Massive Stars Across Redshifts in the Era of JWST and Large Surveys
Proceedings IAU Symposium No. 402, 2026
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doi:10.1017/S1743921326107510

Preface

This volume contains contributions from IAU Symposium 402, "Massive Stars across Redshifts in the Era of JWST and Large Surveys." It was held in Ensenada, Baja California, Mexico from the 15th to the 19th of September of 2025.

Massive stars are crucial for solving multiple cosmic puzzles. This is because they are key contributors of ionizing radiation, mechanical energy, metals, cosmic rays, and dust; and when they die, they produce neutron stars, black holes, and/or gravitational waves. However, many competing factors are thought to influence their observed properties and challenge our understanding of how these stars evolve and contribute to the Universe. The Massive Stars Commission (G2) of the IAU's Stars and Stellar Physics Division regularly organizes a symposium, typically every 4 years, to present the latest research findings in the field, discuss the status of current research in massive stars, and chart the way forward for future research. The first meeting was in Argentina in 1971, and in the last decade we organized "Massive Stars: from Alpha to Omega" in Greece (2013), "IAUS 329: The Lives and Death Throes of Massive Stars" in New Zealand (2016), and "IAUS 361: Massive Stars Near and Far" in Ireland (2020, postponed to 2022 due to the pandemic).

Since the last symposium organized by the G2 commission (IAUS 361, 2022), the James Webb Space Telescope has dramatically changed our understanding of the early Universe. Many improvements have been made on individual stars, close binaries and population synthesis models. In addition, a better understanding of the impact of massive stars on their surroundings has been achieved, and analysis techniques are also increasingly sophisticated. These involve accounting for improved or more complete physics, better atomic data, and/or evolving from 1-dimensional to 3D models in the simulations of stellar structure and winds. Despite the large progress, however, outstanding open questions on massive star evolution and winds remain (e.g. the role of metallicity, true mass loss rates, internal transport mechanisms and magnetic fields to name a few). The view of massive star evolution also needs to be reconciled with the view of the massive star graveyard drawn by gravitational wave experiments. These issues, need to be solved to properly account for the role of massive stars across cosmic time, and to maximize the return of empirical datasets and models in the era of JWST and large surveys (SDSS V Mappers, SKA, and Rubin/LSST, among others). Fortunately, the field of massive stars is entering a new era also enabled by large scale spectroscopic surveys. By targeting vast samples of massive stars in the Milky Way and our neighbors the Magellanic Clouds, IACOB, WEAVE, 4MOST, SDSS IV APOGEE, RIOTS, HST-ULLYSES, and VLT-XShootU, as well as complementary observations, these surveys are enabling detailed constraints on theory obtained thanks to quantitative spectroscopic analyses. In addition, new promising research areas are consolidating, such as massive-star asteroseismology, that is providing an unprecedented view of their interior. We organized IAUS402 so that experts from complementary communities could gauge the progress that has been made so far, identify areas of opportunity, and discuss future technological developments.

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https://doi.org/10.1017/S1743921326107510 Published online by Cambridge University Press

The symposium was divided into the following eight scientific sessions:

1) Large surveys and key observations
2) High-redshift stars: observed and synthetic
3) Stellar evolution and atmosphere models: theory
4) Stellar evolution and atmosphere models: observations
5) Asteroseismology, spectropolarimetry, interferometry
6) Final products of massive stars
7) Population synthesis models and feedback
8) Looking to the future

In addition, we organized two outreach and educational activities to enhance the legacy of the symposium, in Ensenada. A public talk on Gaia/Milky Way/massive-star science was given by Dr. Jesús Maíz Apellániz, one of the invited speakers to our symposium, on September 19 (Fri) 2025, in the auditorium of the Caracol Science Museum of Ensenada. As the speaker was from Spain, the talk was given in Spanish, which is the local language. The total number of attendees was about 20. In addition, members of the LOC (María de los Ángeles López Villegas, Alma Maciel and Carlos Román Zúñiga) organized a drawing contest on massive stars for Ensenada middle-school students. A text describing massive stars was prepared and made available to the students, in order to provide background on the topic prior to the contest, by LOC members. An exhibit of the best 25/40 drawings was held at the Caracol Science Museum of Ensenada. We gave celestron binoculars as prizes to the best three drawings, which were selected by members of the LOC. The prizes were given on the day of the public talk, so that the students would meet the invited speaker. The drawings constituted a traveling exhibit in Ensenada until the end of 2025. In particular, the exhibit was displayed on November 29th 2025 at a major outreach event that takes place simultaneously, nation-wide, every year, "Noche de las Estrellas", which was amended by hundreds of individuals of all ages in Ensenada. This event was free of charge.

We wish to extend our gratitude to the Institute of Astronomy of Universidad Nacional Autónoma de México for their financial support to IAUS 402. Staff from Hotel Coral y Marina and the Caracol Museum of Science in Ensenada also supported local planning. We would also like to thank our designer and webmaster: Abisai Lucero for his work on this symposium. For IAUS 402, Division G "Stars and Stellar Physics" agreed to be the coordinating division; Divisions H "Interstellar Mamer and Local Universe" and J "Galaxies and Cosmology", as well as Commission G2 "Massive Stars", also kindly supported IAUS 402. Finally, we would like to thank the IAU for supporting 25 scientists via travel grants that enabled their participation in the symposium.

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