Phenomenology and physics of High Mass X-ray Binaries (HMXBs)

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Duration: 20 hours

Evaluation: Presentation of a monographic work by the students.

Requirements: Physics up to Electromagnetism and basic Astrophysics

Contents:

1. Nature of High Mass X-ray Binaries

In the first class of this course I will describe the nature of High-Mass X-ray Binaries, and how we distinguish the 3 kinds of HMXBs: i. those hosting a Be star as companion star, ii. those directly accreting from the wind of supergiant stars, and iii. those accreting through Roche lobe filling supergiants. Different star masses, radii and characteristics of the binary system produce different types of accretion transfer in these systems, which therefore form and evolve in different ways.

2. Formation of High Mass X-ray Binaries

The 3 different types of HMXBs form through distinct scenarii, and we now have in hand observational, numerical and theoretical constraints about their formation, that we will describe here in detail. The parameters that we need to take into account are the transfer of mass and angular momentum, the spin and metallicity of the stars, the kick during the supernova event, etc, giving birth to systems of different nature.

3. Obscured High Mass X-ray Binaries discovered by INTEGRAL

A wealth of new observations, from the high-energy side -mainly coming from the INTEGRAL satellite-, and completed by multi-wavelength observations -mainly optical/near-infrared/mid-infrared from ESO-, shows that a new population of supergiant HMXBs has been recently revealed. These sources, much more absorbed than sources of similar nature that were known before, exhibit a high intrinsic absorption likely due to the presence of a dense cocoon of gas and dust surrounding the supergiant star.

4. Supergiant Fast X-ray transients (SFXTs) discovered by the INTEGRAL satellite

While previously known HMXBs were persistent X-ray sources, many HMXBs hosting a supergiant star discovered by the INTEGRAL satellite have been shown to be transient sources, exhibiting fast and intense X-ray flares lasting for a very short time of a few hours. However this observational fact is hard to reconcile with the size of the stars involved and the orbit of the binary systems. We will describe and discuss the various models of accretion proposed to reproduce the observations of these sources: clumpy stellar wind, transitory accretion disk, and magneto-centrifugal inhibition of accretion.

5. Evolution of High Mass X-ray Binaries

In the last class of this course I will describe new observational facts and theoretical results about the evolution of each of these various categories of HMXBs, and show the existence of an evolutionary link between Be, supergiant HMXBs and SFXTs. I will finally bring comparisons between observations and results from population synthesis models, allowing us to discuss the final fate of each kind of HMXBs.

Bibliography

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- Chaty, S., 2009, Compact Objects and their emission, AAABS N°1, edited by G.E. Romero & P. Benaglia, ISBN 978-987-24948-0-3 (arXiv :0809.1076), INTEGRAL sources: from obscured high mass X-ray binaries to supergiant fast X-ray transients

- Chaty, S., 2008, ChJA&AS, 8, 197, Obscured Sources and Supergiant Fast X-ray Transients : New Classes of High Mass X-ray Binaries (Invited review at the Frascati Workshop 2007, Vulcano, Italy, May 28 - June 2 ; Multifrequency Behaviour of High Energy Cosmic Sources, 710)

- Coleiro, A., Chaty, S., 2011, New Astronomy Reviews, in press, Study of the distribution of High Mass X-ray Binaries in the Milky Way (International ESO conference on Binary star evolution), Viña del Mar, Chile, March 6-11, 2011

- Romero, G.E., Paredes, J.M., 2011, Introducción a la Astrofísica Relativista, Textos Docentes, Universitat de Barcelona, Barcelona.