NEW WINDOWS ON MASSIVE STARS, ASTEROSEISMOLOGY, INTERFEROMETRY AND SPECTROPOLARIMETRY

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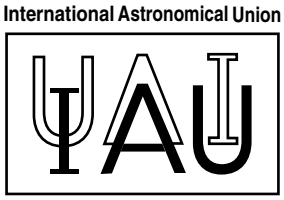

NEW WINDOWS ON MASSIVE STARS, ASTEROSEISMOLOGY, INTERFEROMETRY AND SPECTROPOLARIMETRY

PROCEEDINGS OF THE 307th SYMPOSIUM OF THE INTERNATIONAL ASTRONOMICAL UNION HELD IN GENEVA, SWITZERLAND JUNE 23–27, 2014

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Preface

A Universe without massive stars would be very different from the one we can observe. Indeed these stars are important drivers for the photometric and chemical evolution of galaxies, they are the sources of important elements for the building of living bodies, they feed with their strong winds and supernova explosion the interstellar medium with momentum and kinetic energy having thus an impact on the star formation rate. They are the progenitors of core collapse events and of the most energetic stellar explosions in the Cosmos, the Gamma Ray Bursts. They give birth to compact objects as neutron stars and black holes.

From what precedes, one can figure out that knowing the evolution of massive stars is not only important for stellar physics, but also for probing the evolution of galaxies and their star formation history along the whole cosmic history. This subject also connects in a particularly strong and direct way the observations of nearby objects with that of far distant galaxies.

In this context, the possibilities that became operative only recently to probe the interior of stars, to constrain the size of their convective cores and the way they rotate in their interiors through asteroseismology, to determine the strength and topology of their surface magnetic fields through spectropolarimetry and to measure their shape and the distribution of their circumstellar environments through interferometry opened new paths for investigating their properties. Associated with other more classical methods, as photometry and/or spectroscopy, these technics will change our understanding of massive star evolution and may show that beside the initial mass and the metallicity, the evolution of massive stars, either single or in close binary systems, may also depend on their axial rotation and on their surface magnetic field.

Although for some of these technics, the application to massive stars is still in its infancy, we thought that it was time to convey astronomers from these different areas in order 1) to investigate how these technics can guide us towards new and innovative solutions to the most topical questions regarding the evolution of massive stars, 2) to allow the participants of different disciplines, and hopefully the readers of these proceedings, to grasp the essential of these observing methods and 3) to stimulate new ideas for using synergies between different observational technics.

At the end of 2012, a letter of intent, followed by a detailed description of the project was sent to IAU. We were very pleased to receive in May 2013 the announcement that our project of Symposium was one of the 9 selected symposia among the 17 proposals. Began then the work of organizing the sessions and selecting the invited reviewers with the SOC.

The present conference conveyed 138 astronomers from 28 countries. The scientific programs consisted in 6 sessions (Challenges in massive star evolution, Asteroseismology, Interferometry, Spectropolarimetry, Synergies between different techniques, and Towards a synthetic view), with 17 review talks, 33 contributed talks, 2 general discussions, and 2 poster sessions. Each session dedicated to one observational technics began with two review talks providing first a simple but rigorous presentation of the principles on which the observations are based and second a discussion of the main results obtained so far. We hope that the readers of these proceedings will take benefit from all these presentations as much as the participants of the symposium. We had also the pleasure to organize an outreach conference given by Coralie Neiner entitled *Le magnétisme stellaire : son rôle sur la vie des étoiles et la nôtre*, which attracted about 100 people.

The present conference belongs to the family of the following recent meetings: the IAU Symposium 272 entitled *Active OB stars: structure, evolution, mass loss, and critical limits*, held in Paris, in July 2010, the IAU Symposium 302 dedicated to *Magnetic fields throughout stellar evolution*, held in August 2013, at Biarritz, France, the conference *Magnetic Fields in the Universe IV: From Laboratory and Stars to the Primordial Structures*, held in February 2013, at Playa del Carmen in Mexico and the conference *Massive Stars: From Alpha to Omega*, held in June 2013, at Rhodes in Greece.

It is a great pleasure to acknowledge the financial support of our sponsors listed on page *xv* of these Proceedings and the active and efficient support of the members of the LOC, in particular Chantal Taçoy and Sylvia Ekström (Department of Astronomy of the Geneva University).

We dedicate these proceeding to our dear friends and colleagues Olivier Chesneau (left picture) and Stan Stefl (right picture), who passed away this year.

Georges Meynet and Phillipe Stee, co-chairs SOC,
Geneva, August 31, 2014

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Address by the Local Organizing Committee

Dear colleagues,

This is a great pleasure to welcome you all here in Geneva and more precisely in Geneva University for this IAU Symposium number 307. Marcel Proust, the famous french author has written: *The true exploration does not consist in discovering new landscapes, but in having new eyes.* This sentence underlines the fact that the capacity to see what is around us with new methods or from a different viewpoint, opens the way to discoveries.

The discovery of the principles of spectroscopy, in the mid of the nineteen century by Bunsen and Kirchoff, well illustrates this sentence. The stars had not changed but the way to look at them was new. Spectroscopy allowed to unveil the nature of stars and their surface composition. This discovery happened about 14 years after Auguste Comte a prominent French philosopher, made one of the worst intellectual predictions regarding the limits of astrophysics. He wrote, about the observations of stars: *All investigations which are not ultimately reducible to simple visual observations are ... necessarily denied to us. While we can conceive of the possibility of determining their motions, we shall never be able by any means to study their chemical composition.* Today, we use spectroscopy to measure chemical abundances, temperatures, velocities, rotations, ionization states, magnetic fields, pressure, turbulence, density, and many other properties of distant planets, stars, and galaxies. Spectroscopy is the richest source of information about the universe. So we have to be cautious in front of unbalanced statements that close for ever a field. We should never forget that new windows can open unexpectedly.

This conference is dedicated to three observational technics that provide new views on stars. The technics which is the nearest from spectroscopy is **spectropolarimetry**. Measuring the polarization of the radiation field allows us to obtain complementary information about astrophysical objects that may remain hidden to the ordinary intensity spectrum. The polarized spectrum, in contrast to intensity, enables us to determine vector quantities, e.g. the magnetic field vector.

Astronomical interferometers can produce higher-resolution astronomical images than any other type of telescope. At radio wavelengths, image resolutions of a few microarcseconds have been obtained, and image resolutions of a fractional milliarcsecond have been achieved at visible and infrared wavelengths. This allows to study the size, the shape and the circumstellar environment of stars, close enough for allowing this technic to be applied.

Asteroseismology provides the tool to find the internal structure of stars. The pulsation frequencies give the information about the density profile of the region where the waves originate and travel. Asteroseismology helps to constrain other characteristics of stars such as mass and radius.

We are here 138 astronomers from 29 countries for understanding a little better how nature is working and how these new windows provide new and complementary guidelines that can sharpen our knowledge. As organizers, we hope that through the talks and discussions, each of us will go back home with new ideas and new eyes to observe the stars.

Georges Meynet, for the LOC
Geneva, 23 June 2014