

Program

August 2, 10:30 – 12:00: Session 1. The FUV and EUV from massive stars

- 10:30 – 10:45: *Organizers* — Welcome
- 10:45 – 11:15: *Andreas Sander* — Massive Stars in the Far and Extreme UV (invited talk)
- 11:15 – 11:30: *Jorick Vink* — X-Shooting ULLYSES (talk)
- 11:30 – 11:45: *Kathryn Grasha* — Non-Solar Scaled Abundances for Massive Stars: The Chemical Abundance Breakthrough for Galaxy Evolution (talk)
- 11:45 – 12:00: *Olivier Verhamme* — Weakening the Winds with the ULLYSES Data Set: Examining the Presence of a Bi-Stability Jump (talk)

August 2, 13:30 – 15:00: Session 2. Binary stars

- 13:30 – 14:00: *Hugues Sana* — Massive Binaries and the UV Connection (invited talk)
- 14:00 – 14:15: *Calum Hawcroft* — New Empirical Mass-Loss Rates and Wind Properties of Massive Stars at Low Metallicity (talk)
- 14:15 – 14:30: *Gautham Narayana Sabhahit* — Mass-Loss Implementation and Temperature Evolution of Very Massive Stars (talk)
- 14:30 – 15:00: *Organizers* — e-Poster presentations (2 minutes each)

August 2, 15:15 – 16:45: Session 3. Very massive stars and very metal-poor stars

- 15:15 – 15:45: *Miriam Garcia* — Very Massive Stars and Very Metal-Poor Stars: Connected Topics? (invited talk)
- 15:45 – 16:00: *Aida Wofford* — Are Very Massive Stars Truly Needed to Explain the Extreme Broad He II Emission of NGC 3125-A1? (talk)
- 16:00 – 16:15: *Grace Telford* — The Ionizing Spectrum of an Extremely Metal-Poor O Star Powering an HII Region (talk)
- 16:15 – 16:30: *Karla Arellano-Cordova* — Modeling the Ionizing Spectrum of Local Star-Forming Galaxies (talk)
- 16:30 – 16:45: *Peter Senchyna* — Direct Constraints on the Massive Stars Underlying Strong High-Ionization Nebular Emission Locally (talk)

August 3, 10:30 – 12:00: Session 4. Massive stars in extragalactic star clusters

- 10:30 – 11:00: *Paul Crowther* — Observations of Massive Stars in Extragalactic Star Clusters (invited talk)
- 11:00 – 11:15: *Dooseok Jung* — Universal Upper Ends of the Stellar Initial Mass Function in the Young and Compact LEGUS clusters (talk)
- 11:15 – 11:30: *Katarzyna Nowak* — Could Kilomasers Pinpoint Supermassive Stars? (talk)
- 11:30 – 11:45: *Mattia Sirressi* — Clues to Massive Star Clusters as Engines of Galaxy Evolution (talk)
- 11:45 – 12:00: *Naira Azatyan* — The Stellar Content of UCHII Regions: The Molecular Cloud GRSMC 045.49+00.04 (talk)

August 3, 13:30 – 15:00: Session 5. Feedback from massive stars in stellar clusters

- 13:30 – 14:00: *Sara Beck* — Stars and Gas in Clusters: Feedback, Efficiency, and Emergence (invited talk)
- 14:00 – 14:15: *Keunho Kim* — How Ionizing Radiation Escapes from Compact Star-Forming Regions in the Sunburst Galaxy (talk)
- 14:15 – 14:30: *Lena Komarova* — Lyman Continuum-Driven Superwind in Green Pea Analog Mrk 71 (talk)
- 14:30 – 14:45: *Michael Rutkowski* — OVI Emission in the Halos of $z \sim 0.25$ Star-Forming Galaxies (talk)
- 14:45 – 15:00: *Varsha Ramachandran* — Massive Star Feedback in the Magellanic Clouds and the Tidal Bridge (talk)

August 3, 15:15 – 16:45: Session 6. Population models for young star clusters

- 15:15 – 15:45: *Gustavo Bruzual* — Modeling Young Star Cluster Populations (invited talk)
- 15:45 – 16:00: *Jaehong Park* — Calibrating Excursion Set Reionization Models to Approximately Conserve Ionizing Photons (talk)
- 16:00 – 16:15: *John Chisholm* — What Lurks Below the Lyman Limit? Unearthing the Unseen Ionizing Continua of Extragalactic Massive Star Populations (talk)
- 16:15 – 16:30: *Kaelee Parker* — Tracing Massive Star Populations with Neutral and Low-Ionization Gas (canceled)
- 16:30 – 16:45: *Organizers* — Closing remarks

e-Poster and e-Talk Session

- *Ali Taani* — Studying the Age of Supergiant Companions in the Magnetized X-ray Binaries (e-poster)
- *Ashkbiz Danehkar* — UV Diagnostics of Radiatively Cooling Superwinds in Super Star Clusters (e-poster)
- *Bolivia Cuevas Otahola* — Revisiting the Cluster Initial Mass Function of a sample of super star clusters in the disk of M82 (e-talk)
- *Claus Leitherer* — A New Probe of Dust Attenuation in Star-Forming Galaxies (e-poster)
- *Danielle Berg* — Bridging Galaxy Evolution Across Cosmic Time With the CLASSY Survey (e-poster)
- *Gustavo Bruzual* — A New Demarcation Line in the BPT Diagram From Optical and Infrared Line Emission Ratios (e-poster)
- *Hee-Weon Yi* — On the properties of six cores in the λ Orionis cloud (e-poster)
- *Miora Rakototafika* — Investigating the Properties of Star Cluster Complexes in the Collisional Ring Galaxy Arp 147 (e-poster)
- *Riley Owens* — Toward Analysis of UV Integrated Spectra with a Full Spectrum Fitting Tool (e-poster)
- *Riley Owens* — Spatially Variable Ly α Line Profiles and Environments in a Strong LyC Leaking Galaxy (e-poster)
- *Sally Oey* — Nebular C IV Imaging of Mrk 71 with HST (e-poster)
- *Sang-Hyun Chun* — Metallicity-Dependent Mixing Length in the Evolutionary Model from Red Supergiant Stars in IC 1613 (e-poster)
- *Suhyeon Choe* — On the connection between the O32 ratio and LyC escape from simulated star-forming clouds (e-poster)

Focus Meeting 4: UV Insights to Massive Stars and Young Stellar Clusters

Executive Summary

This Focus Meeting brought together astronomers who study resolved massive stars, the integrated light of stellar clusters, and their effects on their host galaxies, combining state-of-the-art rest-frame UV spectra and photometric observations with models. This meeting had a significant interdisciplinary component, focusing on the interplay between massive stars and their host galaxies (e.g. the consequences of environment on the formation and evolution of massive stars and clusters, and their subsequent feedback in terms of ionizing photon production, mass-loss due to winds, and properties of the ISM). The topics and the timing of the meeting were largely driven by the data release of the HST ULLYSES and CLASSY surveys. The former is a complete spectroscopic UV survey of individual massive, metal-poor stars in the Local Group, and the latter provides integrated high-resolution UV spectra of young massive star clusters in the nearby universe.

Scientific Highlights

An important characteristic of massive stars (MSs) is that they spend most of their lives as hot stars. Consequently, their peak flux falls in the UV, drive strong winds, and emit a significant number of ionizing photons. However, the details of these processes are still far from resolved. Atmosphere models have been improving to take into account millions of lines from iron and other elements that yield a complex line-blanketing effect. Thus, the SED of a hot, massive star often deviates significantly from a black body. As an extension, J. Vink discussed developments in line-driven wind theory and the need for UV-to-IR spectroscopy to optimally extract key observables. To address this issue, the public XShootU project is complementing the UV massive star observations conducted by the STScI directors' discretionary program ULLYSES with high-resolution optical-near IR spectra using the VLT/XSHOOTER spectrograph. Additionally, this rich dataset has allowed exploration of the "bi-stability jump" (a theoretical increase in mass loss rates of low-luminosity MSs at $T_{\text{eff}} = 20,000$ K). However, recent radiation-driven mass-loss models show no bi-stability jump; O. Verhamme confirmed this prediction with empirical results from ULLYSES: stellar mass loss seems to decrease with stellar luminosity/temperature. Stellar wind models have also become more sophisticated with the addition of optically thick clumping, as presented by C. Hawcroft. This work suggests that half of the wind velocity field is covered by clumps 25x denser than the average wind. Finally, H. Sana showed that accurate stellar wind characterization is needed to properly constrain the CNO abundances used to trace single and binary star evolution.

MSs also provide the ionizing flux budgets of galaxies, but determining accurate models of their spectral energy distributions (SEDs) remains challenging. A. Sanders showed that high T_{eff} and thin winds are necessary to produce the HeII ionizing photons seen in extreme spectra, but Karla Arellano-Córdova showed no stellar population synthesis (SPS) models could produce sufficient ionizing photons to reproduce the high-ionization emission lines observed in the low-metallicity galaxies in the CLASSY sample. Metallicity may be a key solution: K. Grasha showed that non-solar abundance patterns in young SPS models leads to ionizing photon output differences of up to 2 dex and G. Telford

demonstrated that extremely metal-poor ($< 10\% Z_{\odot}$) O stars seem to be rotating faster than expected, resulting in increased ionizing photon production.

Our ability to determine an ionizing flux budget also depends on our ability to characterize the stellar clusters. Mattia Sirressi used LEGUS observations to show that, for clusters older than 5 Myr, photometric and spectroscopic ages are similar, but for clusters older than 5 Myr, degeneracies in photometric models result in older ages.

A key test of ionizing photon production has long been H ϵ emission. G. Bruzual presented updated SPS models that include Wolf Rayet stars and are able to better reproduce observed broad H ϵ profiles, while A. Wofford showed that broad H ϵ emission in NGC 3152 could originate in the winds of Very Massive Stars (VMS; $>100 M_{\odot}$). G. Sabahit presented the first physically motivated models of VMSs, finding that at $M > 200 M_{\odot}$, VMSs undergo chemically-homogeneous evolution on the main sequence. Further, M. Garcia showed observations of OB stars in Sextans A that suggest that VMSs may be more common in metal-poor galaxies. P. Senchyna showed that 4-8 M_{\odot} stripped stars can also be observed in nearby galaxies to be powerful ionizers. But J. Chisholm showed that the total number of ionizing photons sensitively depends on the stellar astrophysics assumed, and studies attempting to determine the production of ionizing photons must account for the large impact of stellar astrophysics on the production of ionizing photons.

Environment can also have a large effect on massive stars. Using observations of the Sunburst Arc, K. Kim showed that highly-ionized, compact, star-forming regions with little dust promote the escape of ionizing photons. From spatially-resolved IFU emission line observations of Mrk 71, L. Komarova found that high-velocity, power-law wings may be a distinctive signature of radiation-driven winds and indicative of LyC escape. However, environment does not seem to impact the initial mass function: D. Jung examined young stellar clusters from the LEGUS survey and found that the upper end of the IMF shows no dependence on cluster mass, suggesting that the maximum stellar mass that can be produced in star clusters is universal.

Demographics

Invited Speakers: Sara Beck (F), Gustavo Bruzual (M), Paul Crowther (M), Miriam García (F), Hugues Sana (M), Andreas Sander (M). Six total, two female, four male. All six original invitees accepted.

Session Chairs: Yumi Choi (F), Richard de Grijs (M), Bruce Elmegreen (M), Andrea Mehner (F), Themiyá Nanayakkara (M), Monica Rubio (F). Six total, three female, three male.

Contributed Talks: Karla Arellano (F), Naira Azatyan (F), John Chisholm (M), Kathryn Grasha (F), Calum Hawcroft (M), Dooseok Jung (M), Keunho Kim (M), Lena Komarova (F), Katarzyna Nowak (F), Jaehong Park (M), Varsha Ramachandran (F), Michael Rutkowski (M), Gautham Sabhahit (M), Peter Senchyna (M), Mattia Sirressi (M), Grace Telford (F), Olivier Verhamme (M), Jorick Vink (M), Aida Wofford (F). 19 total, 8 female, 11 male.