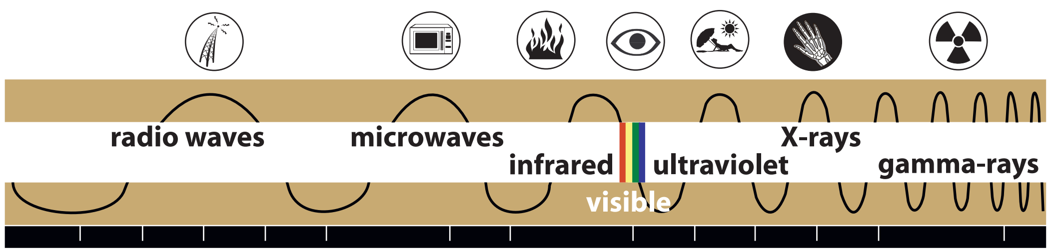
The Universe in a Different Light

There is more to the Universe than meets the eye. By looking in space using detectors for energy invisible to our eyes, we get a more complete story.

Different energies of light reveal many secrets about the lives of stars and galaxies that are otherwise hidden from us.

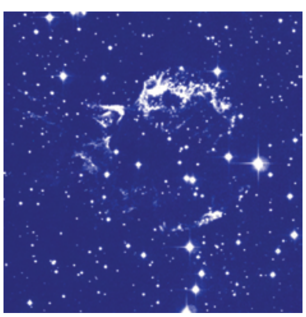
The attached cards contain examples of objects commonly observed with backyard telescopes. The cards contain a typical visible light image and a few images in different energies (or wavelengths) of light.

The explanations on the back of the cards tell what astronomers are discovering by studying objects in energies of light invisible to the eye.



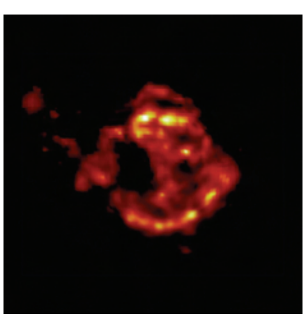
Front #1

Supernova Remnant
(Cassiopeia-A)



Credit: Digitized Sky Survey

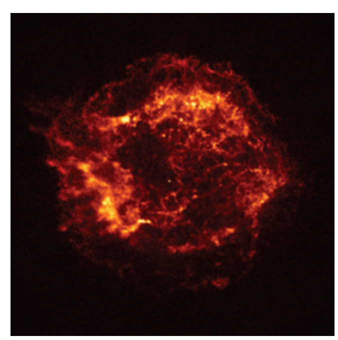
Visible



Credit: Infrared Space Observatory

Infrared

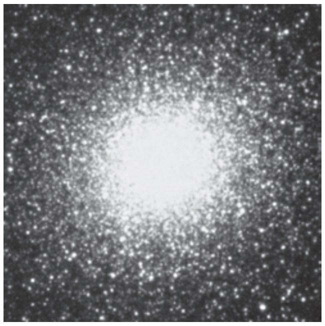
X-ray



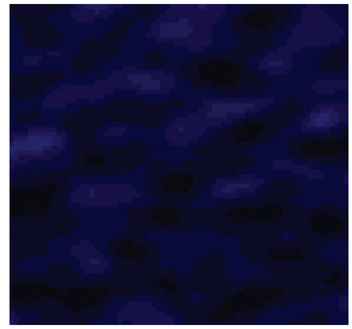
Credit: NASA/CXC/SAO/Rutgers/J. Hughes

Front #2

Globular Cluster
(M13 – Hercules Cluster)

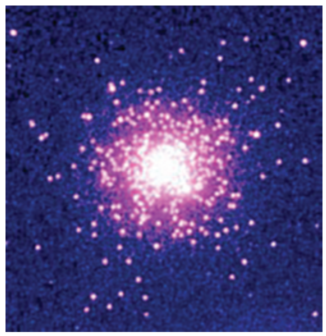

Credit: Digitized Sky Survey

Visible


Credit: IRAS

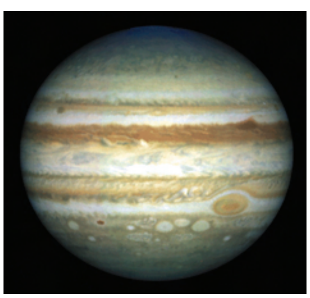
Infrared

Ultraviolet


Credit: FOCA

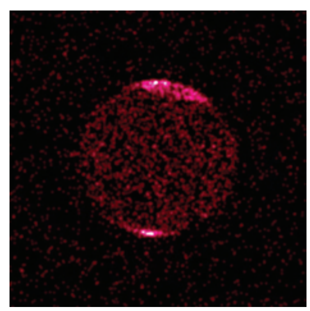
Front #3

Jupiter

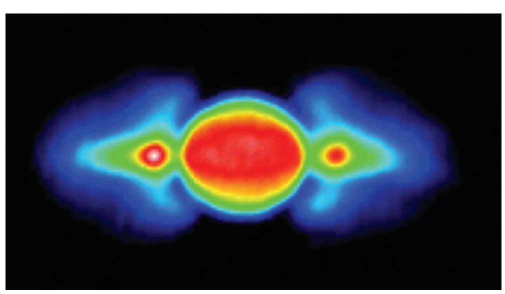

Credit: NASA

Visible

Radio


Credit: NASA/CXC/SWRI/G.R. Gladstone et al.

X-ray


© Australia Telescope National Facility

Front #4

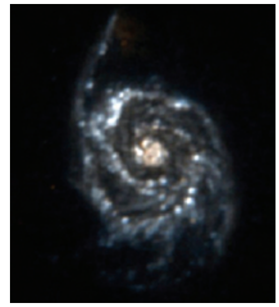
The Universe in a Different Light: Sheet C

Galaxy
(M51)

Visible

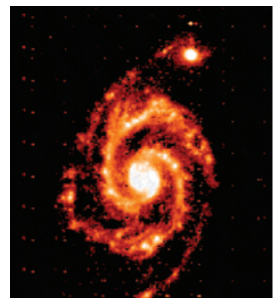
Credit: Digitized Sky Survey

Ultraviolet



Credit: GALEX, NASA

Infrared



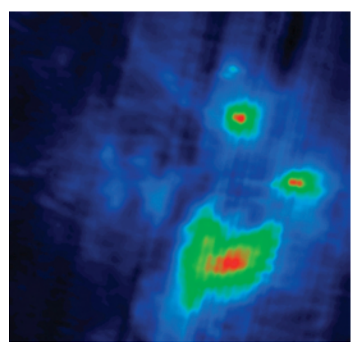
Credit: ESA Infrared Space Observatory

Front #5

Open Star Cluster
(M45 – Pleiades Cluster)

Credit: Alexander Jäger
Interessengemeinschaft Astronomie

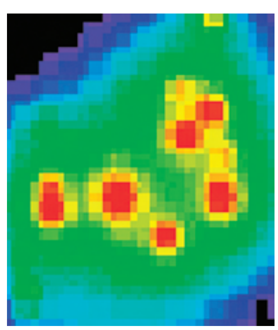
Visible



Credit: IRAS

Infrared

Ultraviolet



Credit: Midcourse Space Experiment

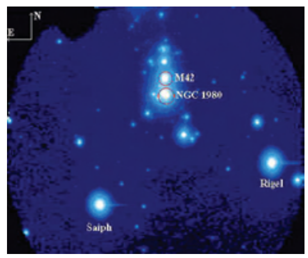
Front #6

Star-Forming Region – Nebula of Dust and Gas
(Constellation of Orion & M42)

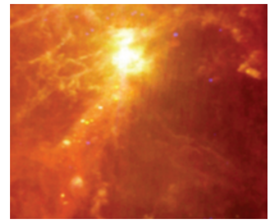

Credit: Bill Drelling

Visible

Ultraviolet



Credit: Midcourse Space Experiment


Credit: IRAS

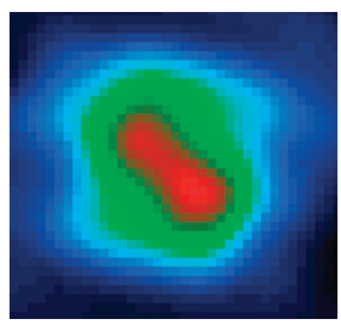
Infrared

Front #7

Planetary Nebula – A Dying Star
(M27 – Dumbbell Nebula)

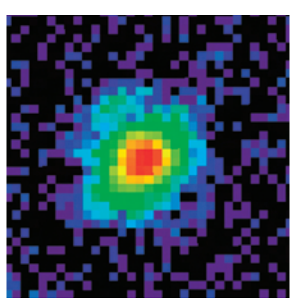

Credit: 2MASS

Visible


Credit: IRAS

Infrared

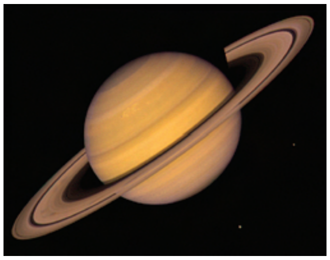
X-ray


Credit: ROSAT

Front #8

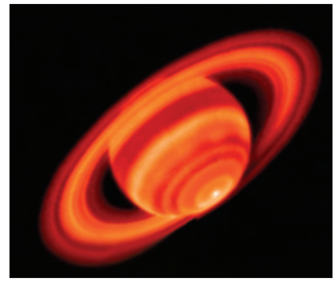
The Universe in a Different Light: Sheet E

Saturn



Credit: NASA/JPL/Voyager

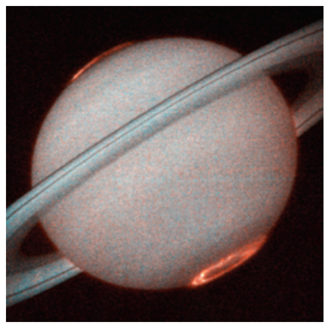
Visible



Credit: W.M. Keck Observatory/NASA/JPL-G. Orton

Infrared

Ultraviolet

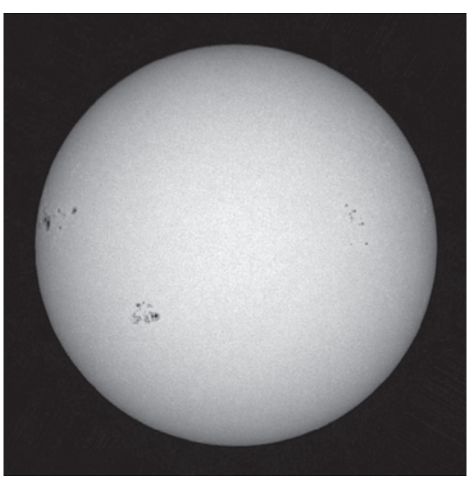


Credit: J. Trauger JPL/NASA

Front #9

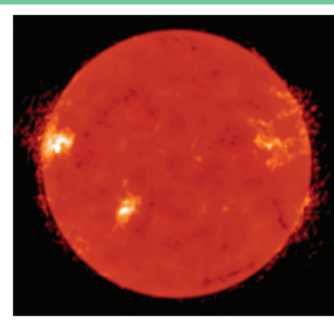
The Sun

Visible



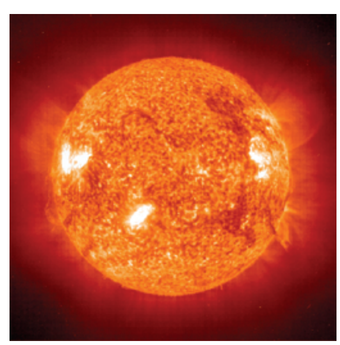
Credits: Big Bear Solar Observatory

Radio



Credits: Nobeyama Radio Observatory

Ultraviolet



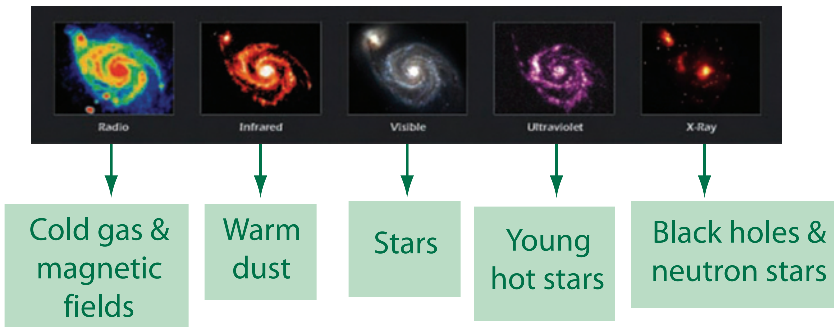
Credits: NASA/ESA SOHO

Front #10

Let's take a distant galaxy (M51):

- Radio detectors can reveal magnetic fields and cold clouds of gas and dust.
- Infrared detectors find the dust being warmed by nearby stars. Gas and dust combine to make new stars.
- The view our eyes see shows us the combined light of billions of stars.
- Ultraviolet detectors show us where the hot young stars are.
- X-ray detectors reveal massive black holes in the centers of galaxies.

We cannot know any of this by just looking at stars in the galaxy with our eyes (Visible).



Back #1

Supernova Remnant
(Cassiopeia-A)

This is what remains of the material expelled from a huge star when it died in a supernova explosion.

Visible light: Supernova remnants are often unimpressive in visible light. They barely reveal the expanding shell of gas from the powerful supernova explosion. What can you see in the telescope?

Infrared: Shows the warm dust left over from the explosion. Supernova explosions create the dust of heavy elements, like iron and gold, and spread them out into space. It is this dust that mixes with other dust and gas between the stars and eventually contributes to building new stars and planets, maybe a planet like Earth.

X-ray: The bright regions show where material from the explosion is crashing into the gas and dust of interstellar space, heating it to millions of degrees. These collisions contribute to compressing the gas and dust and after millions of years, forming new stars from the wreckage of these dead stars.

Back #2

Globular Cluster
(M13 – Hercules Cluster)

Visible light: When you look through a telescope you see a spherical cluster of thousands of stars tightly bound together by gravity. Do you suppose these stars are young or old?

Infrared: What happened to the cluster of stars? Infrared light Is supposed to reveal dust. The view in infrared of this cluster shows us that there is no dust - nothing from which new stars can form. These stars are very old - any dust that was leftover from their formation billions of years ago is long gone. No young stars are in this cluster.

Ultraviolet: If there are no young stars in this cluster, why is the ultraviolet image so bright? These stars are hot, but they are not young. This image shows us which ones are very compact stars nearing the end of their lives: white dwarfs. These stars have lost their outer atmospheres and have used up most or all of their nuclear fuel. All that is left of these is an exposed hot collapsed core.

This is a quiet, serene cluster of old stars all living together for billions of years.

Source: http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_museum/m13.html

Back #3

Jupiter

Visible light: As you look at Jupiter through the telescope, note the bands of clouds and its slightly flattened appearance. Watching the features on Jupiter rotate across its face, we can tell this huge planet rotates about once every 10 hours. This fast rotation causes Jupiter to be slightly flattened at the poles.

Radio: Is this Jupiter? Radio energy reveals magnetic fields. In this image, you are able to see that Jupiter has strong magnetic fields - similar to, but much stronger than, the magnetic fields on Earth. Can you see magnetic fields with your eyes? A compass will show you the direction of the magnetic fields on Earth, but we need radio telescopes to reveal the magnetic fields on Jupiter.

X-ray: This image shows us that high-energy particles trapped in Jupiter's magnetic field are accelerated along the lines of force and slam into Jupiter's poles, releasing a lot of energy. Jupiter's strong magnetic fields generate a more energetic aurora (northern and southern lights) than Earth's fields do – so energetic that it is invisible to our eyes.

Back #4

Galaxy
(M51)

Visible light: When you look through the telescope at a galaxy, you'll see a fuzzy patch of light. Long exposures using cameras or CCDs will show much more detail, like this image. You are seeing the glow from billions of stars, but what kind of stars are they?

Infrared: In addition to showing stars, infrared reveals dust warmed by stars within the spiral arms. These dusty regions are cool, not nearly as hot as stars, but much warmer than the background of space. Dust and gas are what new stars are made from.

Ultraviolet: Shows star formation concentrated in the spiral arms, since ultraviolet reveals where the massive hot young stars are. What happened to the companion galaxy at the top? Notice that it is not visible in the ultraviolet image, telling us that this region has little or no new star formation taking place.

Back #5

Open Star Cluster
(M45 – Pleiades Cluster)

Visible light: You might see a hazy patch in the sky, but the view through a telescope or binoculars reveals many bright stars in a loose group. Do you think these stars are old or young?

Infrared: The view in infrared shows us the warm dust leftover from the recent formation of these stars just a few million years ago. These are *new* stars!

Ultraviolet: The hottest stars can be seen in the ultraviolet image. Can you see how the red spots (which show the highest emissions of ultraviolet light) match the locations of the brightest stars in the visible image?

This is a loose association of new stars, just breaking out of the cocoon of gas and dust where they formed–ready to go out and have lives of their own. These stars will eventually separate from each other–some perhaps with families of planets around them.

Source: http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_museum/m45.html

Back #6

The Universe in a Different Light: Sheet I

Star-Forming Region – Nebula of Dust and Gas

(Constellation of Orion & M42)

Visible light: This image of the constellation shows stars of all ages and temperatures as we would see with our eyes. Can you see a faint, hazy patch? What can we find out about what this is?

Infrared: The brightest regions in infrared show where the highest concentrations of dust are. The entire region seems to glow with warm dust clouds. Is the fuzzy patch one of the brightest regions? New stars are probably forming from all this dust. Notice how some of the stars are almost invisible. Very hot stars emit most of their light in ultraviolet and visible light energies. They generate only a little energy at the cooler infrared levels. What kind of stars do you suppose are forming in the fuzzy patch?

Ultraviolet: This view of the area around the fuzzy patch shows the nebula hot with the ultraviolet light of massive young stars. Notice how brightly some of the stars shine in ultraviolet – these are the really hot stars!

Back #7

Planetary Nebula – A Dying Star

(M27 – Dumbbell Nebula)

Visible light: A shell of gas and dust is being expelled from an average star (like the Sun) nearing the end of its life. Our star might have a shell around it like this in a few billion years.

Infrared: Infrared light from cool dust traces the outline of the dusty cloud around the dying star. This dust is enriching space with elements like oxygen and calcium to make new stars and their planets - and maybe beings like you!

X-ray: The hot X-rays coming from the center of the planetary nebula (red in the center indicates the most intense X-rays) reveal the exposed hot core - the remains of the dying star - a white dwarf.

Source: http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_museum/m27.html

Back #8

Saturn

Visible light: In visible light we begin to see features in Saturn's atmosphere as well as in its vast ring system.

Infrared: The image shows both the planet and the rings radiating heat absorbed from the Sun. The lighter the color, the warmer the area. We can see that Saturn's south pole is warmer than its equator. The equator is about -300° F, so at -188° F, the south pole is comparatively pleasant!

Ultraviolet: Ultraviolet reveals Saturn's auroras which are over 1,000 miles above the clouds. These auroras are caused by solar wind particles guided to Saturn's polar regions by the planet's magnetic field where they collide with gases in Saturn's atmosphere–Saturn's equivalent of the Northern Lights.

Source: http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_museum/m13.html

Back #9

The Sun
A close-up view of a star!

Visible light: This is the view through a telescope with a solar filter on it. What do you see? Some dark spots? Do you suppose all stars have dark spots like this? What are they? They appear dark because the are cooler than the surrounding gas which is glowing at about 6000° C. Let's look at other energies of light to find out more.

Radio: Do you notice the regions of strongest radio energy seem to correspond with the placement of the sunspots? Radio can reveal magnetic fields. Does it look like there are strong magnetic fields near sunspots?

Ultraviolet: Magnetic fields trap hot gases. The ultraviolet allows us to see hot flares and material looping out of the Sun at temperatures of up to a million degrees. Solar storms and flares, which can disrupt communications on Earth, result from changes in the magnetic fields of the Sun.

Back #10