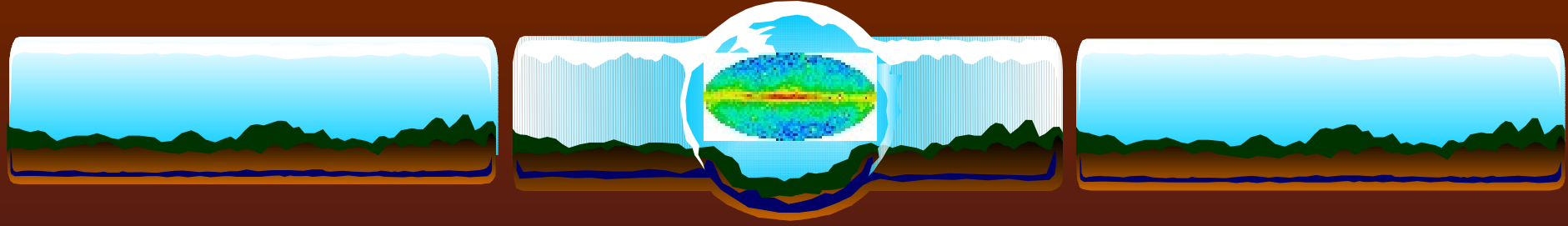


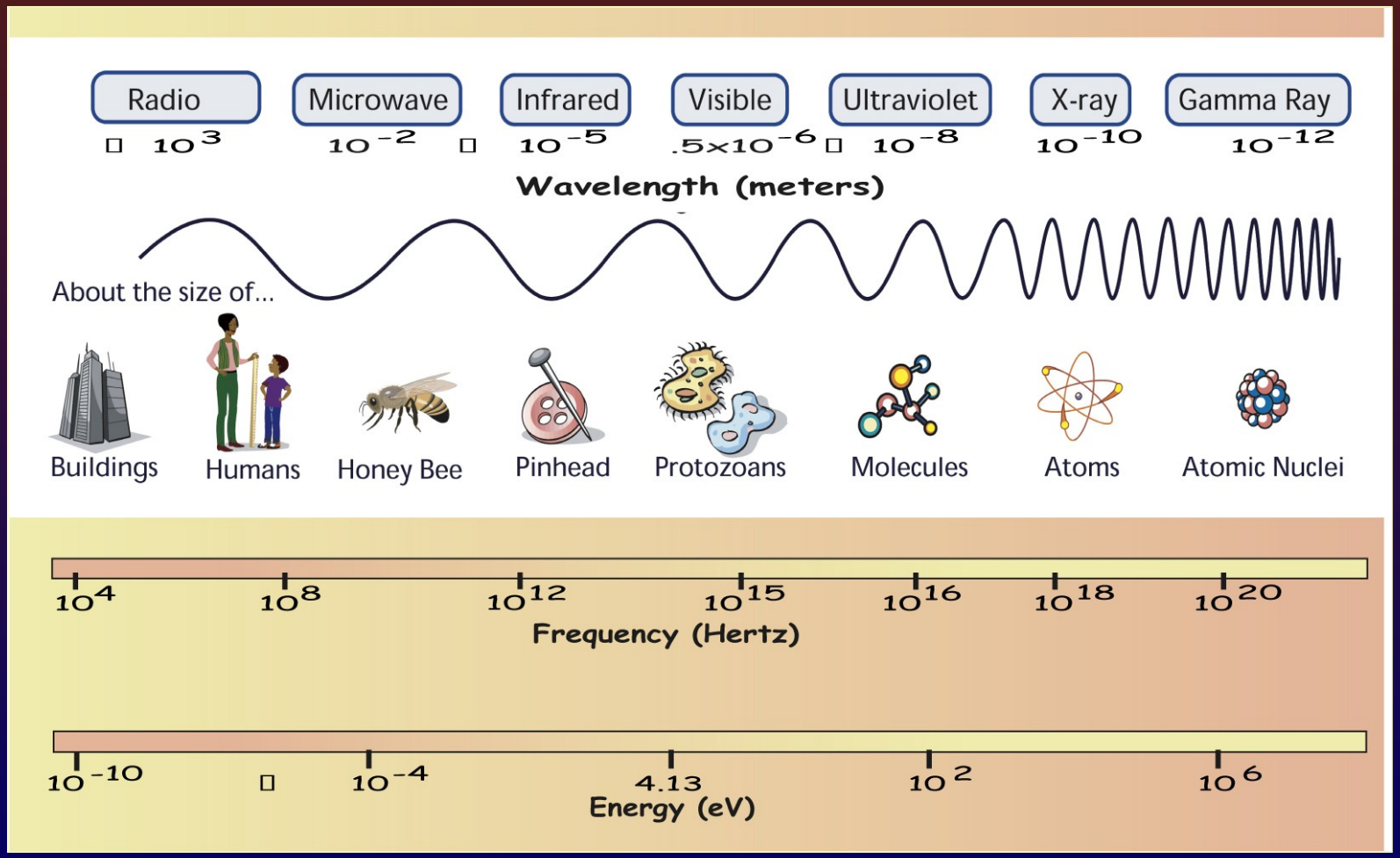
Extreme Astronomy and Supernovae

Professor Lynn Cominsky

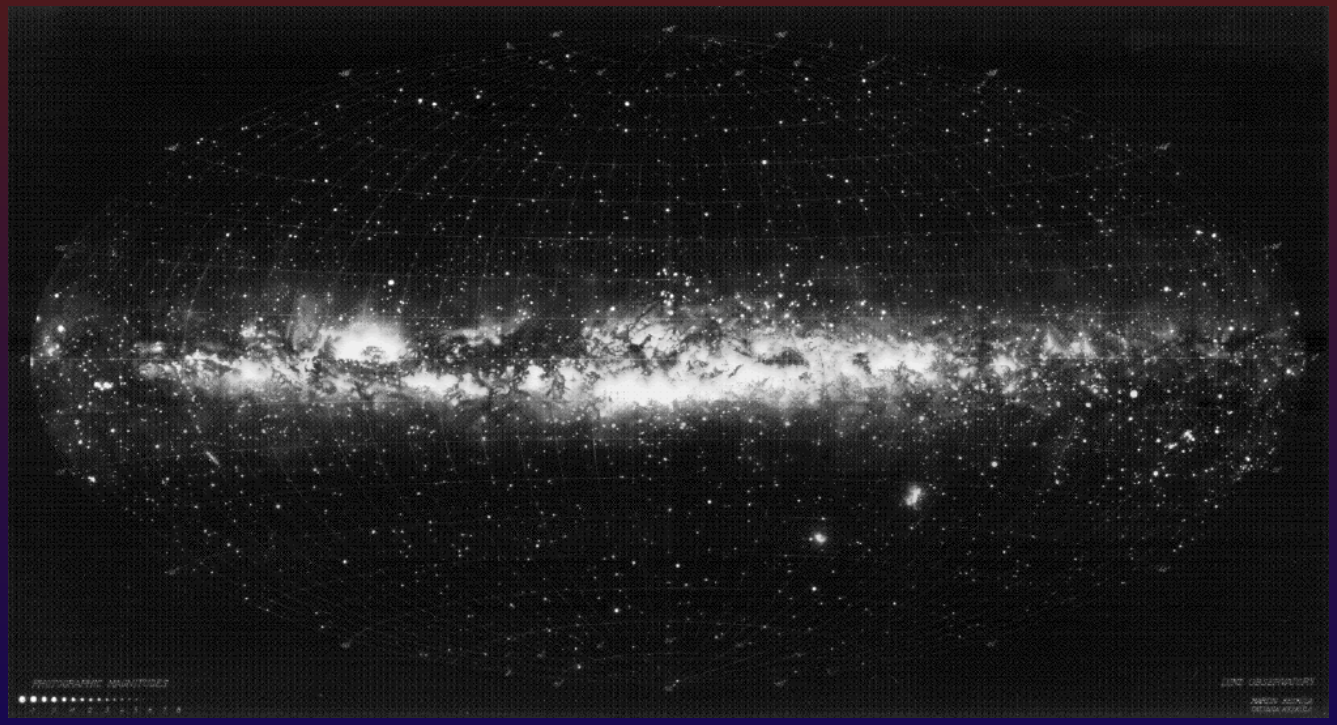
Department of Physics and Astronomy

Sonoma State University

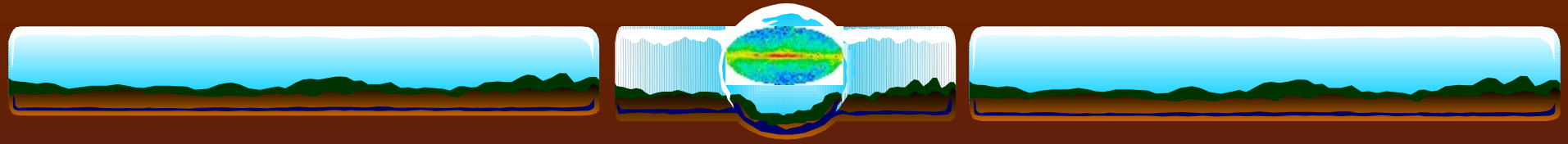
What are X- & Gamma rays?



Why study X- & gamma rays?



- Universe as seen by eye is peaceful

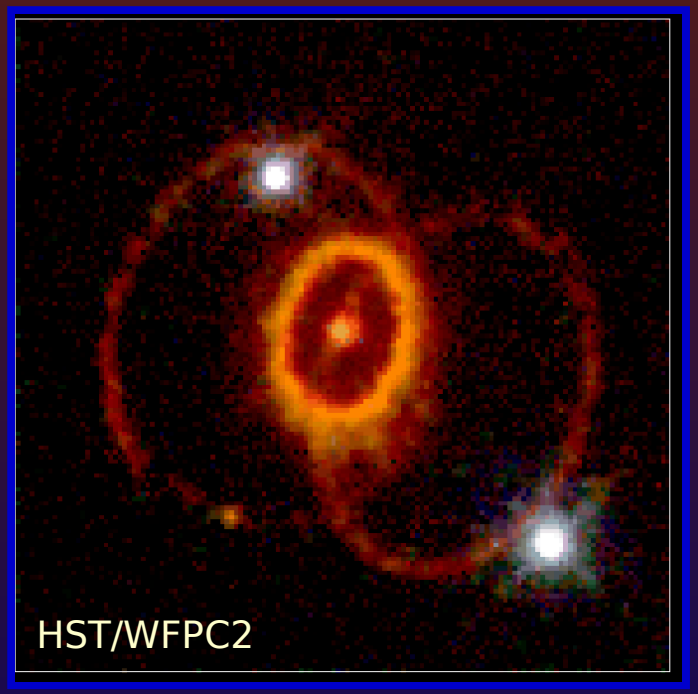


How to study X- & Gamma rays?

- Absorbed by the Earth's atmosphere
- Use rockets, balloons or satellites
- X-rays can be focused using special telescope designs
- Can't image or focus gamma rays
- Special detectors: CCDs, crystals, silicon-strips

Balloon experiment

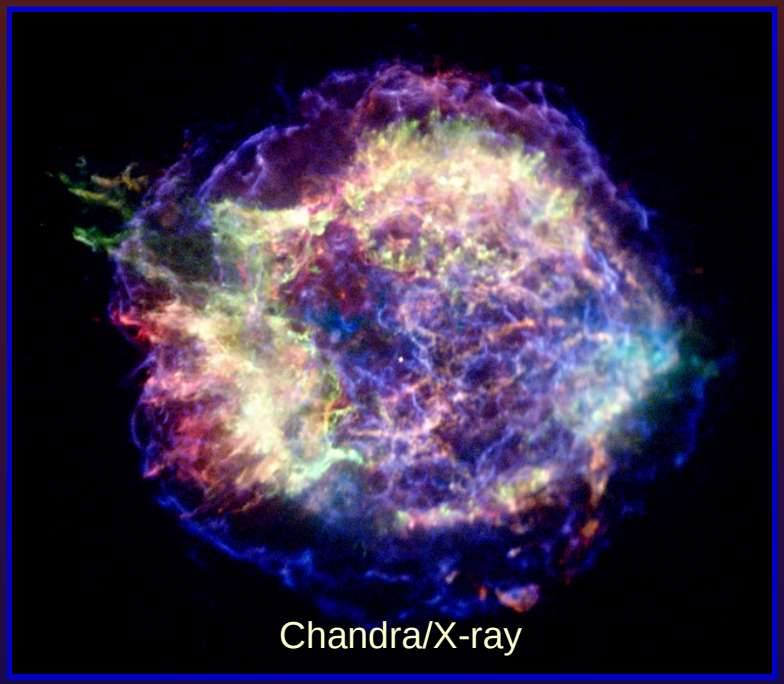
Exploding Stars

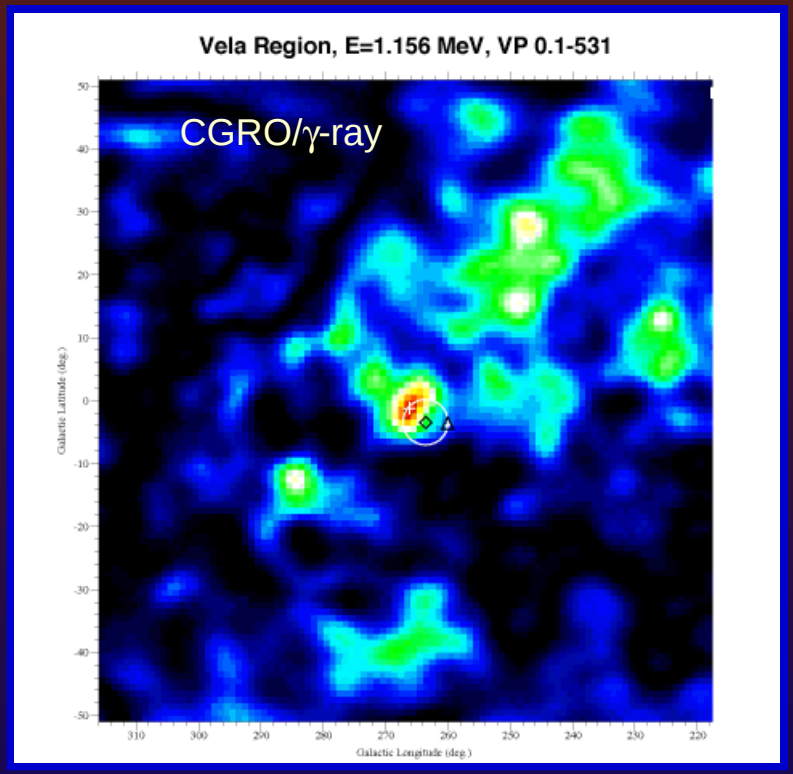


Credit: Dana Berry

- At the end of a star's life, if it is large enough, it will end with a bang (and not a whimper!)

Supernova Remnants

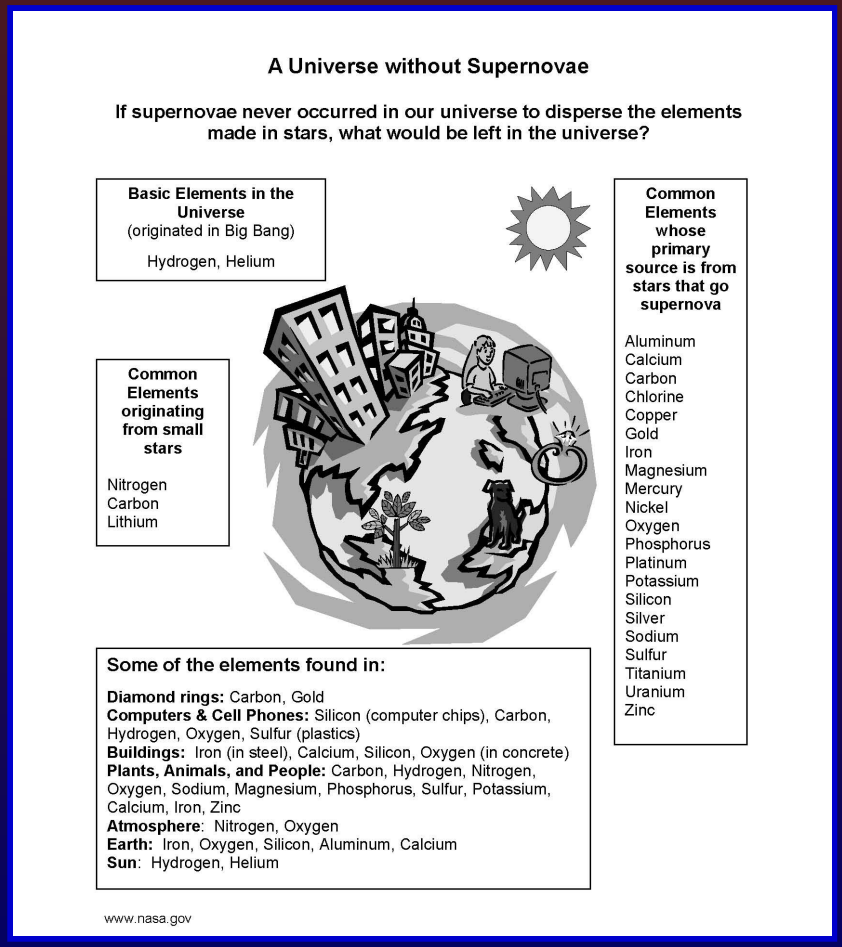




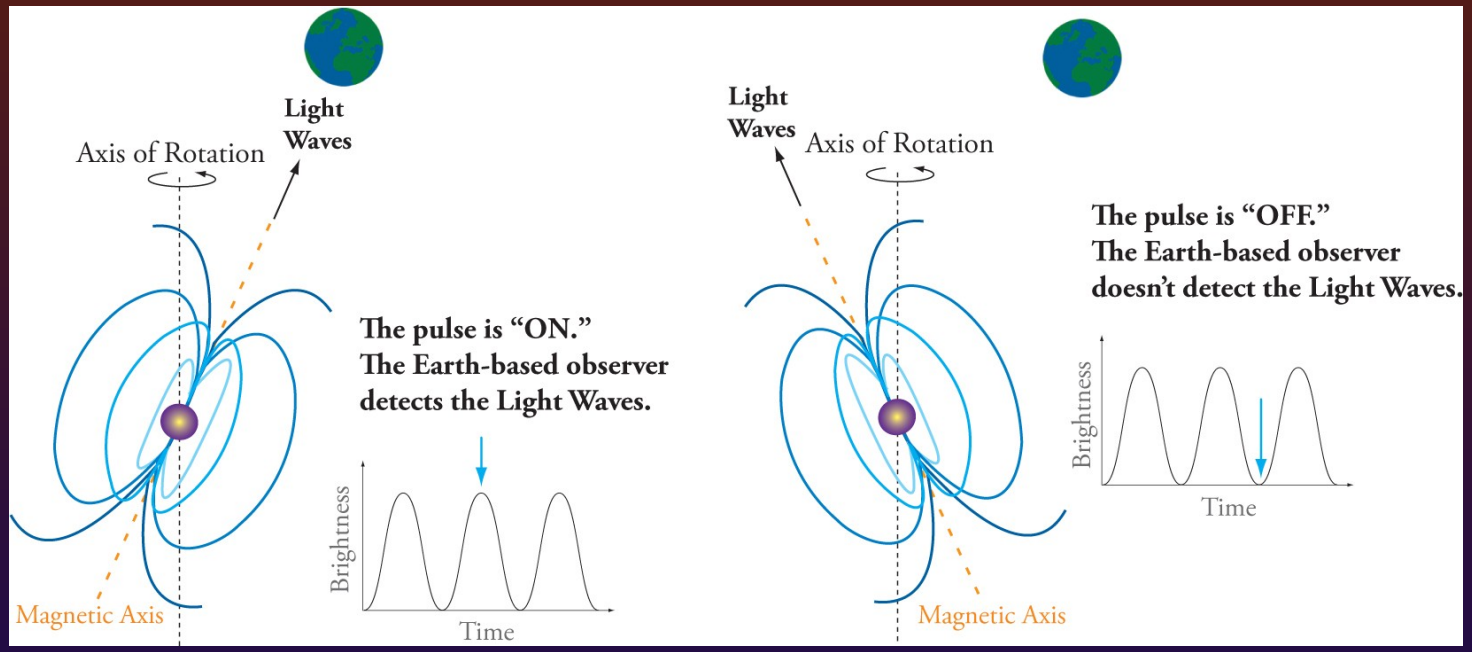
- Radioactive decay of chemical elements created by the supernova explosion

Cosmic Connection to the Elements

- Only H and He are primordial
- Lighter elements made in stellar cores
- Heavier elements made in explosion itself
- *"We are all star-stuff" – C. Sagan*

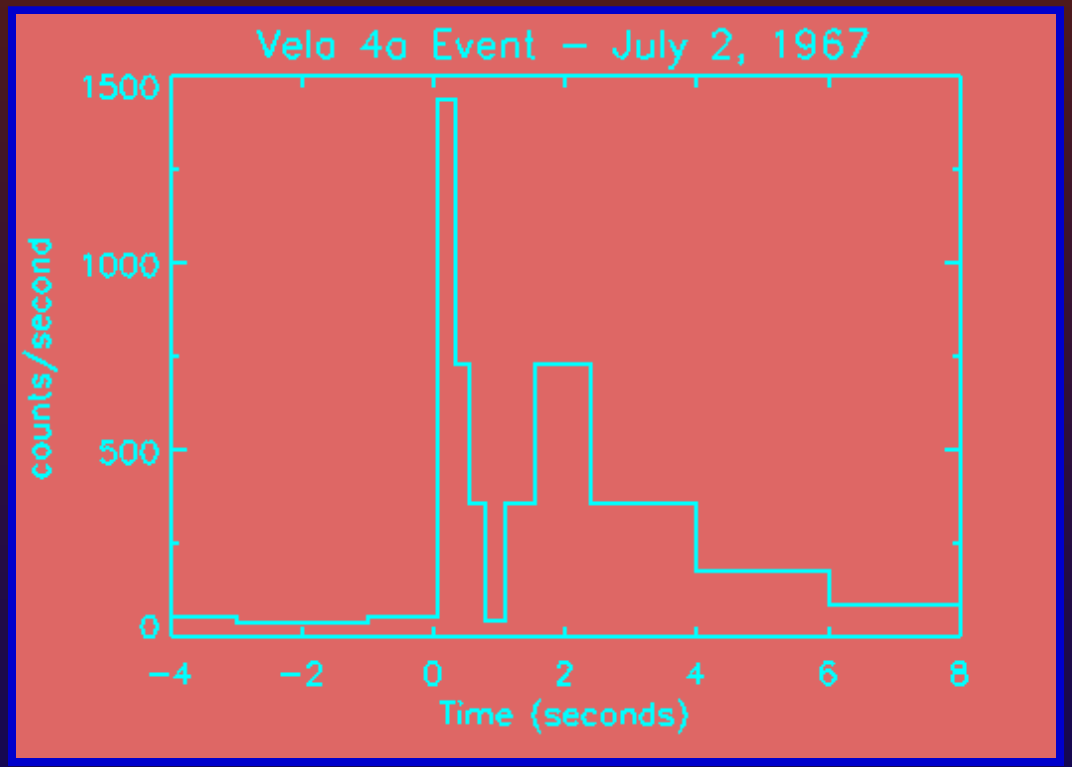


Pulsars



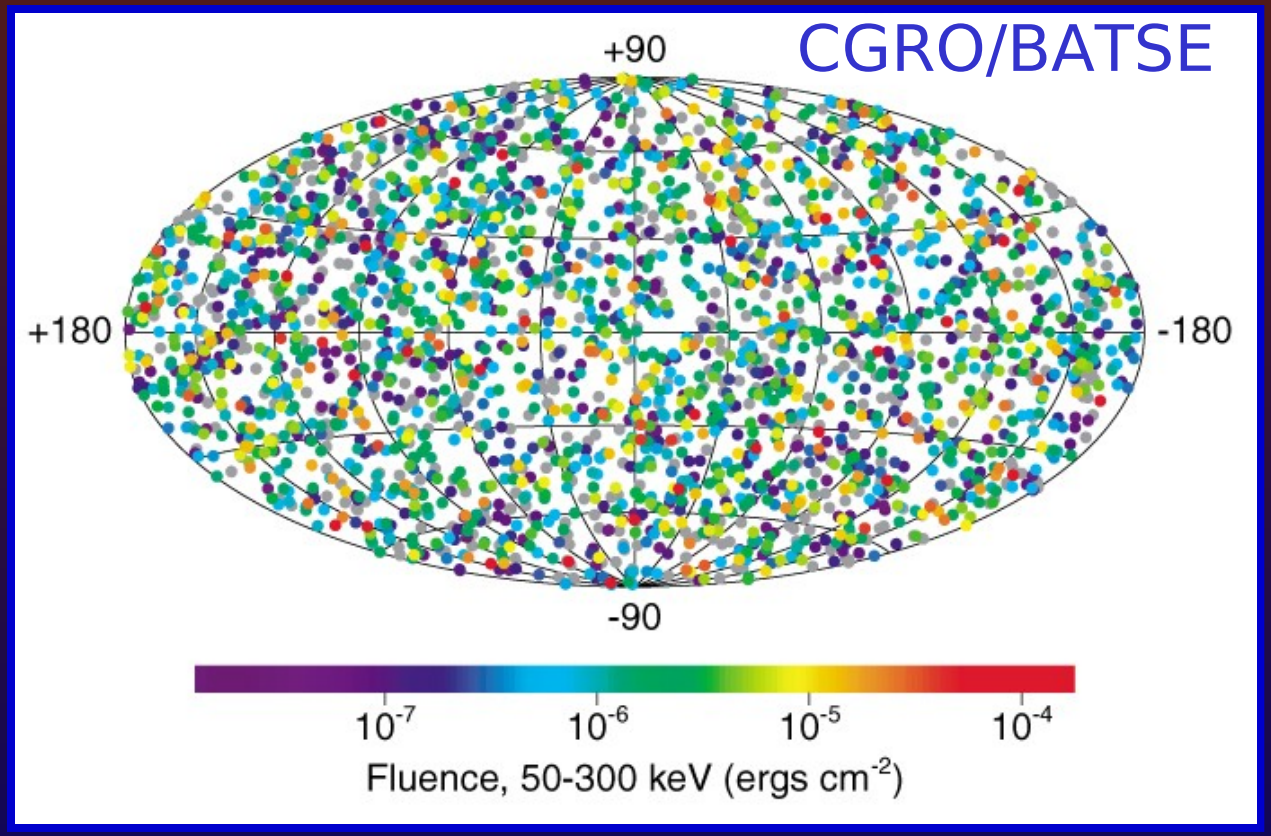
- Stellar corpses - size of a city, mass of the Sun, spinning up to 1000 times per second
- Exist in isolation and also in binary systems

Gamma-ray Bursts



- Discovered in 1967 while looking for nuclear test explosions

Gamma-ray Burst Sky

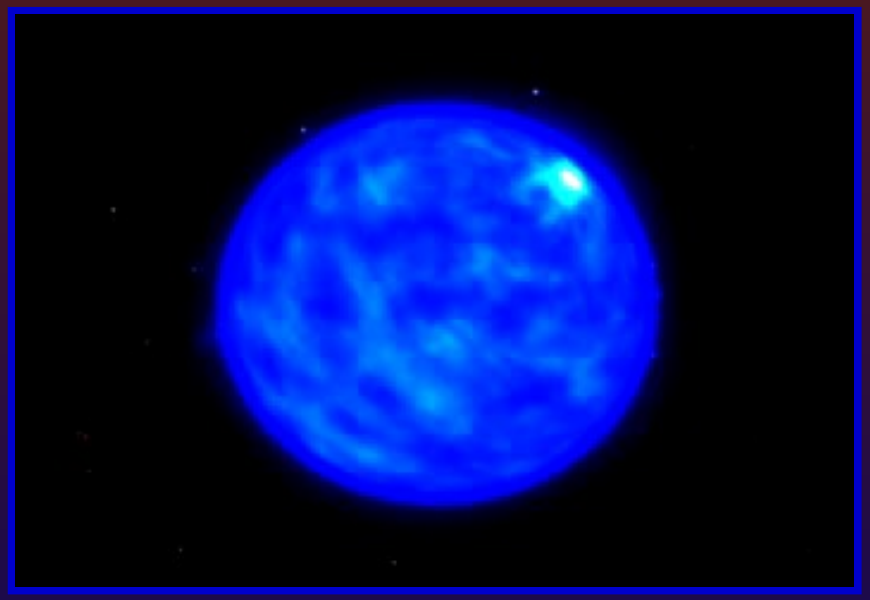


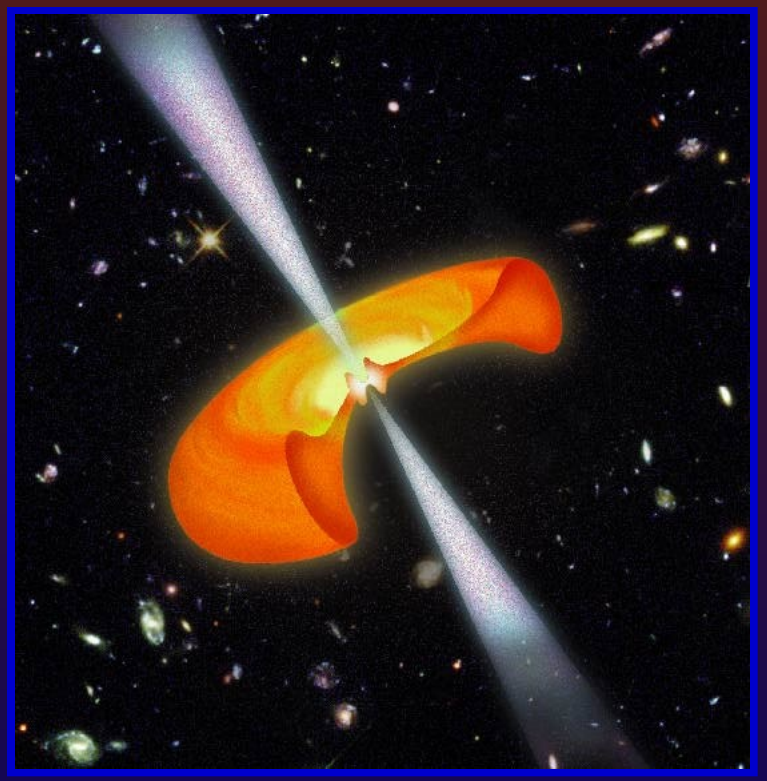
- Once a day, somewhere in the Universe

Gamma-ray Bursts

- Signal the birth of a black hole?
- Seen to occur in two types: long and short
- Connection between the long GRBs and supernovae

Hypernova

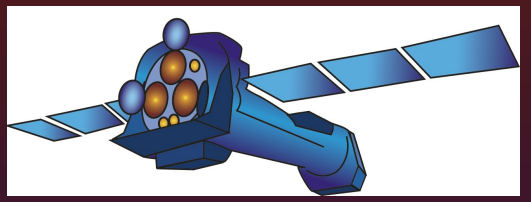




- A billion trillion times the power from the Sun

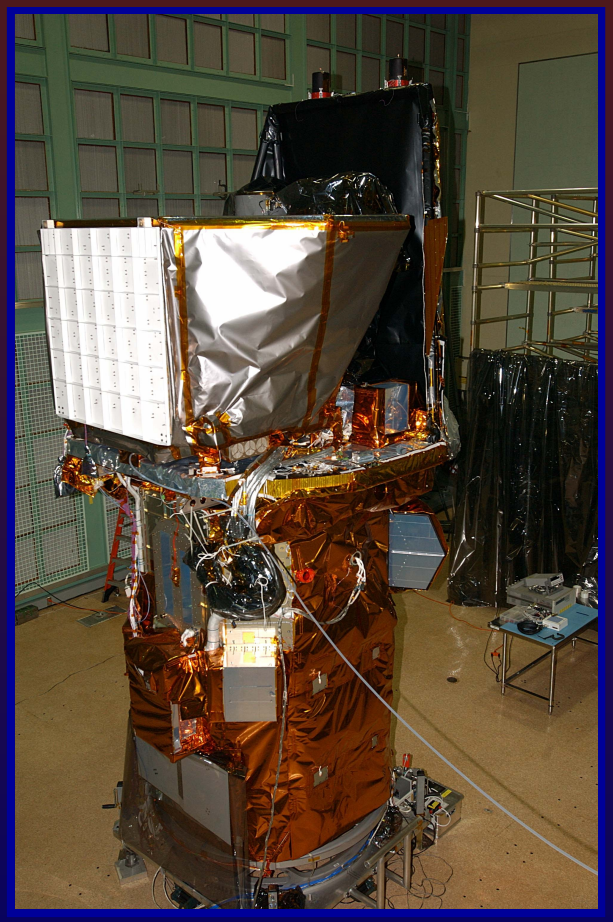
XMM-Newton

- Launched in December, 1999
- European Space Agency mission with NASA instruments and Guest Observers
- Large X-ray focusing mirror assembly
- High throughput X-ray spectroscopy



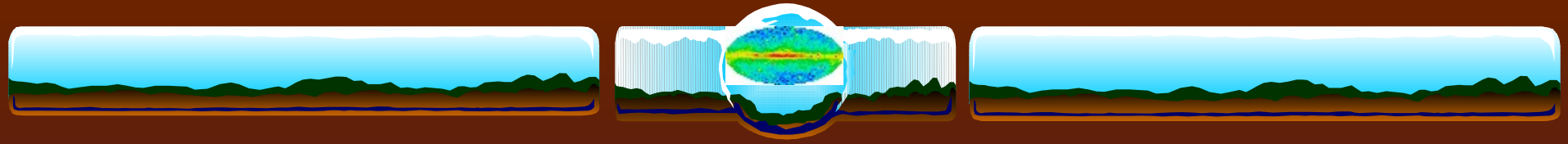
Swift Gamma-ray Burst Mission

- Burst Alert Telescope (BAT)
- Ultraviolet/Optical Telescope (UVOT)
- X-ray Telescope (XRT)
- Launched 11/20/04



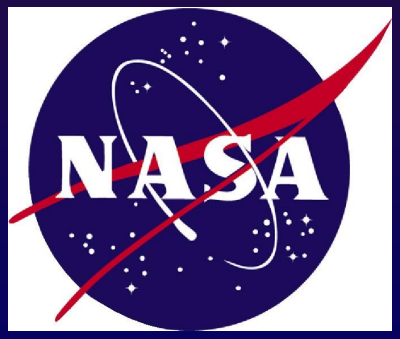
Gamma-ray Large Area Space Telescope (GLAST)

- GLAST Burst Monitor (GBM)
- Large Area Telescope (LAT)

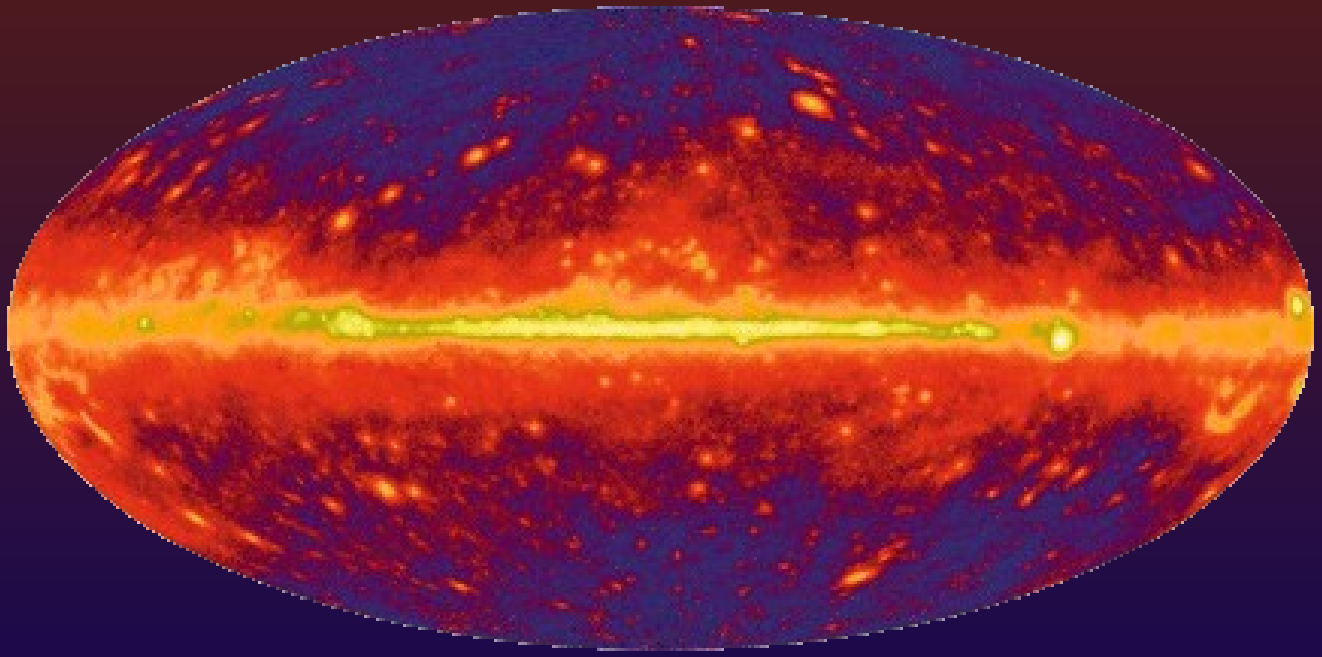


GLAST Mission

- First space-based collaboration between astrophysics and particle physics communities
- Launch expected in 2008 (June?)
- Expected duration 5-10 years
- Over 3000 gamma-ray sources will be seen



GLAST view of the Universe



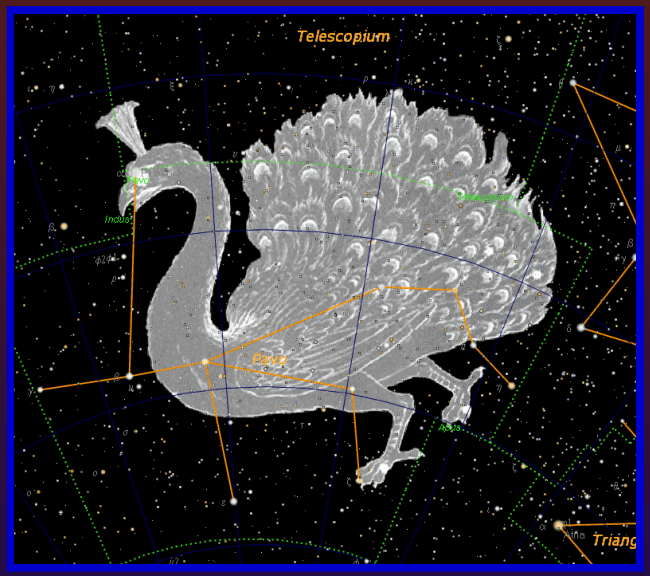
- Studies blazars, supernovae, gamma-ray bursts, pulsars and more!

Global Telescope Network

- Ground-based observations of GRBs and flaring galaxies
- Coordinated with Swift and GLAST satellite data
- http://gtn.sonoma.edu

GORT

Fly the Extreme Skies

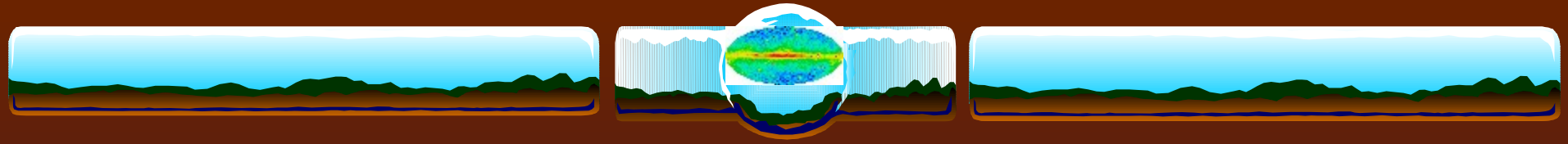


- Follow GRBs on the GRB Skymap site
- Join the Global Telescope Network
- XMM-Newton skymaps are on Google Earth/Sky

For more information:

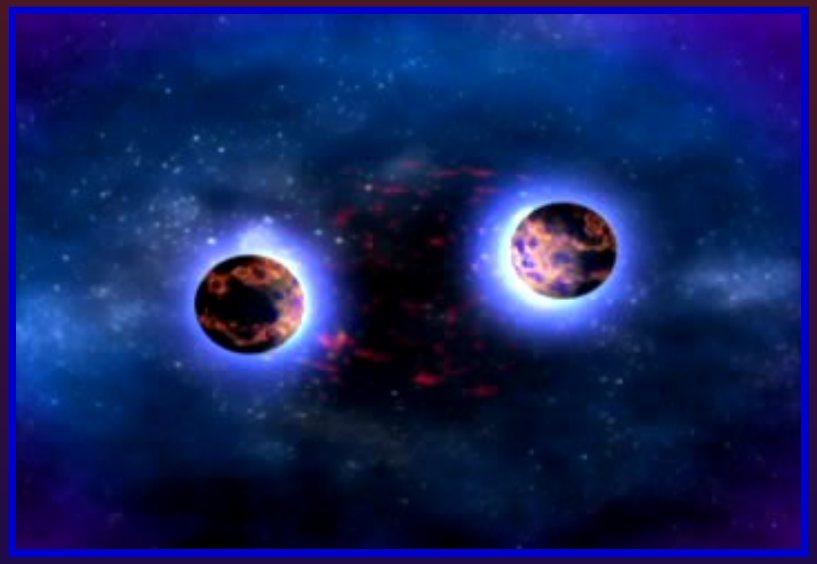
- http://glast.sonoma.edu
- http://swift.sonoma.edu
- http://grb.sonoma.edu
- http://gtn.sonoma.edu
- http://xmm.sonoma.edu
- http://epo.sonoma.edu

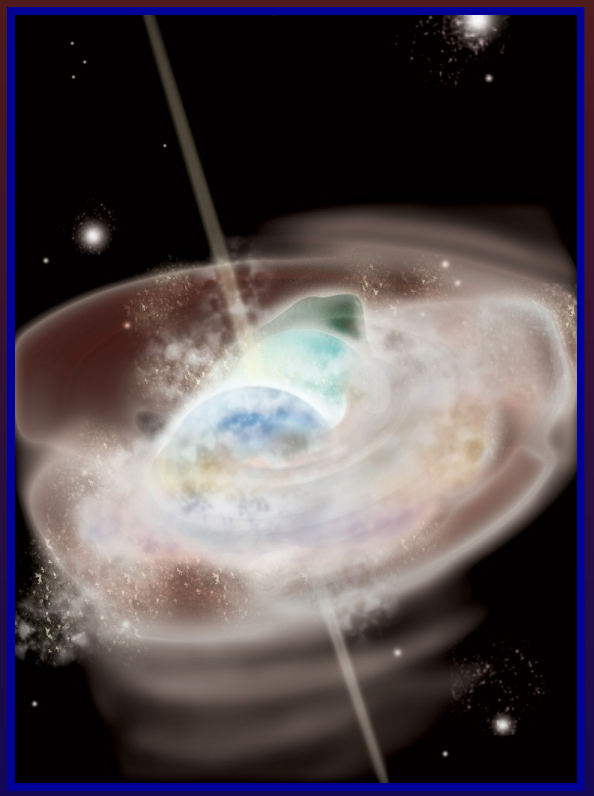
Photo Credit: Linnea Mullins



Backups Follow

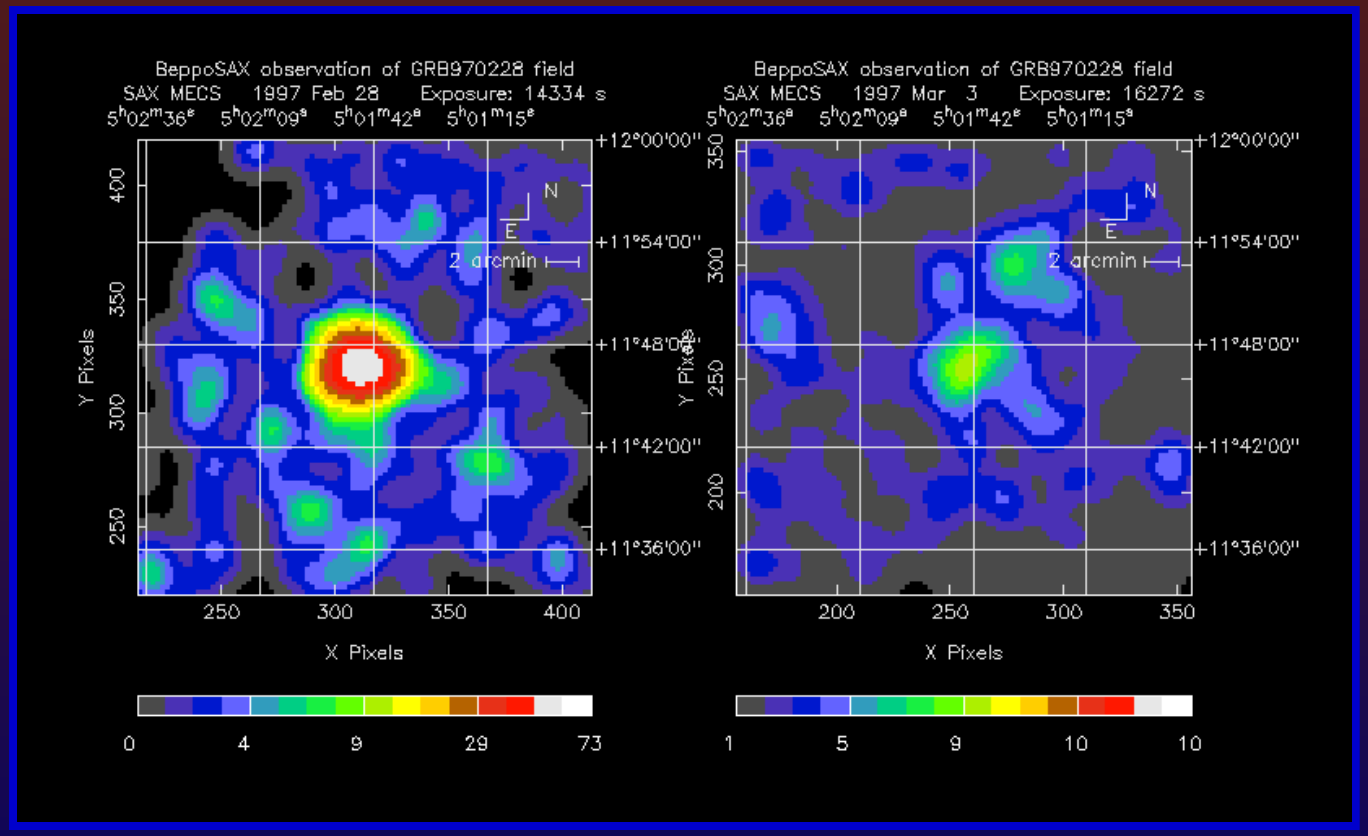
Catastrophic Mergers



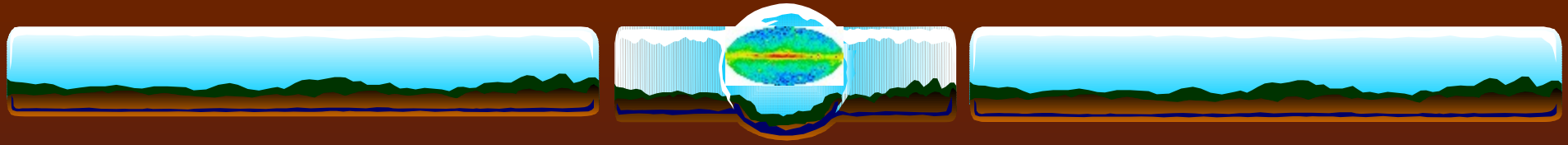


- Death spiral of 2 neutron stars or black holes

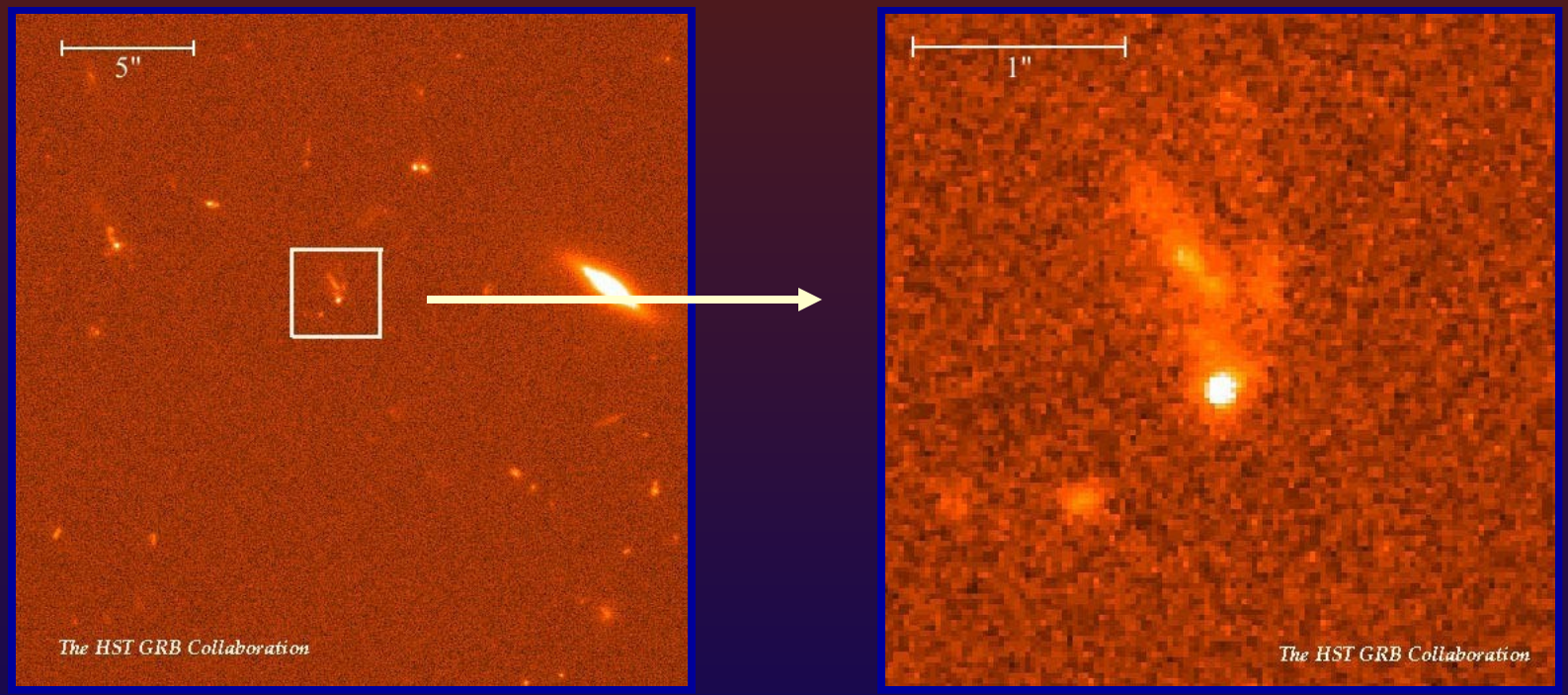
Afterglow



- Discovered in 1997 by BeppoSAX satellite



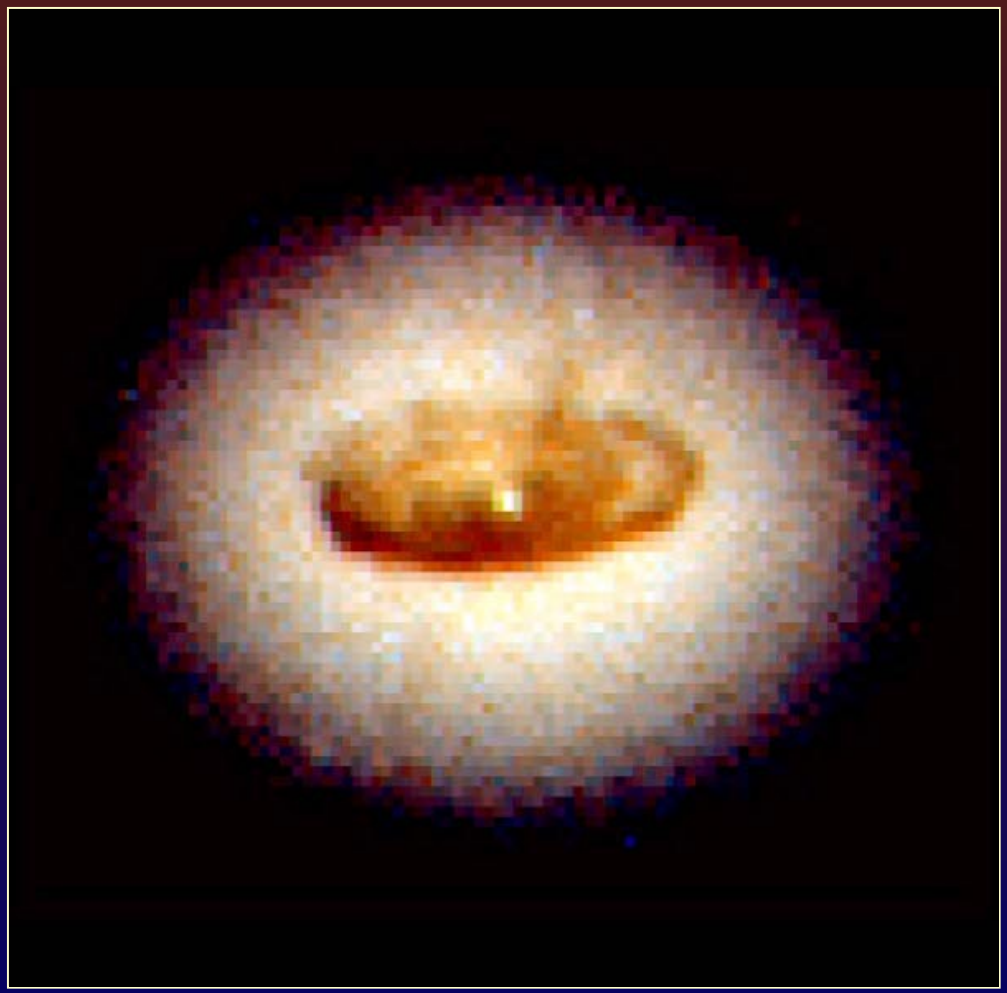
Afterglow



- Cooling ashes in distant galaxies

Monstrous black holes

- At the heart of every galaxy lies a black hole, millions to billions times the mass of our Sun



HST/NGC 4261

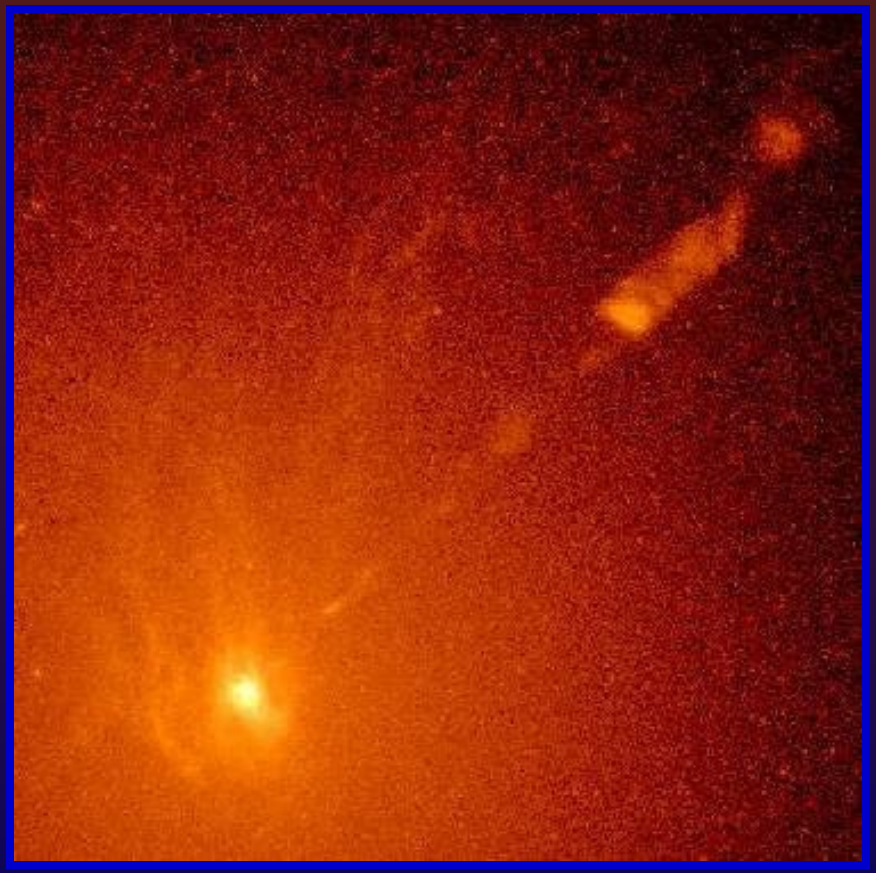
Blazing Galaxies

Credit: Dana Berry

- Gravity is so strong inside its “event horizon” that not even light can escape

Jet Mysteries

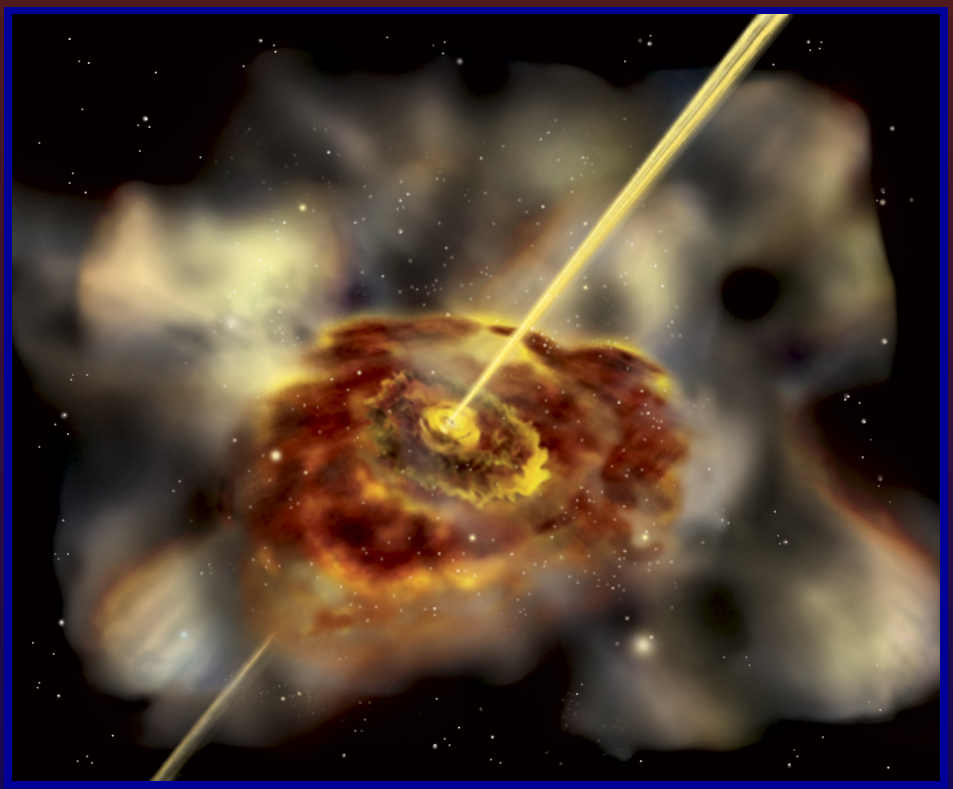
- So, how do black holes emit jets of particles and light?
- And, how do the particles in the jets accelerate to near light speed?



HST/ M87

Gamma-ray Jets

- Jets flare dramatically in gamma rays
- Galaxies that point their jets at us are called “blazars”
- GLAST should detect thousands



Credit: Aurore Simonnet

Dark Matter

- Dark Matter makes up over 90% of the matter in the Universe
- You can't see it, but you can feel it!

HST/CL0024+1654

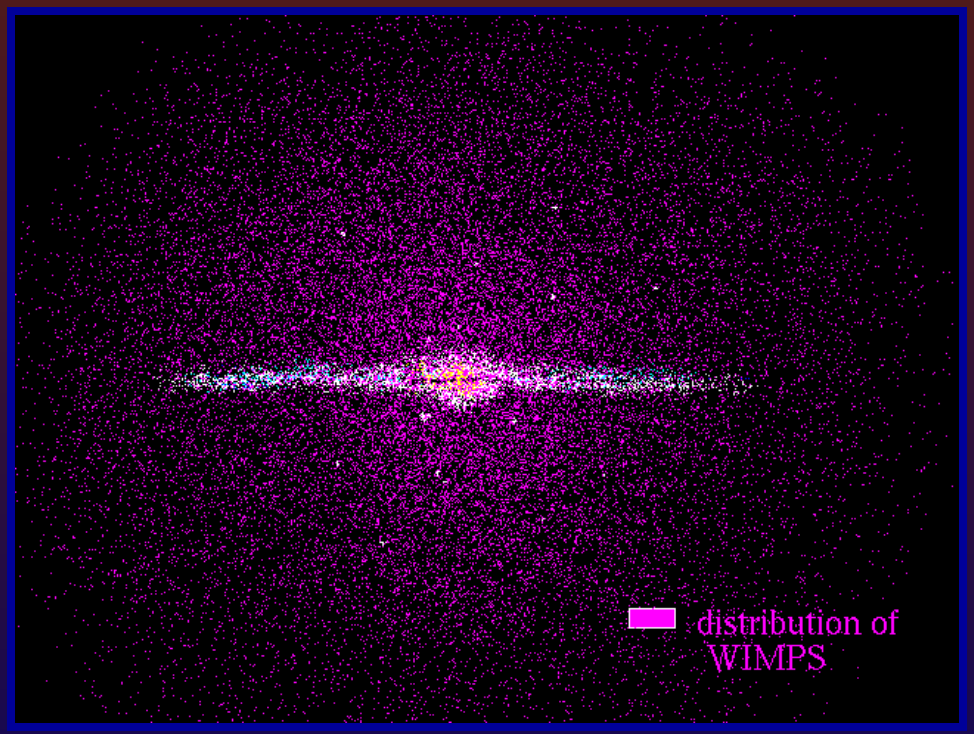
Shining light on dark matter

- Dark Matter can be traced by studying X-rays from hot gas in clusters of galaxies

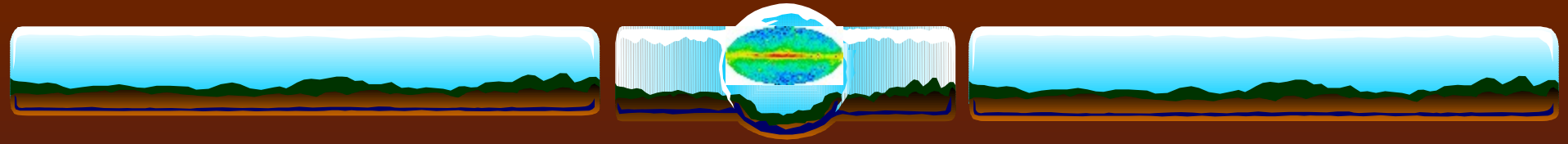
ROSAT X-ray over visible light image

WIMPs

- Dark matter may be Weakly Interacting Massive Particles
- Annihilating WIMPs may produce gamma rays



A calculation of WIMPs around our galaxy



GLAST and WIMPs

- If WIMPs are the dark matter and…
- If WIMPs self-annihilate producing GeV gamma rays….
- Then GLAST should be able to see gamma rays from WIMPs within 3 years of observations

  - *"The most incomprehensible thing about the Universe is that it is comprehensible" - A. Einstein*