Red Stars over China

Science Lessons from Supernovas

By J V NARLIKAR

ONE of the most spectacular celestial events is an exploding star, or a supernova, seen from a reasonably close but safe distance. Close, because, the nearer it is the more spectacular is its appearance. But safety is also important. For, at its peak, the exploding star outshines the whole galaxy empowered with the brilliance of over a 100 billion normal stars. And amongst the radiation issuing from it are highly energetic cosmic rays which are fast moving atomic nuclei. If the supernova were located closer than, say, 30 light years, the flux of cosmic ray particles would cause irretrievable damage to the earth's protective atmosphere, leading eventually to the extermination of all life.

Ancient Chinese records dating back to the 11th century tell us of a supernova in these words: "On a Chi-Chhou day in the fifth month of the year of Chi-Ho's reign, a guest star appeared at the south east of Thien-Kaun,... After more than a year it faded away." Thanks to the old but detailed records, today's scholars can put a date to the event. It was on July 4, 1054, that the Chinese saw a 'guest star' in the heavens, a star that was so bright that it could initially be seen in daylight. It was certainly brighter than planet Venus. As per the Chinese records, the star eventually disappeared from the sky, which explains why they gave it the appellation of 'guest'.

It is interesting to know why the Chinese kept such meticulous records. They did so because their emperors believed that warning signs would appear in the heavens if they strayed from the path of righteousness. Which is why royal courts had observers for keeping tabs on the sky. It was their duty to alert the ruler if they saw anything unusual in the sky.

That event of stellar explosion left behind a spectacular debris which, under the name of the Crab Nebula, are of interest to astronomers even today, some nine and a half centuries later. For, the location of the event, specified by the old records can be compared to the relic in the present sky viewed with modern techniques. Techniques much more sophisticated than the visual sightings of the 11th century tell us that the visual fade-out did not mean that the 'guest' went away. The debris seen today contain the remnant of explosion in the form of a pulsar, that is a regularly pulsating extremely compact and dense star largely made of neutrons. Indeed it is generally believed that a supernova leaves behind a compact dense remnant, which can be a tiny star known as white dwarf or a more compact one called the neutron star or the even more dramatic black hole.

An interesting handle on these spectacular events has recently emerged from X-ray astronomy. Gerhard Borner and Bernd Aschenbach from Germany in collaboration with Li Quibin of China have examined the images taken by the X-ray satellite ROSAT, looking for the debris of other similar supernova explosions. In a typical star explosion, a shock wave is generated, which heats up the surrounding gas, to the extent that it can radiate even X-rays. The mechanism, though complex can be reasonably well understood by the mathematical discussion by the plasma physicist Sedov. Using Sedov's method, the history behind the observed present state of the debris can be traced back to the epoch of explosion. Carrying out such an analysis on the X-ray images of three such supernova debris, these authors are able to estimate approximately the time elapsed since the explosions. Having worked out approximately when the explosion might have taken place, these authors then proceeded to find old Chinese records to match them.

IN BRIEF

- The Chinese kept meticulous records of celestial events
- Old records compared with modern data can help us understand the evolution of astronomical events
- India does not have the kind of records China has because of its largely oral tradition

For example, in the oldest of the three cases, the X-ray source RXJ1714-3939, the explosion is dated to have taken place about 3,000-5,000 years ago. This age estimate they were able to match with an old event recorded in 14th century BC inscriptions on tortoise shells or bones. The inscription reads: "On the Jisi day, the seventh day of the month, a big new star appeared in the company of the Huo star (identified with the star Antares)." Now the direction given in this record matches with the present day position of the X-ray source, as does the era of the inscription tally with the estimated age of the explosion. These scientists point out that inscriptions on tortoise shells or bones were a common practice in the Yin dynasty some 3,300 years ago.

This work holds out the possibility of understanding the long-term evolution of astronomical events by comparing old records with modern data. It is, therefore, very important to find old records in different civilisations around the earth, for the same celestial event would have been witnessed by them. In the case of the Crab Nebula, supporting evidence of the sighting of the event from other parts of the earth has indeed emerged.

Sadly, attempts to discover evidence of the event in contemporary Indian manuscripts have so far drawn a blank. In a project sponsored by the Indian National Science Academy, this author and Saroja Bhate of Pune University department of Sanskrit and Prakrit studies had searches for pertinent descriptions carried out in manuscripts from important libraries all over India. The precision with regard to chronology and location found in Chinese records can nowhere be matched. A similar lack of reference to the event in the European records where the tradition of writing and preserving information in manuscripts has been commented on by two scholars, science historian George Sarton and astrophysicist Fred Hoyle. Both have independently suggested that with the notion of a universe created once and for all by God at a specified time, there was no place in the medieval Christian belief for a new or guest star to appear. So the event was quietly ignored.

Could one argue somewhat differently for the Indian absence of records? In a largely oral tradition, ancient knowledge was passed down from generation to generation, virtually unchanged. Unlike the Chinese case, where the emperor needed the information, there was little incentive for fresh observations and even less for recording them. Astronomical observations coupled with archaeological ones can, therefore, make a significant comment on the social history of a civilisation.