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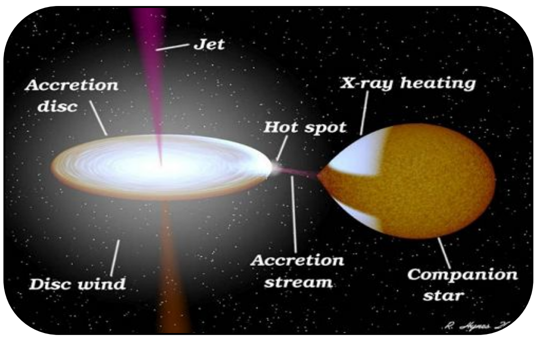
REVIEW OF RESEARCH

X-RAY BINARIES

Jogdand Sharada Keshav
Research Scholar



ABSTRACT

A type of binary stars that shine brightly in X-rays are called X-ray binaries. Matter from one element, known as a donor, falls into another, known as an accretor, which is extremely compact: a black hole or neutron star. As X-rays, falling matter releases up to several tenths of its rest mass's gravitational potential energy. The donor star's evolutionary state, the mass ratio between the stellar components, and their orbital separation all affect X-ray binaries' lifetime and mass transfer rate.

KEYWORDS : X-ray Binaries, Low Mass X-Ray Binaries, High Mass X-Ray Binaries.

INTRODUCTION

The brightest X-ray emission source in the universe is an X-ray binary, which consists of a compact star (a white dwarf, neutron star, or black hole) and a component star (a brown dwarf or white dwarf). By transferring material from their constituent stars, compact stars absorb gravitational energy and emit X-ray radiation. Numerous X-ray binaries, both inside and outside the galaxy, have been found through a variety of optical and X-ray surveys, and the number of them varies. The Milky Way is home to more than 400 X-ray binaries, including the Large Magellanic Cloud (LMC) and Small Magellanic Cloud (SMC).

CLASSIFICATION OF X-RAY BINARIES:

There are a variety of X-ray binary sub-systems presented in the classification of X-ray binaries. X-ray binaries can be divided into low-mass X-ray binaries (LMXBs) and high-mass X-ray binaries when the primary star, also known as the invisible star, is either a neutron star or a black hole. second-tier star Based on the differences in the characteristics that have been observed, the X-ray system can be divided into several distinct subtypes when the primary star is a white dwarf. The majority of the time, they are linked to a single essential X-ray source, cataclysmic variables (CVs).

1. **Low Mass X-Ray Binaries:** A binary star system known as a low-mass X-ray binary (LMXB) has either a neutron star or a black hole as one of its components. A donor, another element, typically fills its Roche lobe, transferring mass to the compact star. A degenerate dwarf (white dwarf) or an evolved star (red giant) on the main sequence can serve as the donor in LMXB systems. The donor has less mass than the compact object. Thirteen of the approximately 200 LMXBs that have been observed in globular clusters have been found in the Milky Way. Numerous faraway galaxies have been found to contain LMXBs thanks to the Lunar X-ray Observatory. Low-mass X-ray binaries are among the brightest objects in the X-

ray sky, but they are relatively faint in visible light because they typically emit less than one percent of their radiation in visible light and almost all of their radiation in X-rays. The typical apparent intensity ranges from 15 to 20. The accretion disk that surrounds the compact object is the system's brightest component. The orbital periods of LMXBs range from a few minutes to hundreds of days. Variability in LMXBs is typically depicted as an X-ray burster, but it can also be depicted as an X-ray pulsar. The accretion of hydrogen and helium in thermonuclear explosions is what causes X-ray bursts.

2. **High Mass X-Ray Binaries:** A pair of massive stars, typically O or B stars, blue supergiants, red supergiants, or Wolf-Rayets, with significant X-ray emission is referred to as a "high mass X-ray binary" (HMXB). X-rays are produced by a star, also known as a neutron star or a black hole. When the stellar wind hits a compact object, it emits X-rays because it takes in some of the wind from a large normal star. In a high-mass X-ray binary, the massive star emits more optical light than X-rays, while the compact object mostly emits X-rays. Because they are so bright, giant stars are easy to see. One of the most well-known high-mass X-ray binaries is Cygnus X-1, the oldest known candidate for a black hole. Two more HMXBs are the 4U 1700-37 and the Vela X-1. HMXB is variable as an X-ray pulsar rather than an X-ray burster. The components magnetically enter the compact companion's poles and accrete there, resulting in these X-ray pulsars. Stellar winds accrete normal stars, and Roche lobes overflow to the point where mass transfer is highly unstable and only occurs in brief bursts. If the binary has a lifetime of less than one year, it may merge into a neutron star or a red giant with a neutron core after HMXB is finished. If HMXB is destroyed by a supernova, a double neutron star with periods of at least a year can form a binary.
3. **Intermediate Mass X-Ray Binaries:** A binary star system with a neutron star or black hole as one of the components is known as an intermediate-mass X-ray binary (IMXB). The central mass star is the second element. Low-mass X-ray binary systems are the offspring of intermediate-mass X-ray binaries.
4. **Micro-quasar:** A radio-emitting X-ray binary, also known as a microquasar, is the smallest relative of a quasar. Microquasars were given the name "quasar" because they share a number of characteristics with quasars, such as intense and variable radio emission that can frequently be seen as two radio jets and an accretion disc surrounding a compact object with a black hole or neutron star. The compact object of a microquasar has a mass of a few solar masses, whereas the supermassive black hole of a quasar has millions of solar masses. In microquasars, the accretion disc is extremely brilliant in the optical and X-ray spectra because the normal star serves as the accretion mass. Microquasars are frequently referred to as radio-jet X-ray binaries in order to distinguish them from other X-ray binaries. Some of the radio emission is caused by relativistic jets, which frequently give the impression that they are traveling at the speed of light. When studying relativistic jets, it is essential to comprehend microquasars. Jets occur near compact objects on timescales that are inversely proportional to the object's mass. Consequently, typical quasars traverse the microquasar variant in a single day. GRS 1915+105, with its high jet velocity and brilliant Cygnus X-1, which detected high-energy gamma rays ($E > 60$ MeV) and nuclear emission lines from both jets, is one notable microquasar. The extremely high energy of particles released in the VHE band can be explained by a variety of particle acceleration mechanisms.

BLAC HOLE BINARY SYSTEMS:

Some X-ray binary systems are thought to contain stellar-mass black holes embedded in an inwardly spiraling disk of gas. These accretion disks are known sources of soft and hard X-ray emission and, in some cases, also sources of soft gamma-ray emission. Perhaps the most famous example is Cygnus X-1, the brightest X-ray source in the constellation Cygnus. The X-ray luminosity of these high-mass X-ray binaries is variable and corresponds to different high-energy spectral "states". These states of activity are composed of different mixtures of two main components: a soft thermal blackbody-like component and a hard nonthermal power-law component. This is a power-law factor that can extend, at times, to gamma-ray energies of at least one MeV.

The origin of the MeV gamma ray emission from Cygnus X-1 is not well understood. Most models assume that gamma rays are X-rays scattered by Compton soft relativistic electrons. The exact origin of those energetic electrons is still unclear. Some modelers have speculated that the reconnection of magnetic fields or shocks in the disk outflow accelerate the electrons. However, a particularly attractive idea is that the scattering electrons arise naturally from the innermost stable orbits of the convective disc in the convective current. If the accretion rate is high, Compton emission from the bulk flow can produce the observed gamma ray emission.

Finally, galactic sources that produce intense bursts of X-ray emission are called X-ray novae. They are found in low-mass binary systems in which the common companion star is in close orbit around a compact object of approximately solar mass. Such binary systems can undergo frequent outbursts that can briefly make them the brightest high-energy sources in the sky. Optical observations of these low-mass X-ray binary systems in their quiescent states indicate that the compact object is typically greater than 3.0 solar masses and is therefore likely a black hole. Some X-ray novae are also accompanied by low-energy gamma-ray emission. At least one such nova outburst, Nova Muske in 1991, observed with the Sigma instrument, exhibited a variable positron annihilation line. Subsequent observations of Nova Persei in 1992 with the telescope at the Compton Observatory confirmed that X-ray novae can give rise to extended gamma-ray emission up to photon energies of at least 2 MeV.

CONCLUSION:

X-ray binary stars are one type of important celestial body. They evolved from massive binary stars. The study of their evolutionary processes is very important for the evolution and material exchange of binary stars and other astrophysical fields and plays an important role in relativity. In future studies, by collecting, observing and analyzing more samples of these massive X-ray binaries, our understanding of these objects will be further advanced.

REFERENCES:

1. Chengzhuo Tan (2012). High-Mass X-ray binary: Classification, Formation, and Evolution. Journal of Physics: Conference Series 2012 (2021) 012119, IOP Publication. Pp. 1-8. doi:10.1088/1742-6596/2012/1/012119.
2. Chen, Wen-Cong; Podsiadlowski, Philipp (2016). "Evolution of Intermediate-mass X-Ray Binaries Driven by the Magnetic Braking of AP/BP Stars. I. Ultracompact X-Ray Binaries". The Astrophysical Journal. 830 (2): 131.
3. Giacconi, R., Gursky, H, Paolini, F.R., Rossi, B.B, (1962) Evidence for x Rays from Sources Outside the Solar System. Physical Review Letters 9,439-443.
4. Liu Q.Z., Paradijs J. Van, Van, Den Heuvel E.P.J. (2001). A catalogue of low-mass X-ray binaries. Astronomy and Astrophysics, 368: 1021-1054. DOI: 10.1051/0004-6361:20010075.
5. Patruno, Alessandro; Watts, Anna L. (2021), Belloni, Tomaso M.; Méndez, Mariano; Zhang, Chengmin (eds.), “Accreting Millisecond X-ray Pulsars”, Timing Neutron Stars: Pulsations, Oscillations and Explosions, Berlin, Heidelberg: Springer, pp. 143–208, doi:10.1007/978-3-662-62110-3_4
6. Tauris, Thomas M.; van den Heuvel, Ed (2006). “Chapter 16: Formation and evolution of compact stellar X-ray sources”. In Lewin, Walter; van der Klis, Michiel (eds.). Compact Stellar X-ray Sources. Compact Stellar X-Ray Sources. Cambridge Astrophysics Series. Vol. 39. pp. 623–665.
7. Tetarenko, B. E.; Sivakoff, G. R.; Heinke, C. O.; Gladstone, J. C. (February 10, 2010). “Watchdog: A Comprehensive All-Sky Database of Galactic Black Hole X-Ray Binaries”. The Astrophysical Journal Supplement Series. 222 (2).