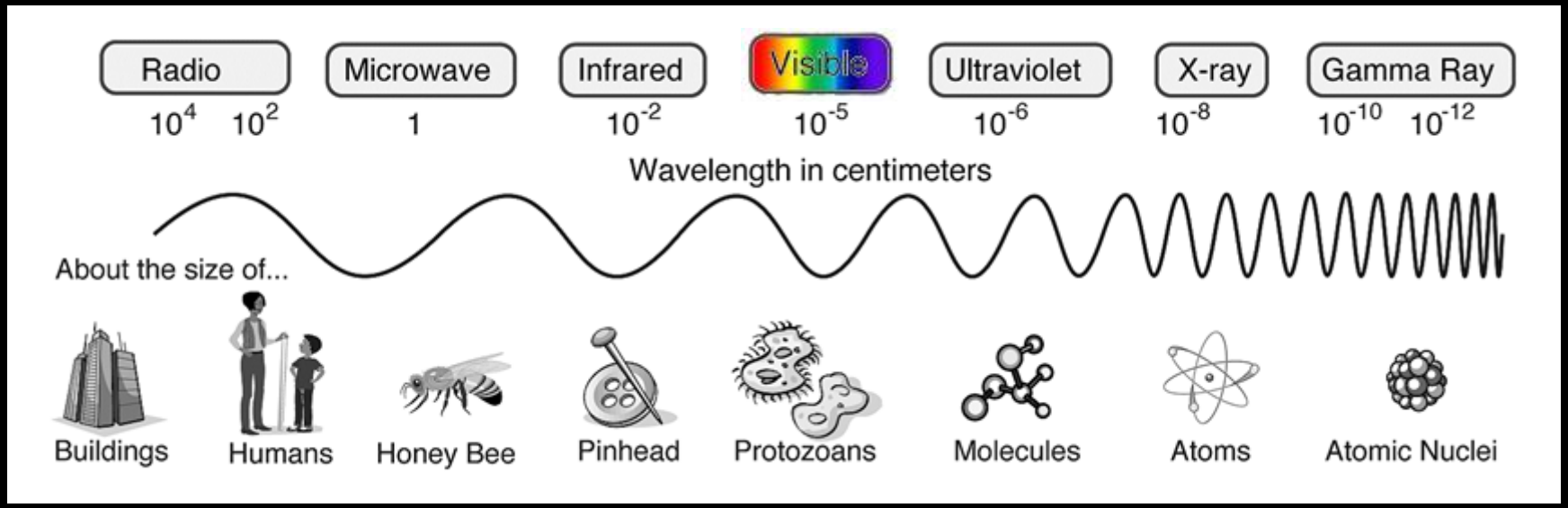
Infrared Astronomy

Infrared Light

- In 1800 William Herschel discovered “invisible light”
- It’s energy with all the same characteristics as visible light, but is not sensed by the human eye
- The light Herschel discovered was just beyond the red part of the spectrum. So it was named “infrared”

The Spectrum of Light

- Visible light is a tiny fraction of the *Electromagnetic Spectrum*
- Gamma rays--billions of waves per inch
- Radio waves--up to miles-long wavelengths

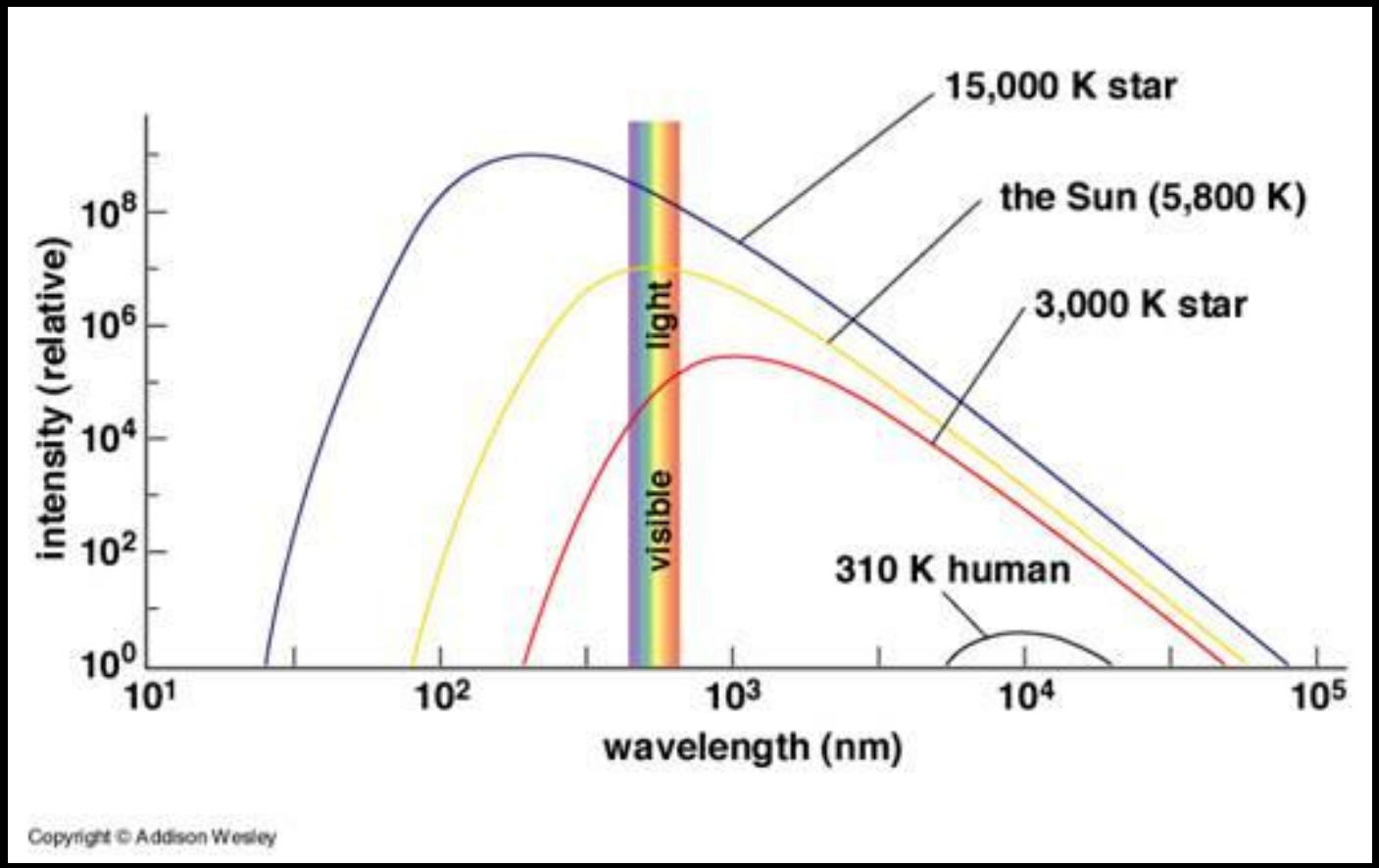


Low Energy Waves

High Energy Waves

The Physics of Light

- All objects in the Universe emit light depending on their temperature.
- Cool objects emit primarily long wavelength light
- Hot objects emit primarily short wavelength waves



The Physics of Light

Objects emit light depending on their temperature.

Cool objects emit primarily long wavelength light

Hot objects emit primarily short wavelength light.

Human

Infrared
33° C (306 Kelvin)

Electric Stove

Red Light
4,130° C (4,400 Kelvin)

Spot Light

White Light
5,230° C (5,500 Kelvin)

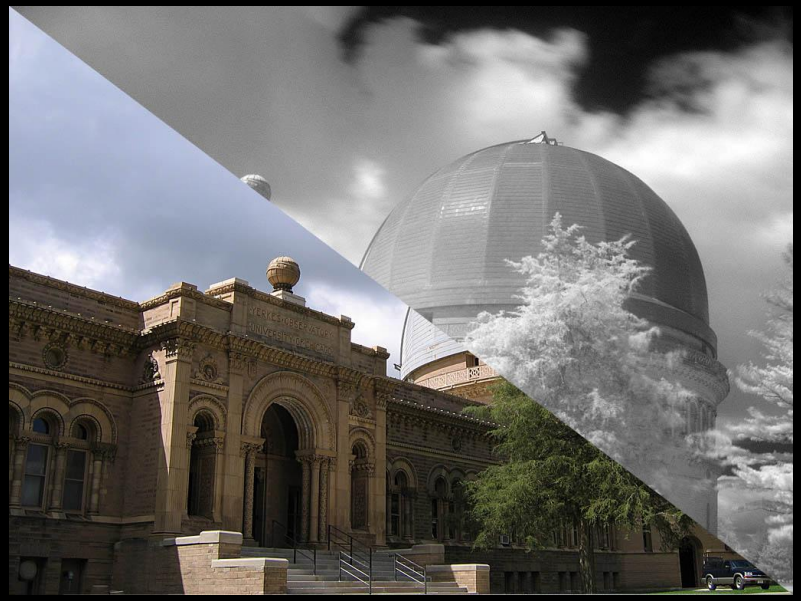
Lightning Bolt

Ultraviolet Light
30,000° C (30,273 Kelvin)

The Range of Infrared Light

Infrared light lies just beyond the red portion of the visible spectrum ("below red“). Infrared wavelengths are about 0.7 to 350 microns.

(a micron is one-millionth of one meter, or about 1/50th the width of a human hair).



Near Infrared

Mid Infrared

The Range of Infrared Light

SPECTRAL REGION	WAVELENGTH RANGE (microns)	TEMPERATURE RANGE (degrees Kelvin)	WHAT WE SEE
Near-Infrared	0.7 – 5	740 – 5,200	Cooler red stars Red giants Dust is transparent
Mid-Infrared	5 – 40	93 – 740	Planets, comets and asteroids Dust warmed by starlight Protoplanetary disks
Far-Infrared	40 – 350	11 – 93	Emission from cold dust Central regions of galaxies Very cold molecular clouds

Getting the WHOLE picture

An object can look radically different depending on the type of light collected from it:

Since shortly after Herschel discovered infrared light astronomers have been observing astronomical objects in Infrared Light to get a more complete picture

Visible Light Image

Mid-Infrared Light Image

Why Study Infrared?

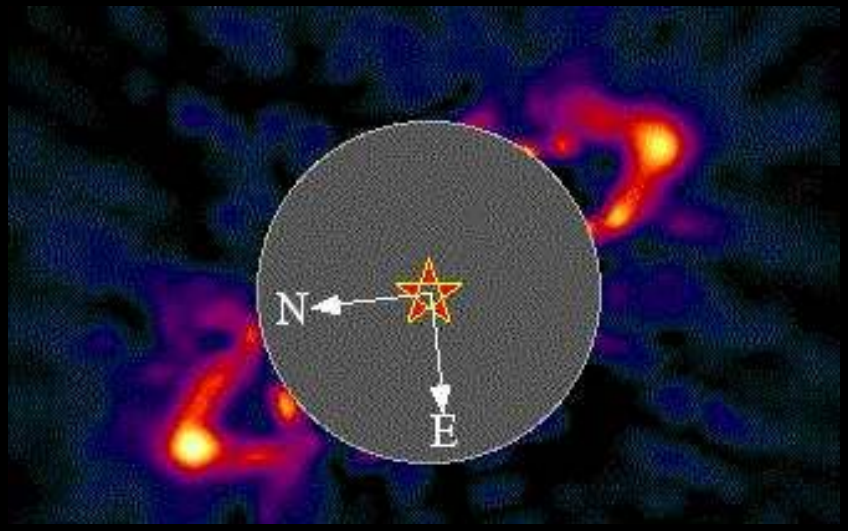
- Visible: dark nebula, heavily obscured by interstellar dust ("Horsehead Nebula")
- Near-Infrared: dust is nearly transparent, embedded stars can be observed forming
- Mid- and Far-Infrared: glow from cool dust is directly observable

Visible

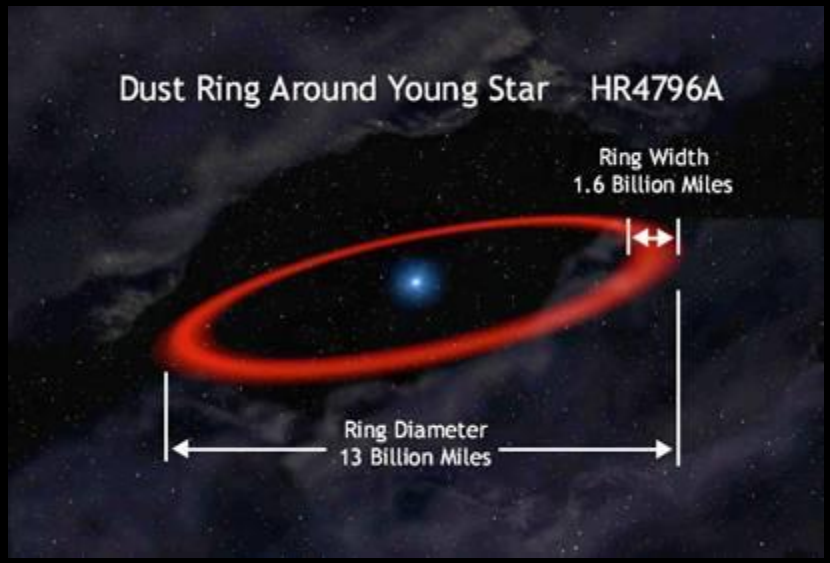
Near Infrared

Mid-Infrared

Why Study Infrared?



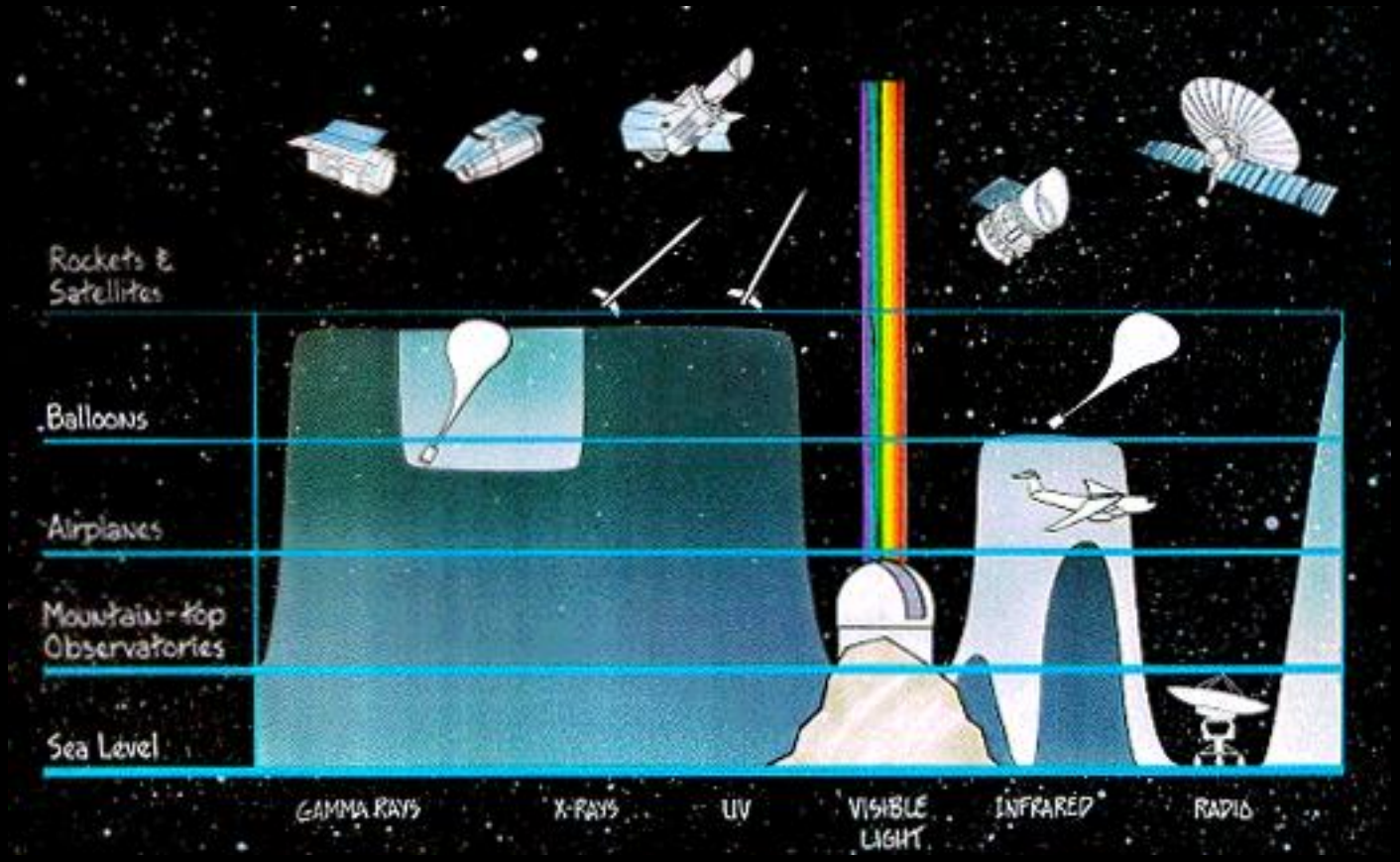
- **Cool objects--like newly forming stars and solar systems--emit almost exclusively in the Infrared**



Why Study Infrared?

Infrared penetrates intervening dust clouds, allowing us to see through or into them

But there's a Challenge...



- Earth's atmospheric water vapor absorbs almost all incoming infrared radiation
- Even mountain-top observatories get a limited view of the infrared universe

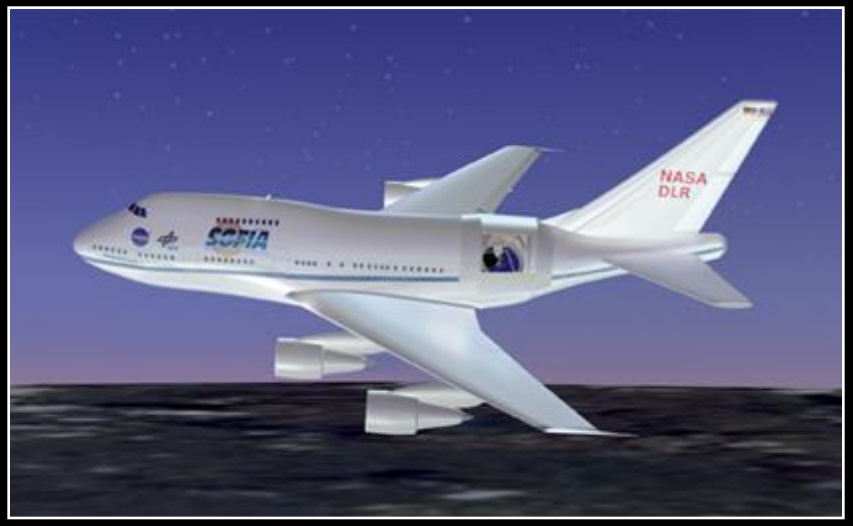
Infrared telescopes need to observe from high altitude or in space

NASA's Infrared Missions

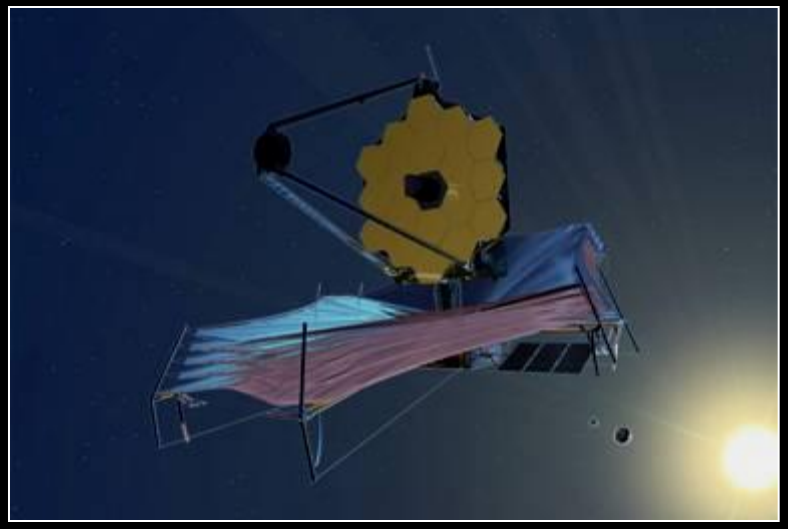
Spitzer Space Telescope

WISE

SOFIA

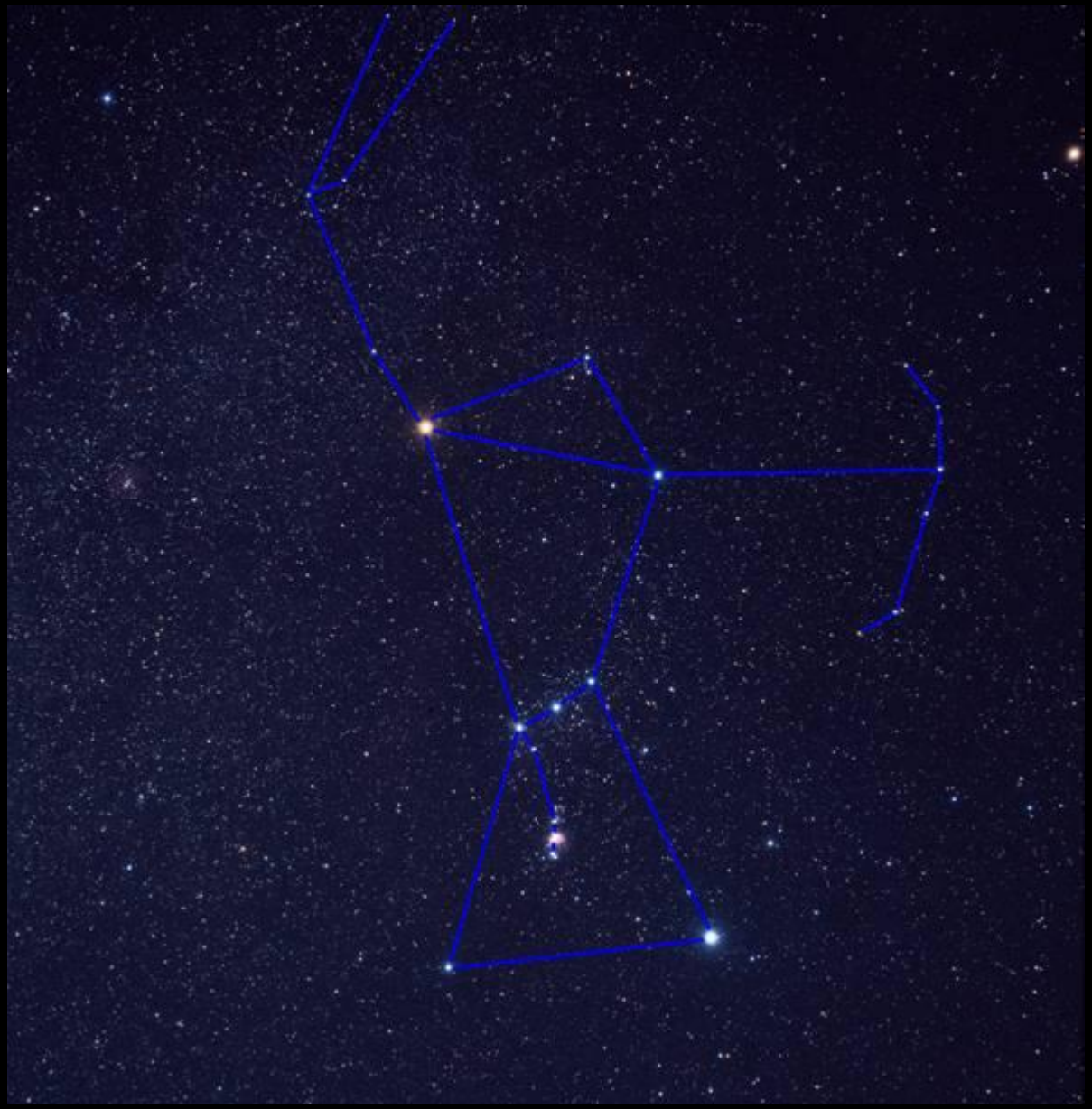


James Webb Space Telescope



Constellation Orion

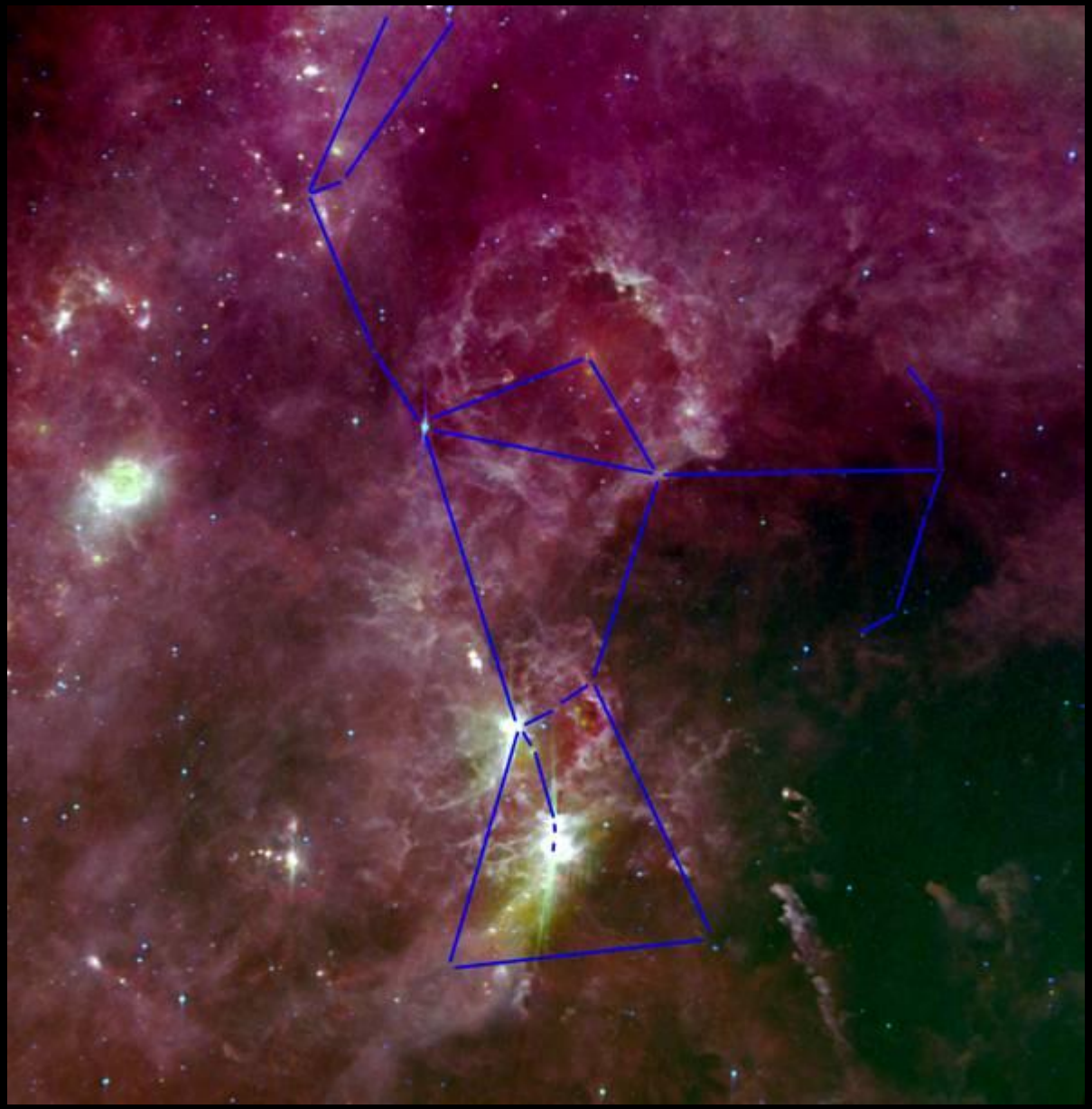
Visible Light



Constellation Orion

Mid Infrared Light

IRAS



Trifid Nebula

Visible Light

NOAO

Trifid Nebula

Infrared Light

Spitzer

Orion Nebula

Visible
Light

Orion Nebula

Infrared
Light

Spitzer

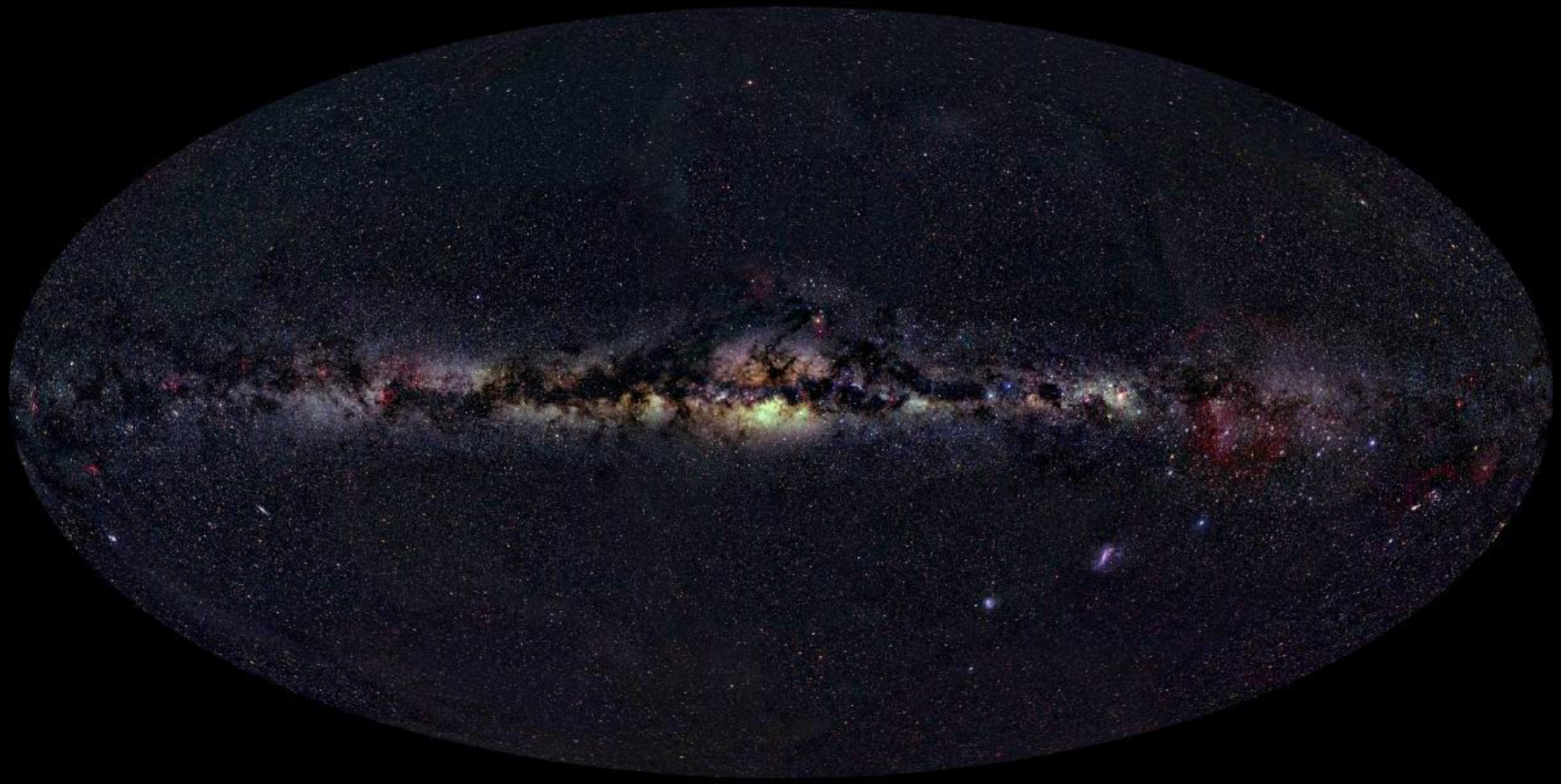
Sombrero Galaxy

Visible Light

HST

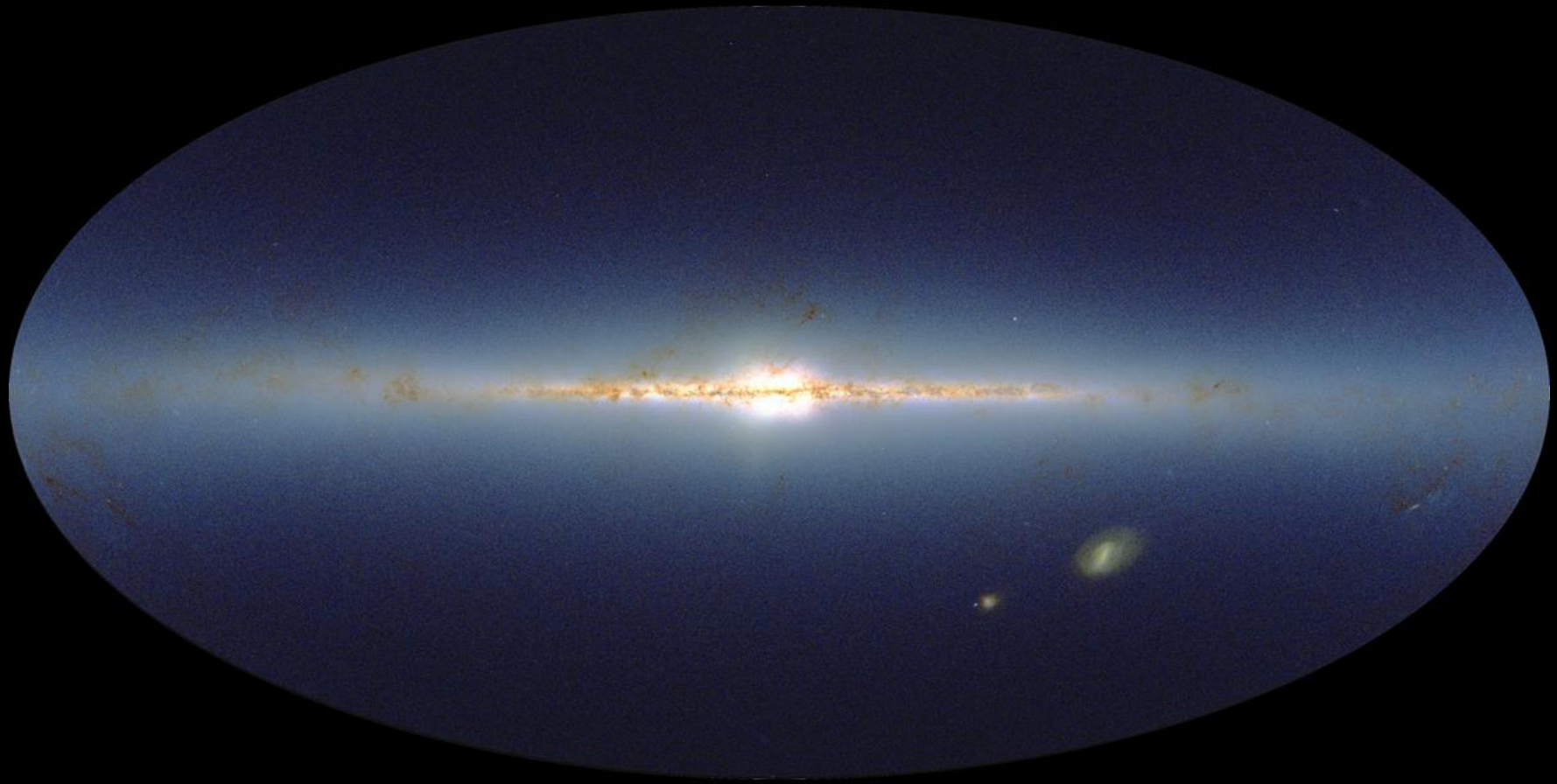
Sombrero Galaxy

The Whole Sky



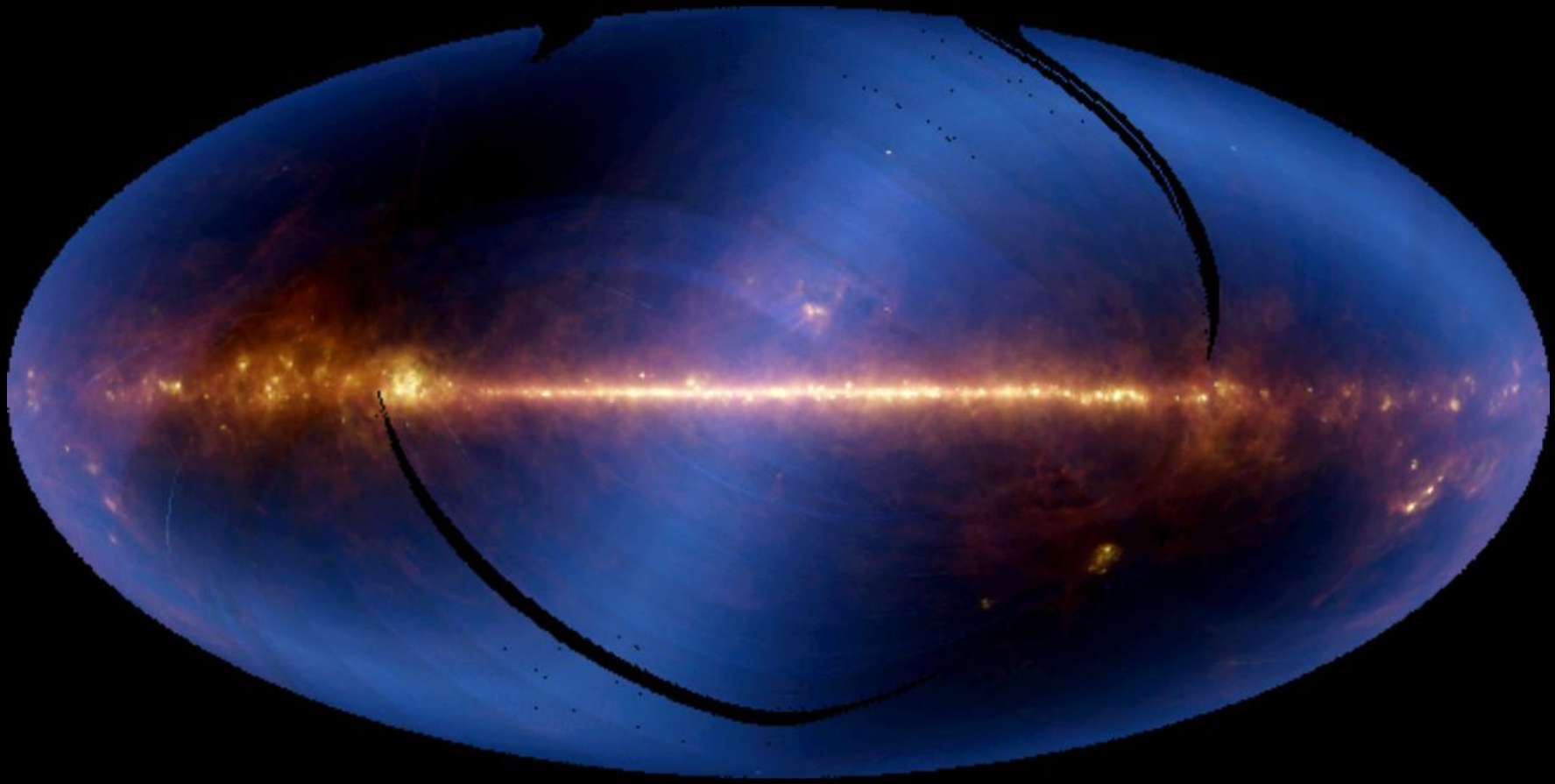
Visible Light - Axel Mellinger

The Whole Sky



Near Infrared Light - 2MASS Survey

The Whole Sky



Mid/Far Infrared Light - IRAS Survey