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Stellar obstetrics

The birth pangs of larger stars are different from those of smaller stars, says S.Ananthanarayanan.

The way smaller stars are formed works well enough for stars like our own sun and till about ten times this size. But the same method cannot work for larger stars. Maria Beltran and colleagues working in Barcelona, Spain, report in ***Nature*** this week that they have evidence of the way stars some twenty times the size of the sun take shape.

The usual way

Stars are born of gas clouds millions of light years across. Under the steady inward pull due to the gravity of all the molecules of gas, the cloud itself begins to collapse and compress. Over millions of years, as the gas reduces to a miniscule fraction of its original volume and the centre becomes massive indeed. The core then begins to actively pull more gas in and it heats up to stupendous temperatures. Many of us may have used a bicycle pump and would know that air gets hot when compressed. It is the same with the cosmic gas cloud.

The cloud is largely hydrogen, the simplest of the elements. At the high temperatures attained in the core, the positive hydrogen nuclei are stripped of the electrons that shield them and they begin to repel each other. But so high are the energies that they are pushed close enough to actually merge, into the nuclei of helium atoms, in a reaction that gives off many times the great energy that it takes for the reaction to occur. (This, in fact, is the way the hydrogen bomb works).

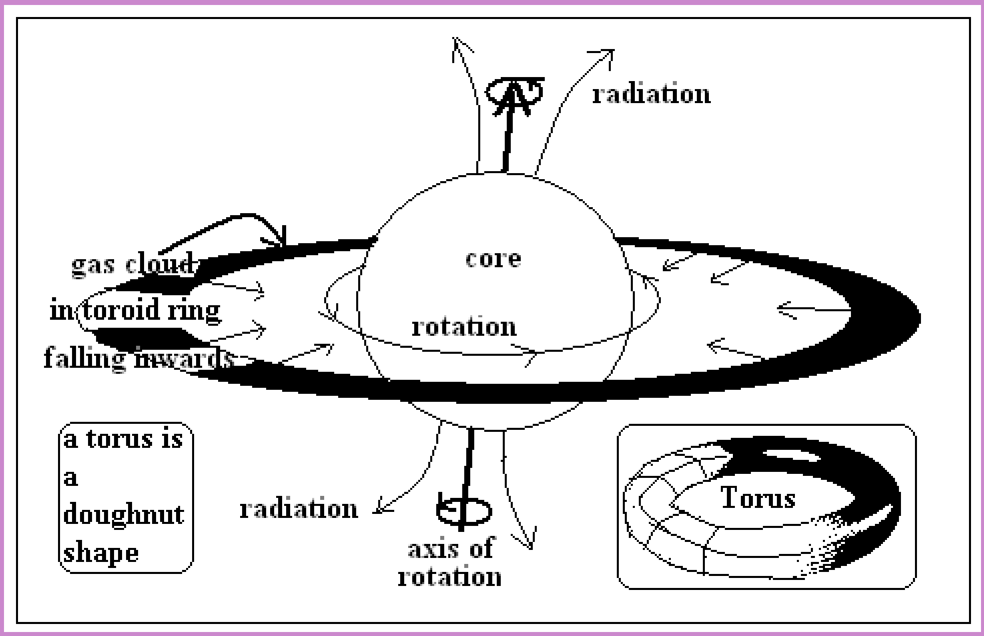
In the case of stars up to ten times the size of the sun, most of the gas has collapsed when the thermonuclear reaction starts and the blazing thing can shine as a star for millennia. Usually, as more and more of the gas joins the fire, the star explodes and spreads the gas out in space again. Expansion, which is the opposite of the bicycle pump and the principle of the refrigerator, cools the gas and the expansion stops. Till the mutual gravity starts another cycle of compression, and so on.

Large stars

The problem with gas clouds that weigh more than ten times the mass of the sun is that they do not get a chance to collapse fully. Well before this happens, the core has already started spewing out radiation that prevents any more gas from joining in. The gravity pulling the gas in is then balanced, or more, by the pressure of the radiation. That this should happen is so well established that it is a serious problem for scientists, because we know that a huge stars do exist. How could so many have formed if the process itself cannot allow a large star to form?

The doughnut cloud

One way that heavier stars could form was when ordinary stars collided and merged. A more plausible way out of the puzzle was suggested by discoveries of massive stars in the process of formation, where the collapse of gas was not uniformly from all sides. It was found that the radiation emitted was along an axis of the star, which allowed a ring of gas to remain around the star's 'equator', and get drawn in by gravity to 'feed' the star. The trouble was that there was no evidence that this kind of star formation through the ***doughnut cloud*** was actually happening.



Maria Beltran and colleagues at Universitat de Barcelona, used the light being emitted from the core of a fledgling star to work out the shape of the gas surrounding it and also the way the current of gas was moving. "We have established the presence of the 3 elements, outflow, rotation and inflow, in the same massive object, for the first time," they report.

The scientists used the fact that colder gas surrounding the hot interior would absorb radiation at characteristic frequencies. Motion of the gas would also cause shift of these frequencies, in the manner that the whistle of speeding locomotive changes while it approaches us or moves away from us.

With the help of a radio telescope consisting of an array of antennas spread over an area several kilometers wide, the scientists identified absorption spectra, as well as some specific frequencies that were not absorbed, as controls, to establish that the doughnut model for larger stars does, in fact, exist!