

# **IAUS 346 High Mass X-ray Binaries: illuminating the passage from massive binaries to merging compact objects**

## **Final Science Program and Invited Speakers**

Monday, 27. Aug.

08:30 – I. Mandel (Gravitational wave astronomy.)

09:00 – Heger, Alexander (Massive stars.)

09:30 – van den Heuvel, Edward (High-Mass X-ray Binaries.)

Tuesday, 28. Aug.

10:30 – Sander, Andreas (Massive star winds and HMXB donors)

11:00 – Martínez-Núñez, Silvia (Our current picture of the physics of wind-fed massive X-ray binary systems)

11:15 – J. Krticka (Wind inhibition in HMXBs: the effect of clumping and implications for X-ray luminosity)

11:30 – El Mellah, Ileyk (Clumpy wind accretion in Supergiant X-ray Binaries)

11:45 – Hainich, Rainer (Massive binary stars with relativistic companions: Studying donor winds with the HST)

13:30 – Rivinius, Thomas (Be stars)

14:00 – Okazaki, Atsuo (Cyclic evolution of misaligned Be disks in Be/X-ray binaries and its observational implications)

14:15 – Bartlett, Elizabeth (CI Camelopardalis: The first sgB[e]-High Mass X-ray Binary Revisited Twenty Years on)

14:30 – Waisberg, Idel (Optical Interferometry of HMXBs: Resolving Wind, Disk and Jet Outflows at Sub-milliarcsecond Scale)

14:45 – Ribó, Marc (MWC 656: the first HMXB containing a BH orbiting a Be star)

Wednesday, 29. Aug.

10:30 – Belczynski, Krzysztof (Evolutionary scenarios for the formation of gravitational wave progenitors)

11:00 – Mapelli, Michela (Black hole and neutron star binaries in star clusters and GW progenitors)

11:30 – Garofali, Kristen (Using High-Mass X-ray Binaries to Probe Massive Binary Evolution)

11:45 – Vink, Jorick (Constraining the progenitor evolution of GW 150914)

13:30 – J. Wilms (Mechanisms of accretion)

14:00 – Chaty, Sylvain (The dark side of HMXBs)

14:15 – Corbet, Robin (Long-term Properties of Superiorbital Periodic Modulation in Wind-Accretion High-Mass X-ray Binaries)

14:30 – Negueruela, Ignacio (On the nature of SFXTs)

14:45 – Grinberg, Victoria (Clumpy accretion in high mass X-ray binaries: the showcase Vela X-1)

Thursday, 30. Aug.

08:30 – M. Gilfanov (Populations of HMXBs in galaxies and links with star formation)

09:00 – Zezas, Andreas (Characterization of compact object populations in nearby galaxies)

09:15 – Fornasini, Francesca (Is the redshift evolution of HMXBs driven by metallicity?)

09:30 – Schulz, Norbert (The Very Young Be-Star X-ray Binary Circinus X-1)

09:45 – Wolter, Anna (The Cartwheel galaxy as a stepping stone for binaries' formation)  
 10:30 – C. Wilson-Hodge (HMXBs in gamma-rays and EM counterparts of GW events)  
 11:00 – Sidoli, Lara (Investigating High Mass X-ray Binaries at hard X-rays with INTEGRAL)  
 11:15 – Zhang, Shu (Multi messengers to gamma-ray XRB)  
 11:30 – Mirabel, Felix (HMXBs in the early Universe)  
 13:30 – Harrison, Fiona (Ultraluminous X-ray sources)  
 14:00 – Fuerst, Felix (Orbital period and pulsed spectrum of the super-Eddington neutron star NGC 7793 P13)  
 14:15 – Carpano, Stefania (Phase connected X-ray light curve and He II radial velocity measurements of NGC 300 X-1)  
 14:30 – Soria, Roberto (An eclipsing Wolf-Rayet ULX in the Circinus galaxy)  
 14:45 – Heida, Marianne (The donor stars of ultraluminous X-ray sources)

Friday, 31. Aug.

08:30 – Haberl, Frank (populations of HMXBs in the Milky Way and the Magellanic Clouds)  
 09:00 – Lehmer, Bret (Empirical Constraints on the Evolution of X-ray Binaries from Chandra Deep Fields and Local Galaxies)  
 09:15 – Bozzo, Enrico (IGR J17329-2731: the birth of a symbiotic X-ray binary)  
 09:30 – Shenar, Tomer (WR binaries in the Magellanic Clouds as progenitors of high mass X-ray binaries)  
 09:45 – Postnov, Konstantin (X-ray binaries with neutron stars at accreting and non-accreting stages)  
 10:30 – Fragos, Tassos (low-mass X-ray binaries and the way to GW sources)  
 11:00 – Klencki, Jakub (High-mass X-ray binaries as progenitors of gravitational wave sources)  
 11:15 – Marchant, Pablo (A new approach to binary population synthesis)  
 11:30 – Qin, Ying (The black hole spin in coalescing binary black holes and high-mass X-ray binaries)  
 11:45 – Torrejon, Jose Miguel (Accreting magnetars: stellar winds and accretion)  
 13:30 – Chruslinska, Martyna (Local merger rates of double neutron star systems)  
 13:45 – Bulik, Tomasz (HMXBs as progenitors of gravitational wave mergers)  
 14:00 – Ricker, Paul (Common Envelope Evolution of Massive Binaries)  
 14:15 – Gies, Douglas (Symposium Summary)

### **Invited review speakers**

- Chris Belczynski (Poland) Evolutionary scenarios for the formation of gravitational wave progenitors
- Tassos Fragos (Switzerland) Low-mass X-ray binaries
- Doug Gies (USA) Symposium Summary
- Marat Gilfanov (Germany/Russia) Populations of HMXBs in galaxies and links with star formation
- Frank Haberl (Germany) Populations of HMXBs in the Milky Way and the Magellanic Clouds
- Fiona Harrison (USA) Ultraluminous X-ray sources
- Alexander Heger (Australia) Massive Stars (plenary review)
- Ed van den Heuvel (The Netherlands) High-Mass X-ray Binaries (plenary review)
- Ilya Mandel (UK) Gravitational Wave Astronomy (plenary review)
- Michela Mapelli (Austria) Black hole and neutron star binaries in star clusters and GW progenitors
- Felix Mirabel (Argentina) HMXBs in the early Universe
- Thomas Rivinius (Chili) Be stars

- Andreas Sander (Germany) Massive star winds and HMXB donors
- Joern Wilms (Germany) Accretion mechanisms in HMXBs
- Colleen Wilson-Hodge (USA) HMXBs in gamma-rays and EM counterparts of GW events

## Session Chairs

Lidia Oskinova	f, Germany
Lex Kaper	m, Netherlands
Ines Brott	f, Austria
Colleen Wilson-Hodge	f, USA
Fiona Harrison	f, USA
Xiang-Dong Li	m, China
Sergei Fabrika	m, Russia
You-Hua Chu	f, Taiwan
ShuangNan Zhang	m, China
Lara Sidoli	f, Italy
Peter Kretschmar	m, Spain

## Summary of the scientific highlights of the meeting

The IAU Symposium 346 was devoted to high-mass X-ray binaries (HMXBs) as the key transitional stage between young binaries and merging compact objects. Consisting of a young massive donor star and an accreting degenerate object (a neutron star or a black hole), HMXBs are unique astrophysical laboratories. The scientific program of the Symposium was covering a broad range of topics that included HMXBs as gravitational wave event progenitors, massive star evolution, donor star winds and disks, and the compact objects they feed. HMXBs are among our cosmic neighbors and hence provide 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 times. Hence the questions on the cosmic role of HMXBs and their significance in the early Universe were also included in the science program. Among other important aspect of the science program were the studies of HMXB populations as tracers of star formation and stellar feedback in their host galaxies in the local Universe. The participants of the Symposium worked together on developing new synergistic approaches comprising the physics of stars, compact objects, and their interactions to fully exploit the scientific potential of HMXBs in the era of multimessenger astronomy.

Perhaps the major scientific achievement of the meeting was bringing together various communities that are traditionally working on different aspects of HMXBs. Previously, the numerous types of HMXBs were usually discussed at separate, specialized meetings. Similarly, meetings focused on the studies of black holes and neutron stars often did not consider the massive donor stars and the implications for stellar evolution posed by compact object populations. Likely for the first time ever, the IAUS 346 adopted a comprehensive and unified approach to the problem. This resulted in many mutually enriching discussions, in building new contacts, and developing new research strategies.

For the young generation of scientists, the Symposium's novel approach allowed to see a broad astrophysical picture. Especially important was that the Symposium was a part of the XXX IAU General Assembly. Given the interdisciplinary approach of this meeting, the GA setting was extremely useful and productive. Just as one of numerous examples, many oral and poster contributions to the IAUS 346 were considering HMXBs in dwarf galaxies, wonderfully

complemented by the science questions considered during the IAUS 344 "Dwarf Galaxies: from the deep universe to the present." The deep integration of IAUS 346 in the science program of the XXX General Assembly resulted in excellent attendance – besides the registered Symposium participants, the talks and posters received large attention from the community in general.

The good timing of the Symposium has contributed to its scientific success. HMXBs are put at the focus of astrophysical research by the detection of gravitational waves from merging compact objects. HMXBs are at the 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. The science program of the Symposium was reflecting this recent development – basically all leading models of gravitational wave progenitors that involve stellar evolution were presented and discussed during the Symposium. This gave the audience a fair representation of current research activity in the field.

Overall, the IAU Symposium 346 strongly consolidated the international scientific communities working on X-ray astronomy, massive stars, and gravitational waves.

## **Executive Summary of the Meeting**

The IAU Symposium 346 "High Mass X-ray Binaries: illuminating the passage from massive binaries to merging compact objects" was held from 27 to 31 August 2018 as a part of XXX IAU General Assembly in Vienna. During the Symposium >130 posters and 50 oral contributions were discussed and attended by an estimated 400 astronomers. The contributions to the Symposium scientific program were made by the scientists from >32 countries, demonstrating the broad interest around the globe in HMXBs and related topics. About 24% of participants were female, which is roughly consistent with a percentage of women working in this field but demonstrates that, as a community, we need to be more inclusive and encouraging.

The three talks presented during the opening, plenary session (I. Mandel, A. Heger, and E. van den Heuvel) reviewed the three key topics of the Symposium, massive star evolution, high-mass X-ray binaries, and gravitational wave astronomy, for the broad astronomical audience. The rest of the science program was organized over ten topics: Massive stars, BeHMXBs, Gravitational Wave Progenitors, Accretion, X-ray luminosity functions and star formation, High Energy and Early Universe, ULXes, Populations in galaxies, HMXB evolution and feedback, and HMXB links with GW sources. These topics were reviewed by 12 review speakers (30 min reviews) and discussed in detail in 35 contributed talks (15 min). There were numerous questions and lively discussions after each talks.

Special attention during the Symposium was paid to poster contributions, which were cross-reference in basically each talk. Poster sessions were well attended, and the feedback on organizing the poster session was positive. Poster contributions also played a major role in the conference summary, which was delivered by Doug Gies.

Altogether, 85 papers were submitted to the conference proceedings, which are in press now (February 2019). The Proceeding Editors are L. Oskinova, E. Bozzo, D. Gies, and T. Bulik. The SOC consisted of 3 female and 13 male colleagues from 13 countries.

- Lidia Oskinova (co-chair), University of Potsdam, Germany
- Enrico Bozzo (co-chair), University of Geneva, Switzerland
- Doug Gies (co-chair), Georgia State University, USA

- Daniel Holz (co-chair), University of Chicago, USA
- John Blondin, North Carolina State University, USA
- Tomek Bulik, Warsaw University, Poland
- Malcolm Coe, University of Southampton, UK
- Gloria Koenigsberger, Universidad Nacional Autonoma de Mexico, Mexico
- Xiang-Dong Li, Nanjing University, China
- Atsuo Okazaki, Hokkai-Gakuen University, Japan
- Biswajit Paul, Raman Research Institute, India
- Konstantin Postnov, Moscow State University, Russia
- Pablo Reig, Universtiy of Crete, Greece
- Lara Sidoli, INAF-IASF Milano, Italy
- John Tomsick, University of California, Berkeley, USA
- Jose Miguel Torrejon, EPS Universidad de Alicante, Spain