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The Lives and Death-Throes of Massive Stars

Edited by

J.J. Eldridge
John C. Bray
Liam A.S. McClelland
Lin Xiao

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THE LIVES AND DEATH-THROES
OF MASSIVE STARS

IAU SYMPOSIUM 329

COVER ILLUSTRATION: R136 in the 30 Doradus Nebula in the LMC.

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Chief Editor
PIERO BENVENUTI, IAU General Secretary
IAU-UAI Secretariat
98-bis Blvd Arago
F-75014 Paris
France
iau-general.secretary@iap.fr

Editor
MARIA TERESA LAGO, IAU Assistant General Secretary
Universidade do Porto
Centro de Astrofísica
Rua das Estrelas
4150-762 Porto
Portugal
mtlago@astro.up.pt

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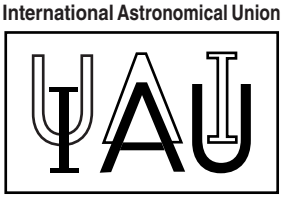

THE LIVES AND DEATH-THROES OF MASSIVE STARS

PROCEEDINGS OF THE 329th SYMPOSIUM OF THE INTERNATIONAL ASTRONOMICAL UNION HELD IN AUCKLAND, NEW ZEALAND NOVEMBER 28–DECEMBER 2, 2016

Edited by

J.J. ELDRIDGE
Department of Physics, University of Auckland

JOHN C. BRAY
Department of Physics, University of Auckland

LIAM A.S. McCLELLAND
Department of Physics, University of Auckland

and

LIN XIAO
Department of Physics, University of Auckland

CAMBRIDGE UNIVERSITY PRESS

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Table of Contents

https://doi.org/10.1017/S1743921317003623 Published online by Cambridge University Press

Session 3: Observations and surveys of massive stars: hot stars, cool stars, transition objects and binaries

https://doi.org/10.1017/S1743921317003623 Published online by Cambridge University Press

Session 4: Theory of stellar evolution & atmospheres: beyond standard physics, rotation, duplicity, mass loss and magnetic fields and instabilities

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Session 5: Massive stars and their supernovae as galactic building blocks and engines: Milky Way, nearby galaxies and the early Universe

Session 6: Conference Summary

Splinter Session: X-ray observations of massive stars

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Posters

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Preface

Research on Massive Stars is undergoing a period of rapid progress. While these stars are relatively few in number they are the main driver of chemical and dynamical evolution in galaxies via their stellar winds and explosive deaths in core-collapse supernovae. Our understanding of massive stars is going through a remarkable time of change with long held convictions being shown to be incomplete. This evidence arises from new research concerning the formation and evolution of massive stars and linking this to their deaths in core-collapse supernovae. Now is a fortuitous time to make significant advances in massive star research. This meeting was proposed with the central rationale to bring together the two communities that study massive stars and their supernovae.

The impact of massive stars is widely recognized. They are used as tools to interpret the conditions and processes arising in different environments (studies of Galactic structure, chemical and dynamical feedback, population synthesis, Starbursts, high-z galaxies and cosmic reionization). In parallel, the development of new instrumentation, analysis techniques and dedicated surveys across all possible wavelengths have delivered large amounts of exquisite new data. This data is now providing a harsh test for the current state-of-the-art theoretical calculations of massive star birth, evolution and death.

We are beginning to gain some measure of success understanding how complex phenomena such as magnetic fields, pulsations, rotation, mergers and multiplicity act within massive stars. This enables us to revolutionize our understanding of short-lived and enigmatic phases such as seen in Wolf-Rayet stars, Red Supergiants, the Luminous Blue Variables and B-Supergiants. But at the same time, mysteries persist surrounding these phases and the supernovae produced by these stars. For example there is growing evidence that all these stars, except the Wolf-Rayet stars, give rise to supernovae.

Finally, while we know individual stars are important, the impact of massive star populations via their evolution and death, including the influence of X-ray and gamma-ray binaries, is of high interest to those studying the high-z Universe. Locating the source of photons needed to reionize the early Universe remains unsolved. Uncertainties in our understanding of massive star populations impacts our interpretation of galaxies at the edge of the observable Universe and how the Universe became transparent.

In view of recent developments and the significant impact massive stars have in the broader community, a new IAU Symposium in late 2016 was proposed. The meeting summarized recent progress and established stronger links between the massive star community and closely-linked fields, particularly those studying end stages of massive star evolution and massive star cosmic implications.

The massive star community has traditionally held IAU Symposia with a frequency of 4-5 years (Argentina, 1971; Canada, 1978; Mexico, 1981; Greece, 1985; Indonesia, 1990; Italy, 1994; Mexico, 1998; Spain, 2002; USA, 2007). More recently, a last meeting was held in Greece in June 2013, without IAU sponsorship, but with great success (225 participants from 27 countries). Seeking for a long-term geographical balance, the IAU MSWG selected New Zealand as location for this meeting among a total of seven proposals. We hoped that the selection of this venue will allow greater participation by countries in the Asia and Pacific area.

The meeting covered 4 broad areas related to massive stars and included one splinter session. The topics were:

(*a*) Massive stars deaths in core-collapse supernova and other events.
(*b*) Observations of massive stars.
(*c*) Theoretical modelling of massive stars.

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(*d*) Massive stars as building blocks of galaxies through the history of the Universe.
(*e*) Splinter session: X-ray observations of massive stars

During the week the linkage between these sessions was strong with several talks being able to be placed in any session. This reflects the growing collaborative nature of the study of massive stars. Formal discussion during the week was kept to a minimum. However long breaks were worked into the schedule to encourage informal discussion during the week. This was also further encouraged by setting the room up in a cabaret style with round tables rather than the normal lecture room format. Thus allowing people to form round table discussion groups. There was an extended discussion on Thursday run by Nathan Smith and Jose Groh concerning the best observations to test our theoretical models. In some ways bringing together all the topics of the week so far.

In addition to IAU sponsorship for travel grants it was also sponsored by the Department of Physics from the University of Auckland as well as CAASTRO (ARC Centre of Excellence for all-sky astrophysics). We also acknowledge the work of the LOC in organizing all the numerous details required to make such a symposium a success. In particular we thank Aimee Crawshaw for her tireless effort and dedication to making sure the meeting was a success.

There were two conference excursions, one to the Auckland Domain museum in Auckland the other a trip to Rangitoto island. A volcano in the bay of Auckland that erupted some 600 to 800 years ago. Surprisingly (to the tour organizer) 150 of the attendees went on the latter trip. Many enjoyed the race to the summit, exploring the lava caves afterwards and investigating a Kiwi bach (holiday home). The tour operator who organized the trips also made themselves available during the week to answer questions from attendees to plan their future travel in New Zealand after the conference. On the day after the meeting several conference attendees contributed to a public symposium. Where the highlights of the meeting were discussed along with varied subjects from ancient astronomy, the structure of the Galaxy and science-fiction comic books.

At the end of the meeting and afterwards we received great positive feedback on our organization of the meeting with the worst points being around trouble with the AV systems. Students and early-career researcher seems to be those who enjoyed the meeting the most and we hope that many productive collaborations will arise due to the meeting.

J.J. Eldridge, Margaret Hanson and Artemio Herrero, co-chairs SOC.

Equity Report

We are also particularly proud that our meeting from the onset worked hard to achieve an equitable meeting. Key to this was setting up an balanced SOC with 7 men, 7 women and 1 person of diverse gender. Also in selecting invited and contributed abstracts members were reminded to think about achieving an equitable balance at the meeting our efforts appeared to pay off. We also had the impression that the population of junior scientists, students and post-docs, was higher than usual at an international conference. 21% of the talks were given by PhD students with two-thirds of these being women. This was another indication of our positive approach.

For all talks 68% were by men and 32% by women. This was representative of the number of abstracts submitted and similar to the balance of attendees (Men 68.5%, Women 30.9%, Diverse 0.6%). The first day we were able to achieve equity with the ratio at 48% to 52%. We list the relevant equity statistics below in two tables.

The meeting also had a code of conduct to make the meeting spaces safe, inclusive and free of harassment. In the shortest form it said,

> *NZstars2016 is dedicated to providing an equitable and harassment-free conference experience for everyone regardless of gender, gender identity and expression, sexual orientation, disability, physical appearance, body size, race, age or religion. We do not tolerate harassment of conference participants in any form. Conference participants violating these rules may be sanctioned at the discretion of the conference organizers*

A reporting proceeding was explained on the first day as well as identifying those on the "equity committee" who were responsible for enforcing the code. The experiment worked well but in future we recommend that the process to deal with breaches of the code be outlined before the meeting.

We also recorded further equity information such as the gender of those who asked questions. We are still analyzing this data but of the 160 questions asked 74% were asked by men, 17% were asked by women and 9% by asked by people of diverse gender. We should note that in all the above statistics we are using the presumed gender. We only know of one gender diverse person who attended and asked those questions.

Our treatment of equity at the meeting also went beyond the talks and discussion. During the conference dinner for example we worked hard to provide entertainment that did not appropriate local culture and continue the safe inclusive environment. The result of this was to use a conference quiz (based on the "pub quiz" format common in the UK, Australia and New Zealand).

Finally we note that the aim of future meetings should build upon the work of the IAUS329 organizing committees to make future meetings more inclusive and equitable. We summarize our list of recommendations for future meetings as follows:

(*a*) Have an equity committee which at least is balanced in gender with representatives from all career stages.

(*b*) Publicize consequences of breaking the code of conduct in advance and have a clear process for dealing with issues.

(*c*) From the outset select and task the SOC from the onset with creating a speaker list that is diverse in terms of gender, race, nationality, and career stage.

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(*d*) Ask participants for their gender and other demographic information at registration so that these can be analyzed as much as possible without assumptions.

(*e*) Take steps to encourage more people to ask questions. For example, highlight that asking questions is a skill to practice. Or have prizes for first student question.

Group	Number by assumed gender (F/M/D)	Fraction in % by assumed gender (F/M/D)
SOC	7:7:1	47%:47%:6%
LOC	3:2:1	50%:33%:17%
EC	2:2:1	40%:40%:20%
Invited speakers	7:21:0	25%:75%:0%
Contributed speakers	16:27:0	37%:63$:0%
Splinter session speakers	2:6:0	25%:75%:0%
Student prizes	4:0:0	100%:0%:0%
Chairs	6:2:1	67%:22%:11%
Question askers	27:119:14	17%:74%:9%
Participants	55:122:1	30.9%:68.5%:0.6%
Submitted abstracts	81:168:1	32%:67%:0.4%

Country	Number of Attendees
Argentina	1
Australia	4
Austria	3
Belgium	5
Brazil	3
Bulgaria	1
Canada	8
Chile	13
China	2
Czech Republic	4
Finland	1
France	5
Georgia	2
Germany	15
Ireland	1
Israel	1
Japan	11
Malaysia	1
Mexico	4
New Zealand	10
Russia	1
South Korea	2
Spain	13
Sweden	1
Switzerland	2
Taiwan (R.O.C.)	1
The Netherlands	3
UK	17
U.S.A.	43

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THE ORGANIZING COMMITTEE

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Local

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J.J. Eldridge (chair)
N. Rodrigues
J.C. Bray
L.A.S. McClelland
L. Xiao

Equity

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J.L. Hoffman
L.A.S. McClelland
M. Hanson
P. Massey
L. Xiao

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The Local Organizing Committee operated under the auspices of the Department of Physics, University of Auckland.

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Department of Physics, University of Auckland,
ARC Centre of Excellence for All-Sky Astrophysics (CAASTRO),
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CONFERENCE PHOTOGRAPH

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Participants

Michael **Abdul-Masih**, Institute Of Astrophysics, Ku Leuven, Belgium — mabdul02@villanova.edu
Claudia **Agliozzo**, Departamento De Ciencias Fisicas, Universidad Andres Bello, Chile — c.agliozzo@gmail.com
Robert **Andrassy**, Physics and Astronomy, University of Victoria, British Columbia, Canada — andrassy@uvic.ca
Jennifer **Andrews**, Astronomy, University Of Arizona, United States — jandrews@as.arizona.edu
Ignacio **Araya**, Instituto De Física Y Astronomía, Universidad De Valparaíso, Valparaíso, Chile — ignacio.araya@uv.cl
Catalina **Arcos**, Instituto De Física Y Astronomía, Universidad De Valparaíso, Chile — catalina.arcos@uv.cl
Kyle **Augustson**, CEA-Irfu Service D'astrophysique, France — kyle.augustson@cea.fr
Dietrich **Baade**, European Southern Observatory, Germany — dbaade@eso.org
Rodolfo **Barba**, Departamento De Fisica Y Astronomia, Universidad De La Serena, Chile — rbarba@userena.cl
Christopher **Bard**, NASA, Maryland, United States — christopher.bard@nasa.gov
Emma **Beasor**, Astrophysics Research Institute, Liverpool John Moores University, United Kingdom — e.beasor@2010.ljmu.ac.uk
Chris **Benton**, Auckland Astronomical Society, New Zealand — cbenton@xtra.co.nz
Sopia **Beradze**, Abastumani Astrophisical Observatory, Illia State University, Georgia — sopia.beradze.1@iliauni.edu.ge
Melina Cecilia **Bersten**, Astronomy, Ialp-fcaglp, Argentina, Argentina — mbersten@fcaglp.unlp.edu.ar
Federica **Bianco**, New York University, New York, United States — fbianco@nyu.edu
John **Bray**, Physics, University Of Auckland, New Zealand — john.bray@auckland.ac.nz
Fabio **Bresolin**, University Of Hawaii, Hawaii, United States — bresolin@ifa.hawaii.edu
Aaron **Brocklebank**, Jeremiah Horrocks Institute, University Of Central Lancashire, United Kingdom — ajbrocklebank1@uclan.ac.uk
Bram **Buysschaert**, LESIA - Paris Observatory, France — bram.buysschaert@obspm.fr
Saida **Caballero-Nieves**, Physics & Astronomy Department, University Of Sheffield, United Kingdon — saida.caballero@gmail.com
Inés **Camacho**, IAC, Tenerife, Spain — icamacho@iac.es
Matteo **Cantiello**, Kavli Institute For Theoretical Physics, Uc Santa Barbara, California, United States — matteo@kitp.ucsb.edu
Alex **Carciofi**, IAG, Universidade de São Paulo, Sp, Brazil — carciofi@usp.br
Luiz Paulo **Carneiro Gama**, Universität-Sternwarte München / LMU, Germany — luuizpaulo@gmail.com
Heon-young **Chang**, Department of Atmospheric Sciences And Astronomy, Kyungpook National University, South Korea — hyc@knu.ac.kr
Emmanouil **Chatzopoulos**, Physics & Astronomy, Lousiana State University, Louisiana, United States — chatzopoulos@phys.lsu.edu
Andre-nicolas **Chene**, Aura Inc. - Gemini Observatory, Hawaii, United States — achene@gemini.edu
Grant **Christie**, Auckland Observatory, New Zealand — grant@christie.org.nz
Sang-Hyun **Chun**, Department Of Physics And Astronomy, Seoul National University, Seoul, South Korea — shyunc.m@gmail.com
Wonseok **Chun**, Seoul National University, South Korea — wonseok@astro.snu.ac.kr
Benoit **Cote**, University Of Victoria (Canada) / Michigan State University (USA), Quebec, Canada — bcote@uvic.ca
Andrea **Cristini**, Faculty Of Natural Sciences, Astrophysics, Keele University, Staffordshire, United Kingdom — a.j.cristini@keele.ac.uk
Paul **Crowther**, Dept Physics & Astronomy, University of Sheffield, S. Yorkshire, United Kingdom — Paul.crowther@sheffield.ac.uk
Michel **Cure**, Instituto de Fisica y Astronomia, Universidad de Valparaiso, Chile, Chile — michel.cure@uv.cl
Simon **Daley-yates**, Astrophysics & Space Research Group, University Of Birmingham, West Midlands, United Kingdom — sdaley@star.sr.bham.ac.uk
Augusto **Damineli**, Astronomy Dept, IAG, University of Sao Paulo, SP, Brazil — augusto.damineli@gmail.com
Alexandre **David-uraz**, Department of Physics & Space Sciences, Florida Institute Of Technology, Florida, United States — adaviduraz@fit.edu
Ben **Davies**, Astrophysics Research Institute, Liverpool John Moores University, United Kingdom — b.davies@ljmu.ac.uk
Antonio **De Ugarte Postigo**, Iaa-csic, Granada, Spain — adeugartepostigo@gmail.com
Trevor **Dorn-Wallenstein**, Astronomy Department, University Of Washington, Washington, United States — tzdw@uw.edu
Maria **Drout**, Carnegie Observatories, California, United States — mdrout@carnegiescience.edu
JJ **Eldridge**, Physics, University Of Auckland, Auckland, New Zealand — j.eldridge@auckland.ac.nz
Christiana **Erba**, Department of Physics & Astronomy, University Of Delaware, Delaware, United States — cerba@udel.edu
Thomas **Ertl**, Max Planck Institute For Astrophysics, Germany — tertl@mpa-garching.mpg.de
Celia Rosa **Fierro**, Laboratory of Applied Mathematics & Computing of High Perfomance Abacus, Cinvestav, Mexico — celia.fierro.estrellas@gmail.com
Corinne **Fletcher**, Florida Institute Of Technology, Florida, United States — cfletcher2013@my.fit.edu
Morgan **Fraser**, School of Physics, University College Dublin, Dublin, Ireland — mf@ast.cam.ac.uk
Kotaro **Fujisawa**, Advanced Research Institute For Science And Engineering, Waseda University, Japan — fujisawa@heap.phys.waseda.ac.jp
Jim **Fuller**, Astronomy, Caltech, California, United States — jfuller@caltech.edu
Gantcho **Gantchev**, Department of Astronomy, Physics Faculty, University of Sofia, Bulgaria — pgantcho@yahoo.fr
Kristen **Garofali**, University of Washington, Washington, United States — kgarofali@gmail.com
Cyril **Georgy**, Department of Astronomy, Genenva University, Switzerland — cyril.georgy@unige.ch
Douglas **Gies**, Center for High Angular Resolution Astronomy, Georgia State University, Georgia, United States — gies@chara.gsu.edu
Avishai **Gilkis**, Physics, Technion, Israel — agilkis@technion.ac.il
Ylva **Goetberg**, Anton Pannekoek Institute for Astronomy, University of Amsterdam, North Holland, Netherlands — y.l.l.gotberg@uva.nl
Víctor **Gómez-González**, Astrophysics, Instituto Nacional De Astrofísica, Óptica Y Electrónica, Puebla, Mexico — mau.gglez@gmail.com
Michael **Gordon**, Minnesota Institute for Astrophysics, Minnesota, United States — gordon@astro.umn.edu
Alex **Gormaz-matamala**, Instituto De Física y Astronomía, Universidad De Valparaíso, Chile — alex.gormaz@postgrado.uv.cl

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Eric **Gosset**, Institut D'astrophysique - STAR, Université De Liège, Belgium, Belgium — gosset@astro.ulg.ac.be
Götz **Gräfener**, University of Bonn, Germany — ggraefener@gmail.com
Jose **Groh**, Trinity College Dublin, Ireland — jose.groh@tcd.ie
Sergei **Gulyaev**, Institute for Radio Astronomy & Space Research, New Zealand — sergei.gulyaev@aut.ac.nz
Diah Y.A. Setia **Gunawan**, Universidad de Valparaíso, Valparaíso, Chile — diah.gunawan@uv.cl
Rainer **Hainich**, Institute of Physics & Astronomy, University of Potsdam, Germany — rhainich@astro.physik.uni-potsdam.de
Kenji **Hamaguchi**, NASA/GSFC & UMBC, Maryland, United States — Kenji.Hamaguchi@nasa.gov
Wolf-Rainer **Hamann**, Institut Für Physik Und Astronomie, Universität Potsdam, Germany — wrh@astro.physik.uni-potsdam.de
Margaret **Hanson**, Department of Physics, University Of Cincinnati, Ohio, United States — margaret.hanson@uc.edu
Xavier **Haubois**, European Southern Observatory, Chile — xhaubois@eso.org
Gerhard **Hensler**, Dept. of Astrophysics, University of Vienna, Austria — gerhard.hensler@univie.ac.at
Artemio **Herrero**, Instituto De Astrofisica De Canarias, Spain — ahd@iac.es
Anthony **Hervé**, Academy of Science of Czech Republic, Czech Republic — herve@asu.cas.cz
Erin **Higgins**, Armagh Observatory, United Kingdom — eh@arm.ac.uk
D. John **Hillier**, Department of Physics & Astronomy, University Of Pittsburgh, Pennsylvania, United States — hillier@pitt.edu
Jennifer L. **Hoffman**, Physics & Astronomy, University of Denver, Colorado, United States — jennifer.hoffman@du.edu
Gonzalo **Holgado Alijo**, Instituto De Astrofisica De Canarias, Instituto De Astrofisica De Canarias, Spain — gholgado@iac.es
Leah **Huk**, Physics & Astronomy, University Of Denver, Tennessee, United States — Leah.Huk@gmail.com
Delphine **Hypolite**, CEA, France — delphine.hypolite@cea.fr
Natalia **Ivanova**, Physics, University of Alberta, Alberta, Canada — nata.ivanova@ualberta.ca
Hans-Thomas **Janka**, Max Planck Institute for Astrophysics, Germany — thj@mpa-garching.mpg.de
Yan-Fei **Jiang**, Kavli Institute for Theoretical Physics, University Of California, Santa Barbara, Ca - California, United States — yanfei@kitp.ucsb.edu
Stephen **Justham**, University of the Chinese Academy of Sciences & NAOC, China — sjustham@ucas.ac.cn
Lex **Kaper**, Astronomical Institute Anton Pannekoek, University of Amsterdam, Netherlands — L.Kaper@uva.nl
Chinami **Kato**, Waseda University, Japan — chinami@heap.phys.waseda.ac.jp
Dylan **Kee**, Institute of Astronomy & Astrophysics, University of Tübingen, Germany — nathaniel-dylan.kee@uni-tuebingen.de
Zsolt **Keszthelyi**, Royal Military College Of Canada, Ontario, Canada — zsolt.keszthelyi@rmc.ca
Megan **Kiminki**, Dept. of Astronomy / Steward Observatory, University of Arizona, Arizona, United States — mbagley@email.arizona.edu
Robert **Klement**, Astronomical Insitute, Charles University, Czech Republic — robertklement@gmail.com
Nino **Kochiashvili**, Abastumani Astrophysical Observatory, Ilia State University, Georgia — nino.kochiashvili@iliauni.edu.ge
Erik **Kool**, Physics And Astronomy, Macquarie University / AAO, NSW, Australia — erik.kool@students.mq.edu.au
Peter **Kretschmar**, European Space Agency, Madrid, Spain — peter.kretschmar@esa.int
Jiri **Krticka**, Masaryk University, Czech Republic — krticka@physics.muni.cz
Jonathan **Labadie-bartz**, Lehigh University, Pennsylvania, United States — jml612@lehigh.edu
Ryan **Lau**, Caltech/JPL, California, United States — ryanlau@caltech.edu
Claus **Leitherer**, Space Telescope Science Institute, Maryland, United States — leitherer@stsci.edu
Maurice **Leutenegger**, X-ray Astrophysics, NASA/GSFC/CRESST/UMBC, Maryland, United States — maurice.a.leutenegger@nasa.gov
Emily **Levesque**, University of Washington, Washington, United States — emsque@uw.edu
Jamie **Lomax**, Department of Astronomy, University of Washington, Washington, United States — jrlomax@uw.edu
Thomas **Madura**, Department of Physics & Astronomy, San Jose State University, California, United States — thomas.madura@sjsu.edu
Jesús **Maíz Apellániz**, Centro de Astrobiología, CSIC-INTA, Madrid, Spain — jmaiz@cab.inta-csic.es
Grigoris **Maravelias**, Astronomical Institute, Czech Academy Of Sciences, Greece — maravelias@asu.cas.cz
Anthony **Marston**, ESA, STScI, Maryland, United States — tmarston@sciops.esa.int
Philip **Massey**, Lowell Observatory, Arizona, United States — phil.massey@lowell.edu
Seppo **Mattila**, Department of Physics & Astronomy, University of Turku, Finland — sepmat@utu.fi
Liam **McClelland**, Department of Physics, University Of Auckland, New Zealand — liam.mcclelland@auckland.ac.nz
Andrea **Mehner**, ESO Chile, Chile — amehner@eso.org
Tobias **Melson**, Max-Planck-Institute for Astrophysics, Germany — melson@mpa-garching.mpg.de
Athira **Menon**, Monash University, VIC, Australia — athira.menon@monash.edu
Maria **Messineo**, Dep. Astronomy, Univ. Science and Technology Of China, China, China — messineo@ustc.edu.cn
Georges **Meynet**, Astronomy, Geneva University, Geneva, Switzerland — georges.meynet@unige.ch
Takashi **Moriya**, Division of Theoretical Astronomy, National Astronomical Observatory of Japan, Japan — takashi.moriya@nao.ac.jp
Bernhard **Mueller**, Astrophysics Research Centre, Queen's University Belfast, United Kingdom — b.mueller@qub.ac.uk
Melissa **Munoz**, Queen's University, Ontario, Canada — munoz@astro.umontreal.ca
Jeremiah **Murphy**, Florida State University, Florida, United States — jeremiah@physics.fsu.edu
Francisco **Najarro**, Cab Csic-inta, Spain — najarro@cab.inta-csic.es
Ko **Nakamura**, Faculty of Science and Engineering, Waseda University, Japan — nakamura.ko@heap.phys.waseda.ac.jp
Makoto **Narita**, National Institute of Technology, Okinawa College, Japan — narita@okinawa-ct.ac.jp
Tim **Natusch**, Institute for Radio Astronomy & Space Research, Aut University, New Zealand — tim.natusch@aut.ac.nz
Yael **Naze**, University of Liege, Belgium — naze@astro.ulg.ac.be
Ignacio **Negueruela**, Universidad De Alicante, Alicante, Spain — ignacio.negueruela@ua.es
Kathryn **Neugent**, Lowell Observatory, Arizona, United States — kathrynneugent@gmail.com
Maria-Fernanda **Nieva**, Institute for Astro- & Particle Physics, University Of Innsbruck, Austria — maria-fernanda.nieva@uibk.ac.at
Kenichi **Nomoto**, Kavli Institute for the Physics & Mathematics of the Universe (Kavli IPMU), The University of Tokyo, Japan — nomoto@astron.s.u-tokyo.ac.jp

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Takaya **Nozawa**, National Astronomical Observatory of Japan, Tokyo, Japan takaya.nozawa@nao.ac.jp
Keiichi **Ohnaka**, Universidad Catolica Del Norte, Instituto de Astronomia, Chile k1.ohnaka@gmail.com
Atsuo **Okazaki**, Hokkai-Gakuen University, Japan okazaki@lst.hokkai-s-u.ac.jp
Mary **Oksala**, California Lutheran University, California, United States meo@udel.edu
Lidia **Oskinova**, Institute for Physics & Astronomy, University Of Potsdam, Germany lida@astro.physik.uni-potsdam.de
Stanley **Owocki**, Department of Physics & Astronomy, University Of Delaware, Delaware, United States owocki@udel.edu
Herbert **Pablo**, University of Montreal, Quebec, Canada hpablo@astro.umontreal.ca
Manfred **Pakull**, Strasbourg University, Observatoire Astronomique de Strasbourg, France manfred.pakull@astro.unistra.fr
Veronique **Petit**, Department of Physics & Space Sciences, Florida Institute Of Technology, Florida, United States vpetit@fit.edu
Philipp **Podsiadlowski**, Physics, University Of Oxford, UK, United Kingdom podsi@astro.ox.ac.uk
Konstantin **Postnov**, Sternberg Astronomical Institute, Russian Federation kpostnov@gmail.com
Vincent **Prat**, DRF/IRFU/SAp, CEA, France vincent.prat@cea.fr
Joachim **Puls**, University Observatory, Ludwig-Maximilians-Universitaet Munich, Germany uh101aw@usm.uni-muenchen.de
Alan **Rainot**, Institute of Astrophysics, Ku Leuven, Belgium alan.rainot@kuleuven.be
Sebastián **Ramírez Alegría**, Universidad de Valparaíso / MAS, Chile sebastian.ramirez@uv.cl
Oscar Hernan **Ramirez-Agudelo**, UK Astronomy Technology Centre, STFC, United Kingdom oscar.ramirez@stfc.ac.uk
María C. **Ramírez-Tannus**, Anton Pannekoek Institute, North Holland, Netherlands m.c.ramireztannus@uva.nl
Thomas **Rivinius**, European Southern Observatory Chile, Chile triviniu@eso.org
Nicole **Rodrigues**, Department of Physics, University Of Auckland, New Zealand, New Zealand nrdo653@aucklanduni.ac.nz
Sara **Rodriguez Berlanas**, Instituto de Astrofisica De Canarias, Tenerife, Spain srberlan@iac.es
Eliceth Yaneire **Rojas Montes**, Armagh Observatory, Armagh, United Kingdom erm@arm.ac.uk
Margarita **Rosado**, Instituto de Astronomia, UNAM, margarit@astro.unam.mx
Marcelo **Rubinho**, IAG / Departamento de Astronomia, Universidade de São Paulo, São Paulo, Brazil esteemeuemail@gmail.com
Maria Del Mar **Rubio Diez**, Centro De Astrobiología (csic-inta), Spain mmrd@cab.inta-csic.es
Christopher **Russell**, X-ray Astrophysics Laboratory, NASA Goddard Space Flight Center, Maryland, United States crussell@udel.edu
Stuart **Ryder**, International Telescopes Support Office, Australian Astronomical Observatory, NSW, Australia sdr@aao.gov.au
Carolina **Sabin-Sanjulian**, Universidad De La Serena, Chile cssj@dfuls.cl
Hugues **Sana**, Institute of Astrophysics, KU Leuven, Belgium hugues.sana@kuleuven.be
Andreas **Sander**, Institute for Physics & Astronomy, University Of Potsdam, Germany ansander@astro.physik.uni-potsdam.de
Norbert S. **Schulz**, Kavli Institute for Astrophysics & Space Research, Massachusetts Institute Of Technology, Massachusetts, United States nss@space.mit.edu
Peter **Scicluna**, Institute of Astronomy & Astrophysics, Academia Sinica, Taiwan peterscicluna@asiaa.sinica.edu.tw
Tomer **Shenar**, Astrophysik I, University of Potsdam, Germany shtomer@astro.physik.uni-potsdam.de
Isaac **Shivvers**, Astronomy Department, University Of California, Berkeley, California, United States ishivvers@berkeley.edu
Susan **Shoebridge**, Auckland Astronomical Society, New Zealand susan@polarconsult.co.nz
Matthew **Shultz**, Astronomy, Uppsala University, Ontario, Canada matt.shultz@gmail.com
Sergio **Simon-diaz**, Instituto De Astrofisica De Canarias, La Laguna, Tenerife, Spain ssimon@iac.es
Linda **Smith**, Space Telescope Science Institute, European Space Agency, Maryland, United States lsmith@stsci.edu
Nathan **Smith**, Astronomy, University of Arizona, Arizona, United States nathans@as.arizona.edu
Elizabeth **Stanway**, Department of Physics, Universirty Of Warwick, United Kingdom e.r.stanway@warwick.ac.uk
Heloise **Stevance**, Physics & Astronomy, University Of Sheffield, United Kingdom fstevance1@sheffield.ac.uk
Ian **Stevens**, School of Physics & Astronomy, University Of Birmingham, United Kingdom irs@star.sr.bham.ac.uk
Nicole **St-louis**, Département de Physique, Université De Montréal, Canada stlouis@astro.umontreal.ca
Yasuharu **Sugawara**, ISAS/JAXA, Kanagawa, Japan sugawara.yasuharu@jaxa.jp
Alexander **Summa**, Max Planck Institute For Astrophysics, Bavaria, Germany asumma@mpa-garching.mpg.de
Katie **Tehrani**, Physics & Astronomy, University of Sheffield, South Yorkshire, United Kingdom k.tehrani@sheffield.ac.uk
Christina **Thöne**, HETH, IAA-CSIC, Spain cthoene@iaa.es
Alexey **Tolstov**, Kavli IPMU, The University of Tokyo, Japan alexey.tolstov@ipmu.jp
Frank **Tramper**, European Space Astronomy Centre, European Space Agency, Madrid, Spain ftramper@sciops.esa.int
Asif **ud-Doula**, Penn State Worthington Scranton, Pennsylvania, United States auu4@psu.edu
Miguel A. **Urbaneja**, Institute for Astro & Particle Physics, University Of Innsbruck, Austria Miguel.Urbaneja-Perez@uibk.ac.at
Jorick **Vink**, Armagh Obsevatory & Planetarium, Armagh Obsevatory And Planetarium, Northern Ireland, United Kingdom jsv@arm.ac.uk
Gregg **Wade**, Department of Physics, Royal Military College Of Canada, Ontario, Canada marmottecam@yahoo.ca
Michael **Wegner**, University Observatory Munich, Germany wegner@usm.lmu.de
Lin **Xiao**, University of Auckland, New Zealand lin.xiao@auckland.ac.nz
Yu **Yamamoto**, Applied Physics, Waseda University, Shinjuku-ku, Japan yamamoto@heap.phys.waseda.ac.jp
Sung Chul **Yoon**, Physics & Astronomy, Seoul National University, South Korea yoon@astro.snu.ac.kr
Norhasliza **Yusof**, Department of Physics, Faculty Of Science, University Of Malaya, Malaysia norhaslizay@um.edu.my
Janos **Zsargo**, Department of Physics & Mathematics, ESFM-IPN, Mexico City, Mexico jzsargo@esfm.ipn.mx

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