

Gamma Ray Bursts

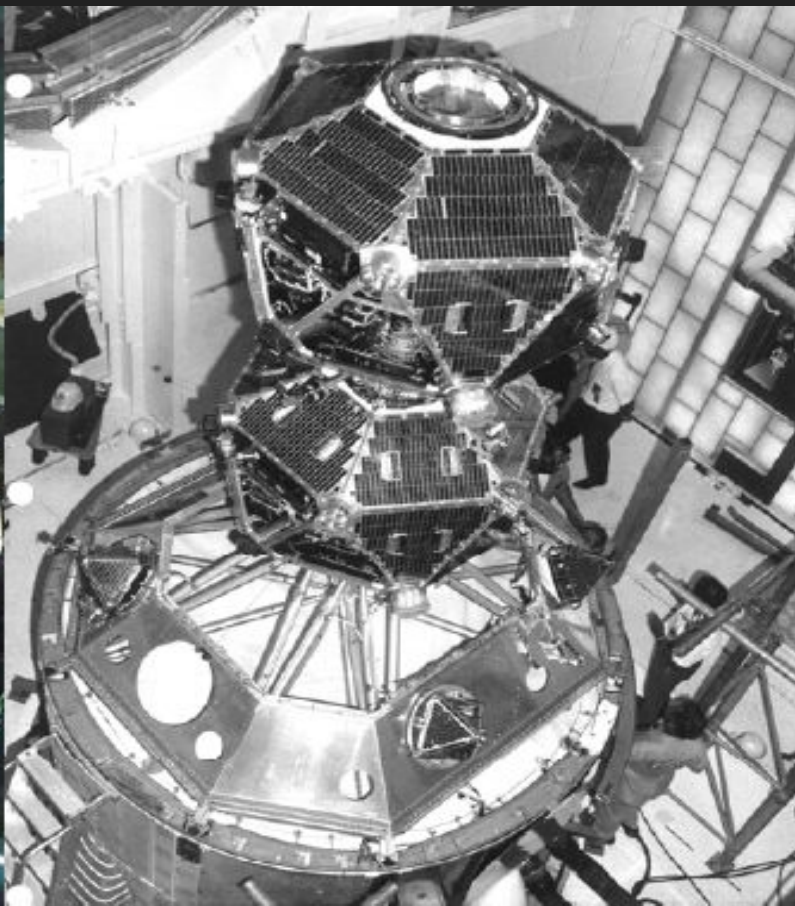
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What Are Gamma Ray Bursts

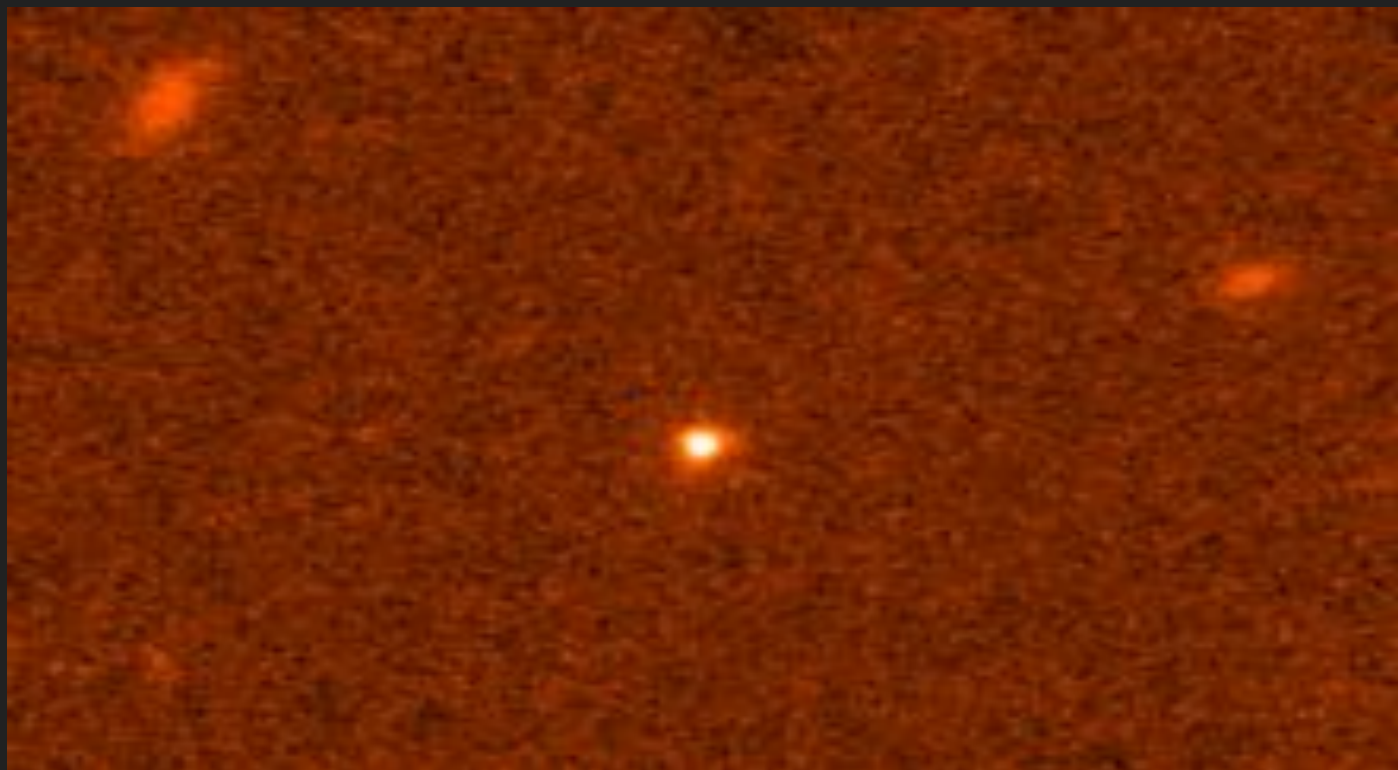
- Gamma Ray Bursts (GRBs) are the most violent explosions in the Universe that are as powerful as 100 supernovae .
- Roughly one GRB per day are detected
- The actual number of GRBs is more like 500 per day.
- The systems that produce GRBs are called 'Progenitors'. NASA's Swift satellite is used to detect recent GRBs.

Discovery Of Gamma Ray Bursts

- In 1963, Outer Space Test Ban Treaty was signed by both soviet union and united states.
- To survey whether any nuclear explosions takes place in space ,US launched a series of satellites called VELA.
- In 1969, they found a flash of gamma rays that was seen by several of the satellites on july 2, 1967.
- The gamma rays that were detected looked completely different from the gamma rays of a nuclear explosion. They were found to be coming from the deep space.



- At those times, gamma ray telescope had fuzzy vision and to add upon this GRBs fade rapidly so they are very hard to follow with optical telescope and It took weeks to position the optical telescopes but still with very high uncertainty.
- GRBs were thought to come from the collision of comet on neutron stars in our galaxy but that was not true.
- In 1997, it detected a gamma-ray burst and was able to get a reasonably decent location for it on the sky. Within hours, ground-based telescopes pinpointed the position.
- The distance to that galaxy was found to be SIX BILLION LIGHT YEARS from us.



GRB in 775 AD

- In 2012 scientists discovered unusually high levels of two particular isotopes: Carbon-14 and Beryllium-10 at two distinct places: In the tree rings of old Japanese Cedars and in ancient layers of Antarctic Ice.
- Both of these sources have been dated to about the same time around the year 775 AD. scientists estimated that the energy that caused these anomalies was roughly equivalent to thirteen Hiroshima bombs. There doesn't appear to be any historical record of people noticing anything unusual in the sky around 775.
- Scientists believe that the explosion must be a GRB that had occurred between 3,000 and 12,000 light-years from Earth.



Cause Of Gamma Ray Burst

- There are kinds of GRBs: Ones that last longer than two seconds like several hours too, they come from hypernovae and ones that lasts less than two seconds, they come from kilonovae.
- Sometimes these short bursts last literally for milliseconds.
- These GRBs are so phenomenally bright that we can detect them from BILLIONS of light years away.
- Most of the detected GRBs are long GRBs. The longest GRB ever recorded is 20 hours, These ultra long GRBs are caused by the collapse of a blue supergiant star, a tidal disruption event or a new-born magnetar.

Long Gamma Ray Bursts

- When the core of a VERY massive star collapses, forming a black hole, the material just outside the core falls down, forming an accretion disk. The magnetic field of that material and from the black hole coil around, wound up by the rapidly spinning disk, pointing up and down out of the disk and away from the black hole.
- This launches twin beams of matter and energy up and away from the black hole. The amount of energy in the beams is mind-crushing, equal to the total energy of the supernova. This kind of explosion which produces GRB is termed as 'Hypernovae'

Short Gamma Ray Bursts

- Imagine two neutron stars orbiting each other. The neutron stars very slowly lose orbital energy by radiating away gravitational waves and very gradually the neutron stars orbit closer together. Finally, they merge.
- If their combined mass is more than 2.8 times that of the Sun, they'll collapse to form a black hole. This merger is called as 'Kilonovae'. Now, the system becomes a black hole orbited by ultra-dense debris from the merger. This simply then mimics what happens in a hypernova.
- Because the material is more compact, the gamma ray flash is much shorter.

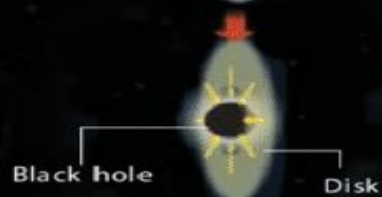


Mechanism Of Gamma Ray Bursts

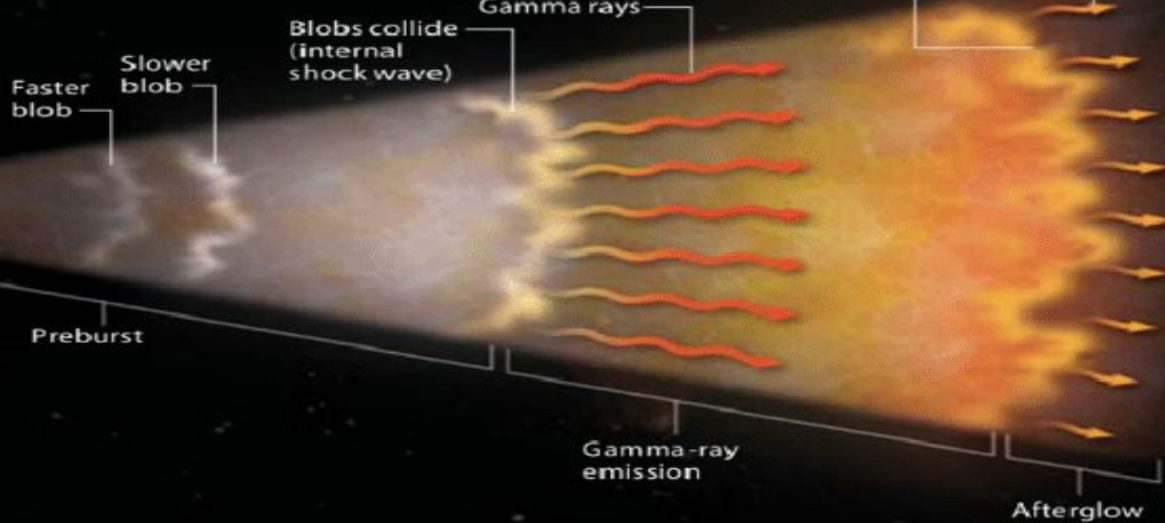
The emission process is identified to be the so-called "inverse Compton mechanism" , in which ultra-high energy electrons collide with low-energy photons and boost their energy.

The same happen here, the ultra high energy electrons flow in the direction of the strong magnet field and interact with the low energy photon and produce high energy gamma rays.

Merger scenario



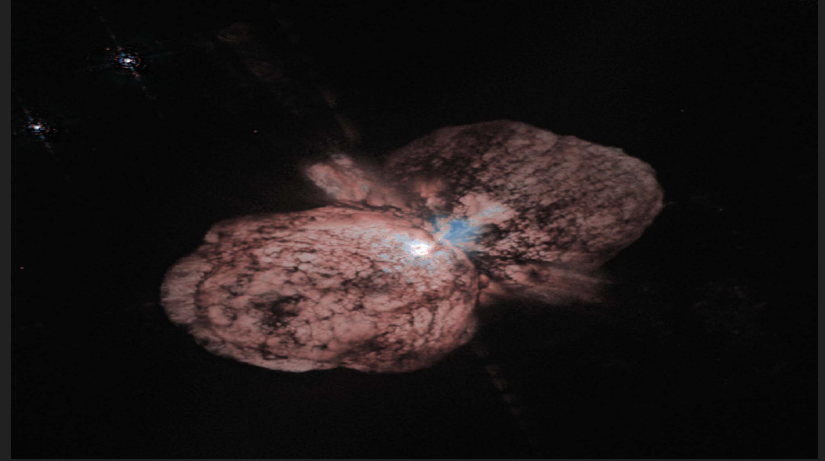
Hypernova scenario



POSSIBLE GRB's FROM THE COLLAPSE OF STARS IN OUR GALAXY ARE:

1. 1.Eta carinae
2. 2.Wolf Rayet 104

But both the poles of the stars are not pointing close to us. So they are not harmful.



THE COSMOS IS WITHIN US. WE ARE MADE OF STAR
STUFF. WE ARE THE WAY FOR THE UNIVERSE TO KNOW
ITSELF.

- CARL SAGAN