 360 liters (about 95 gallons), it will gradually boil off until it is all gone. However, it is hoped that SIRTF's cryostat will keep the science instruments super cold for up to 5 years.

The Targets of the Infrared Telescope

SIRTF (or whatever more memorable name it gets) will give astronomers new eyes for studying objects that are still very mysterious to them, such as

- Brown dwarfs—objects that are too small to ignite and become stars, but that are larger and warmer than the planets in our Solar System.
- Dusty disks around nearby stars, which may be the signposts of planetary systems in formation.
- Super-bright infrared galaxies—galaxies that give off more radiation at infrared wavelengths than in all other regions of the electromagnetic spectrum combined. What's going on in these galaxies? It could be that they are colliding with another galaxy, thus causing many new stars to be formed.

Also, SIRTF will help scientists learn about the early universe. The universe has been continuously expanding since its creation in the Big Bang. Light from very distant stars and galaxies has not only traveled a very long time to reach Earth, but because space itself has been stretching out, the light from these distant places has also been stretched out during the long period of its travel. Thus, the wavelength of the light that started out being in the visible light range may now, when it finally, billions of years later, reaches us, is in the infrared (longer wavelength) range, where it is no longer visible to our naked eyes or to regular, optical telescopes. But SIRTF will be able to detect these objects from the early Universe and help us understand when and how they were formed.

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SIRTF will be launched on a Delta rocket like this one.

So What Will NASA Name This Baby?

Space observatories and other spacecraft have often been named for mythological figures (such as Apollo and Ulysses) or historical figures (like Galileo and Magellan). Others have been named for famous scientists (Hubble, Chandra). Spacecraft have also been given names that describe something about their missions, like Voyager, Pioneer, or Pathfinder.

From the thousands of suggestions received, NASA will pick a name for SIRTF in the tradition of the other great space observatories.

The grand prize winner of the naming contest will be flown to Kennedy Space Center in Florida to see the launch of the Observatory early in 2003.

So go visit **http://sirtf.caltech.edu** to read more about this important space observatory and what it promises to reveal.

Discussion Questions

1. What name would you suggest for SIRTF?
2. If SIRTF were looking at your everyday world, would it see more infrared radiation from . . .

   Your nose or your forehead?
   Your fingers or your neck?
   The ends of the hair or the roots of your hair?
   Your pet cat or your pet snake?
   A baked potato right out of the oven or a piece of toast right out of the toaster?
3. If you could see an additional range of wavelengths of electromagnetic radiation besides visible light, would you rather be able to see radio waves or x-rays? Why?
4. If you were an astronomer and had the opportunity to use SIRTF for your own research, what would you want to study?

For additional interesting space-related activities and amazing space science and technology facts, visit The Space Place at http://spaceplace.nasa.gov. To learn more about the electromagnetic spectrum and the different instruments we use to detect its different frequency ranges, see especially http://spaceplace.nasa.gov/chandra.htm .

This article was written by Diane Fisher, science and technology writer and developer of The Space Place website, and is provided through the courtesy of the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.