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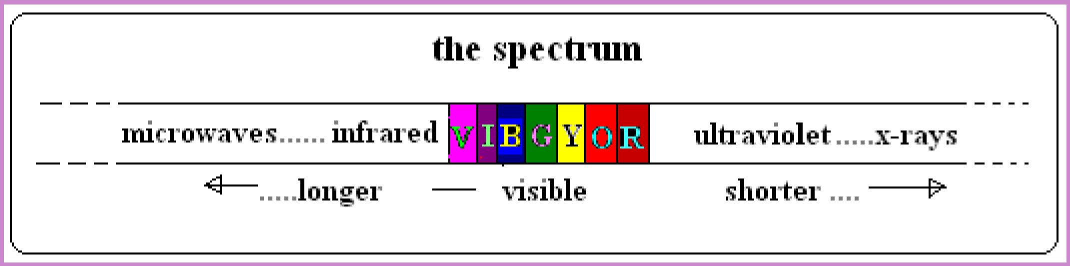
Space telescope snaps stellar family tree

A ***dynastic*** theory of the birth of stars has found spectacular support in satellite pictures, says S.Ananthanarayanan.

Astronomers know that what it takes for stars to form is dust, hydrogen, and gravity. But how these simple ingredients get put together to create a ***massive*** star has not been clear. Is it just that low mass stars pull in surrounding material by gravity or do two ***protostars*** (potential stars) combine to form one massive star? Or is the formation influenced or triggered by a ***parent*** massive star? NASA's infra red space observatory, ***Spitzer*** has found an eyeful of evidence for the third, ***triggered*** star formation theory.

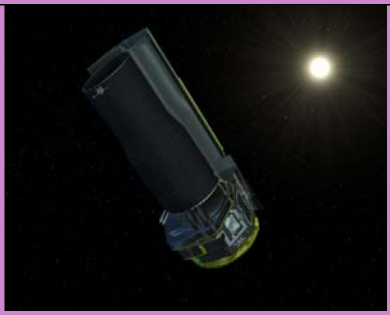
Telescopes and the Infrared

It is a property of waves that long waves are scattered less than short waves. Long waves thus last longer and very distant objects can be seen more clearly if the light they emit on the red side of the spectrum is viewed. This is because the short waves may have got scattered away, but the long waves would persist. Infrared light, which cannot be seen by the eye but can be felt as warmth, has wavelengths just longer than visible light. Imaging stars in the infrared, has hence been of interest to astronomers. But as infra red radiation is rapidly absorbed in the atmosphere, infrared telescopes are best stationed outside the atmosphere, for example in orbit around the earth.

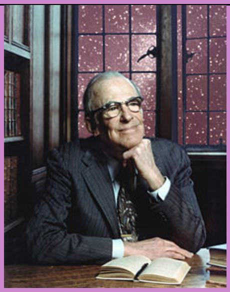


NASA's Spitzer observatory is such an infrared telescope that was launched into space and has been operational since Dec 2003 - and is likely to be in use till 2009. This 'end of life' date for Spitzer is because the year 2009 is how long its supply of liquid helium is likely to last. As all warm bodies emit infra red light, the faint signal from distant stars would get obscured by the 'noise' of other warm objects, like the telescope body. Infrared telescopes thus need to be cooled nearly down to absolute zero (minus 273˚C), so that their own emission at the wavelengths of interest is as low as possible. Spitzer thus needs a store of liquid helium to keep it cool and can work only while the stock does not run out.

This is the reason that Spitzer has been placed in ***heliocentric***, and ***earth-trailing*** orbit around the sun, rather than the usual ***geocentric*** orbit around the earth. In this way, Spitzer is protected from the heating effect of the earth and this reduces the load of liquid helium that needs to be launched along with the telescope. Using an orbit 'at a distance from the earth' and the 'benign thermal environment' also enables other strategies, like shielding the telescope from the sun, to further reduce the helium load and the cost of the launch. The negative side of this is that going far away from the earth calls for special communications arrangements, but the advantage of using up less liquid helium is well worth it.



Orbiting telescopes are generally named after deceased astronomers, the name being chosen by a committee of scientists. This time, the name was selected through an open contest and Dr Lyman Strong Spitzer, a key figure in 20th century physics was chosen. Dr Spitzer helped lay



down the basics of plasmas and interstellar astrophysics and was the founder of the Princeton Plasma Physics Laboratory. It was he that first proposed placing telescopes in orbit around the earth, in the mid 1940s.

The Spitzer observatory was formerly known as Space Infrared Telescope Facility(SIRTF)

Star birth

Stars are believed to form from ***nebulae***, or clouds of dust thinly spread over light years of empty space. Each individual particle exerts an infinitesimal gravitational pull on every other particle and in principle the whole mass should progressively collapse into itself. For this to take place in a credible time-frame, it would need to be set in motion by a passing star or a shockwave, or other gravitational disturbance. It is something like a huge number of marbles at rest in their own depressions on a trampoline. Left to themselves, they may stay put for a long time. But if a slightly larger depression is made somewhere on the trampoline, the marbles move into a swirl that goes faster and faster, till the marbles all clump together.

When the gas and dust of the nebula swirl closer, because of gravity, the gas in fact is being compressed and reduced in volume. Like any gas that is compressed, the air in a bicycle pump, for instance, the nebula heats up. And as the compression increases, the temperature soars to millions of degrees, till hydrogen atoms are moving so fast that when they collide, they ***fuse***, to form atoms of helium and start a nuclear chain reaction (this is exactly what happens in the hydrogen bomb). This process goes on till the hydrogen is used up or till the heat is such that the mass explodes as a ***supernova.*** This is an expansion phase, that goes on till gravitation reverses its direction and the heat of compression again rises till helium atoms ***fuse*** to form higher elements.

For formation of ***massive*** stars, the first theory is that stars that are formed in this way now accrete surrounding matter and grow larger. Another theory is that accretion alone may take too long and massive stars must arise through two nearly complete stars, or stars that are contracting and have not ignited the nuclear reaction, merging into one, larger mass.

Yet another theory of star birth is the so called "***collect-and-collapse***" model, which says that a massive parent star influences the formation of second-generation stars. The theory proposes that when a star enlarges and becomes eight times as massive as the Sun, it begins to radiate energy in the ultraviolet region. The high-energy radiation knocks out the electrons from the atoms of hydrogen in the surrounding gas, and the region near the star fills with charged hydrogen ions

This ionized gas, which is called ***plasma***, gets heated and expands into the cooler region away from the parent star, sweeping dust and gas, like a broom, into a ring around the star. Irregularities in this ring then make the dust and gas to fragment into clumps, which are large enough to collapse and form new, second-generation stars.

The ***collect and collapse*** model thus proposes that massive stars throw forth matter that creates an expanding cavity, with a massive boundary and the boundary then collapses into a next generation star; which again creates an expanding cavity and another generation of stars….

Evidence

While the ***collect and collapse*** theory was plausible and popular, there was no strong evidence for its truth till the Spitzer observatory first put forth a series of images in March 2005. The images were of a region about 17,200 light-years away from Earth in southern Milky Way and in the constellation Centaurus.

Green: dense clouds, Red: heated dust in cavities, White: regions where younger stars form. The oldest stars are blue dots in the centre of the cavities and younger stars line the rims of the cavities

The picture, known as the '***Bubble***' is of young stars within the region and radiating ultra violet light that excites dust in the region to emit in the infrared, which Spitzer detected. In fact, one of these groups of atoms had evolved to begin ultraviolet radiation and could become the parent of another generation of stars!

While this was the first, hard evidence for ***collect and collapse***, the latest images from Spitzer, just released in August 2008, are very much more convincing. The images show a region called W5 about 6,500 light years away and in the constellation Cassiopeia. The pictures show bright, massive stars at the centre of large cavities, whose rims are lined with bright, second generation stars. The picture shows the areas where the youngest stars are forming, the regions of hot gases and the outlines of dense clouds. Scientists analyzing the picture have been able to show that the stars get progressively younger as they go further away from the centre of the cavities. The whole thing is the best evidence so far of the process of '***triggered star formation***'.