Lecture 18 : Supernovae and Neutron Stars

Possible depiction of the 1054 AD Supernova, by unknown Anasazi Indian artist, Chaco Canyon, New Mexico. [Credit: Stockphoto.com/David Rock.]

On July 4, 1054, Chinese and Japanese astronomers observed a new, bright point of light in the constellation of Taurus. This 'guest star', described to be as bright as the moon, was clearly visible even during the daytime for almost a month. And, according to some accounts, it took almost two years to fade out of the night sky. Many ancient cultures recorded the event, including the Anasazi Indians (in present-day Arizona and New Mexico). Findings in Navaho Canyon and White Mesa (Arizona), as well as in the Chaco Canyon National Park (New Mexico) are thought to be depictions of this event; the interpretation arising from the fact that on the morning of July 5, the crescent moon came remarkably close to the position of the 'guest star', as would have been seen from western North America.

Seven centuries elapsed before English astronomer John Bevis discovered the Crab Nebula in 1731. Another two centuries passed before Edwin Hubble and Nicholas Mayall identified it as the remnant of the 1054 supernova explosion. The Crab Nebula is a complex shell of expanding gas with a dense, highly magnetised neutron star, or pulsar, at its centre. Interestingly, it also occupies the central position in the development of our understanding of the physics of supernovae and neutron stars.

In the 1940, Dutch historians and astronomers made the remarkable identification of the Crab Nebula, in the constellation Taurus, with the expanding debris of the Chinese Guest Star that exploded in 1054 AD. In the 1950s, a Russian astrophysicist advanced the revolutionary idea that the X-ray, optical and radio radiation we observe from the Crab Nebula must be synchrotron radiation from relativistic particles gyrating in the magnetic field of the nebula, both being produced by a central engine in the nebula. In 1967, a young Italian conjectured that this central engine could be a rapidly spinning, strongly magnetized Neutron Star. A few months later, precisely such a neutron star was discovered at the dynamical centre of the Crab Nebula. This lecture is devoted to this remarkable story.

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Prepared by Dr. Sushan Konar : ***sushan.konar@gmail.com***

An amazing story..

- February 1931 : Landau completes work on maximum mass of white dwarf. Predicts existence of 'giant atomic nuclei'-like stars.
- 1931 : Chandrasekhar too independently works out this maximum mass.
  Chandrasekhar S., ApJ, 74, 81 (1931)
- 7 January 1932 : Landau submits paper to *Physikalische Zeitschrift der Sowjetunion*.
- 17 February 1932 : Chadwick submits neutron discovery paper to *Nature*.
- 27 February 1932 : Chadwick's paper is published.
- 29 February 1932 : Landau's paper is published.
  Landau L. D., Phys. Z. Sowjetunion, 1, 285 (1932)
- 15-16 December 1933 : Walter Baade & Fritz Zwicky give talks at the APS meeting.
- 15 January 1934 : The abstract of Baade & Zwicky's talk is published.
  Baade W., Zwicky F., Proc. National Acad. Sci., 20, 254 & 259 (1934)
  4. Baade W., Zwicky F. Phys. Rev. 46 76 (1934)

Read about this fascinating story in -
Yakovlev D. G., Haensel P., Baym G., Pethick C. J., Physics Uspekhi, 56 (3), 289 (2013)

1967 : Jocelyn Bell & Antony Hewish detect regular radio pulses from CP1919 (PSR J1921+2153).
Hewish A., Bell S. J., Pilkington J. D. H., Scott P. F., Collins R. A., Nature 217 709 (1968)

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