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To catch a dying star

STARGAZING If the red star Betelgeuse does blow itself up, what would be the consequences for us? For one thing, it would brighten up so that it would appear at least as bright as the full moon in our night sky, writes **C Sivaram**

The reddish star Betelgeuse is a prominent object in the night sky. Also known as alpha-orionis, it is the tenth brightest star visible to the eye. This star is also comparatively near, just over 420 light years away. It has a diameter over a thousand times larger than the sun! If it is positioned in the place of our sun, its surface would stretch out to the orbital distance of Jupiter (that is, about 700 million kilometres).

It has a mass of over 25 times that of the sun (the sun is three lakh times more massive than the earth and has a diameter of more than a 100 times that of the earth).

In its final stages

It has a luminosity of about 25 times that of the sun, but its surface temperature is half of the solar value, implying that it emits mostly longer (red light) wavelengths. In other words it is a red supergiant, a star in a highly evolved state, close to its final stages.

Very massive stars like Betelgeuse have lifetimes 1,000 times shorter than the sun, of the order of millions of years rather than billions of years. They burn their nuclear fuel much faster. Their cores keep contracting, becoming hotter and hotter with the thermonuclear reactions building up successively heavier elements, while their outer envelopes keep expanding.

When the core gets converted to iron, which has the maximum nuclear binding energy, nuclear reactions can no longer produce energy. The massive core collapses (to form a neutron star or a black hole) while the outer layers, containing the elements already synthesised, explode into what is called a core-collapse or type II supernova. Such supernovae are very bright (as bright as Venus) visible in daytime and noted by the Chinese observers of that time. After the rather unspectacular, so called CasA in 1680, there has not been a supernova explosion seen in our galaxy.

First star with diameter determined

This is where recent observations of Betelgeuse are exciting. With its comparative nearness and vast size, it was the first star to have its diameter reliably determined. This was done by Albert Michelson, at the then largest telescope at Mt Wilson, by attaching to it a 20-ft beam interferometer.

Since 1994, astronomers have been monitoring Betelgeuse using Infrared Spacial Interferometer (ISI) at Mt Wilson. Constructed by Nobel Laureate Charles Townes, it consists of three movable telescopes with 1.7 metre wide mirrors spaced up to 70 metres. Fifteen years of monitoring the star's radius has indicated that the star is shrinking by one per cent every year, since 1994. Its radius has shrunk more than 15 per cent.

What would happen to earthlings?

The monitoring has to be continued to see whether it would imply that the star could explode in a 1,000 years from now on. There is a critical radius below which the star could only collapse to its doom. If Betelgeuse does blow itself up, what would be the consequences be for us?

For one thing, it would brighten up so that it would appear at least as bright as the full moon in our night sky! So for a few weeks we would have an object in our skies rivalling the moon in brightness. The first radiation to hit the earth from such an event would be the neutrinos. Several pen-

pernova.

Will it be a spectacular demise?

The red supergiant stage is believed to be a precursor to such a spectacular stellar explosion, which has a luminosity several billion times that of the sun. Our largest telescopes can record such events even if they happen several billion light years away. Only massive stars (like Betelgeuse) are destined to herald their demise in this spectacular manner.

A star like the sun would end its life in a whimper (by comparison) ending as a white dwarf, cooling slowly over aeons. If white dwarfs were part of an appropriate binary system (with a close by companion star) they can also undergo spectacular events like novae or even end up as a different kind of supernova, but that is another story!

In February 1987, a massive star exploded in a neighbouring galaxy, the Large Magellanic Cloud (LMC). In our Milky Way Galaxy in 1054AD, a massive star underwent core collapse and exploded leading to SN1054, which was a bright object (as

billions of neutrinos would pass through each of our bodies in a few seconds. But they would not cause any damage.

The ultraviolet flux could disrupt the ionosphere for some time, but damage to the ozone layer would not be severe. If Betelgeuse had been ten times closer (say 30 light years), then the consequence for life on earth would be far more severe, threatening all higher life forms. The radiation would dampen in a few months while the blast wave from the explosion would take several thousands of years to reach us. The infrared satellite IRAS observed three concentric shells (rings) ejected from the surface of the star in the past.

Even a 1,000 years is a long wait (by human lifetimes). After the telescope was invented, astronomers have not witnessed any spectacular supernova event in our galaxy. If Betelgeuse does explode in 1,000 years or so, one can only imagine the technology man would have at that time to catch it.

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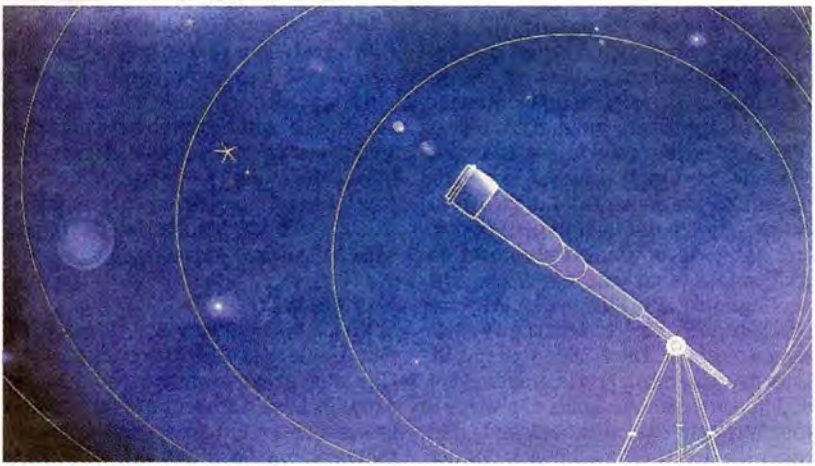

UP ABOVE THE WORLD... After the telescope was invented, astronomers have not witnessed any spectacular supernova event in our galaxy. GETTY IMAGES