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High-mass X-ray Binaries: Illuminating the Passage from Massive Binaries to Merging Compact Objects

Edited by

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HIGH-MASS X-RAY BINARIES: ILLUMINATING THE PASSAGE
FROM MASSIVE BINARIES TO MERGING COMPACT OBJECTS

IAU SYMPOSIUM 346

COVER ILLUSTRATION: HIGH-MASS X-RAY BINARY AND A MASSIVE
STAR CLUSTER

This composite image shows a sky region in the Small Magellanic Cloud galaxy. On the right-hand side is a high-mass X-ray binary. This binary, known as SXP 1062, consists of a massive Be-type star and a neutron star. The diffuse X-rays and optical shell around SXP 1062 both evidence for a supernova remnant. On the left-hand side of the image is the spectacular HII region, LHA 115-N 90, that surrounds a group of young massive stars. X-rays from Chandra and XMM-Newton telescopes have been colored blue and optical data from the Cerro Tololo Inter-American Observatory in Chile are colored red and green. The image is taken from the Chandra X-ray observatory photo album: chandra.harvard.edu/photo/2011/sxp1062/ where further details may be found.

Source: This image illustrates the discussions on deep links between massive stars, X-ray binaries, and compact objects which we had in Vienna, Austria, 27-31 August 2018.

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HIGH-MASS X-RAY BINARIES: ILLUMINATING THE PASSAGE FROM MASSIVE BINARIES TO MERCING COMPACT OBJECTS

PROCEEDINGS OF THE 346th SYMPOSIUM
OF THE INTERNATIONAL ASTRONOMICAL
UNION HELD IN VIENNA, AUSTRIA
27–31 AUGUST, 2018

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Preface

The idea of an IAU Symposium devoted to high-mass X-ray binaries (HMXBs) was born following the realization that a comprehensive understanding of these objects and their cosmic roles could be achieved only when diverse communities studying HMXBs come together. Consisting of a young massive donor star and an accreting degenerate object (a neutron star or a black hole), these objects are unique astrophysical laboratories for studies of stellar evolution, donor star winds and disks, and the compact objects they feed. Importantly, HMXBs are among our cosmic neighbors, and they provide us with deep and detailed insights into the physics of accretion and matter under extreme conditions. HMXBs are also present in the farther realms, and are, undoubtedly, important sources of stellar feedback across cosmic time. Their role in the early Universe was highly significant. The populations of HMXBs trace star formation, uncover their parental star cluster evolution, as well as ionize the interstellar medium of their host galaxies by hard radiation. Following the detection of gravitational wave events produced by merging stellar-mass black holes and neutron stars, HMXBs were put in the focus of current astrophysical research as a key transitional stage between young massive stars and degenerate binaries. Even in very dense star clusters, where degenerate binaries may form dynamically, a significant fraction of the compact object population must have passed through a HMXB stage. At present, there is a burst of theoretical work on the evolution of massive binary systems towards double degenerate mergers. Besides the standard population synthesis models that have predicted gravitational wave detection rates, new models and scenarios are being actively investigated. These models rely on our fundamental understanding of massive star physics. Hence, a scientific organizing committee (SOC) came together to organize an IAU Symposium aimed at developing a synergistic approach, comprising the physics of stars, compact objects, and their interactions.

HMXBs were discovered more than 50 years ago, and during this time an incredibly rich trove of facts, models, and theories has accumulated, calling for a broad interdisciplinary meeting to exchange ideas and share insights. The XXXth IAU General Assembly held in Vienna was uniquely suited for the broad scope meeting the SOC envisioned. Our goal was to build scientific bridges between the well advanced field of massive binary astrophysics and the newly emerging field of gravitational wave astronomy.

The IAUS 346 brought together, perhaps for the first time in the framework of an IAU Symposium, the communities focusing on the studies of compact objects and accretion processes, on the donor stars and binary evolution, as well as on gravitational wave event progenitors. The participants discussed different types of HMXBs – Be/X-Ray binaries (BeXRBs), supergiant HMXBs, Wolf-Rayet XRBs, microquasars, γ -ray binaries, and ultraluminous X-ray sources (ULXs) – trying to place them in one broad astrophysical picture. The SOC encouraged the participants to address and to seek the answers to astrophysical questions of general importance, such as: How do massive stars and binaries evolve, lose mass, and collapse? What are the answers to the enigmas of BeXRBs and Supergiant Fast X-ray Transients (SFXTs)? What is the physics of ULXs and their winds? Which multiwavelength transient phenomena are associated with HMXBs? Why are there different populations of HMXBs in different galaxies? What was the role of HMXBs in the early Universe? How are double degenerate binaries formed? Are properties of neutron stars and black holes in HMXBs similar to those observed in merger events by gravitational wave observatories?

Following endorsement by the IAU Commissions and the IAU Division G “Stars and Stellar Physics” and subsequent approval by the IAU Executive Committee, the IAUS 346 was included in the program of the XXXth IAU General Assembly. Thanks to the

overwhelmingly positive response, a broad and diverse scientific program was formed. Fifteen speakers were invited to review their research fields, including three IAU GA plenary talks on massive stars, HMXBs, and gravitational wave astronomy. The science topics were addressed and clarified in 35 contributed talks, more than 200 posters, and through intense discussions. Altogether more than 400 participants from all around the world expressed their interest and attended the sessions of the IAUS 346.

The IAUS 346 adopted a comprehensive and unified approach to the problem of massive star lives and deaths, theory and observations of HMXBs, and gravitational wave astronomy. This led to many mutually enriching discussions, to building new contacts, and to developing advanced research strategies. For the younger generation of scientists, the Symposium's novel approach allowed them to see a broad astrophysical picture especially in the setting of the General Assembly of the IAU.

This scientific diversity is reflected in this volume. Each manuscript was reviewed prior to the acceptance for the publication. We are indebted to the invited speakers who provided reviews published in this volume that promote the exchange of knowledge among different fields. We are indebted as well as to the contributing authors, whose manuscripts reflect the current thinking and work in all areas related to the subject of the IAUS 346.

We warmly thank the organizing committee of the XXXth General Assembly of the IAU for making the symposium devoted to HMXBs possible. The advent of future facilities for astrophysical research from both space and ground, as well as the broadened on-going theoretical efforts across the different fields involving HMXBs, their progenitors and their descendants, will certainly lead to new discoveries and many unexpected challenges. We hope that this volume of proceedings, realized thanks to the significant effort of many esteemed colleagues coming from different research areas and backgrounds, will remain as a reference for future steps forward in our understanding of HMXBs.

Lidia M. Oskinova, Enrico Bozzo, Tomasz Bulik, Douglas R. Gies

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