

IAU Symposium

350

14–19 April 2019
Cambridge, United Kingdom

Proceedings of the International Astronomical Union

Laboratory Astrophysics: From Observations to Interpretation

Edited by

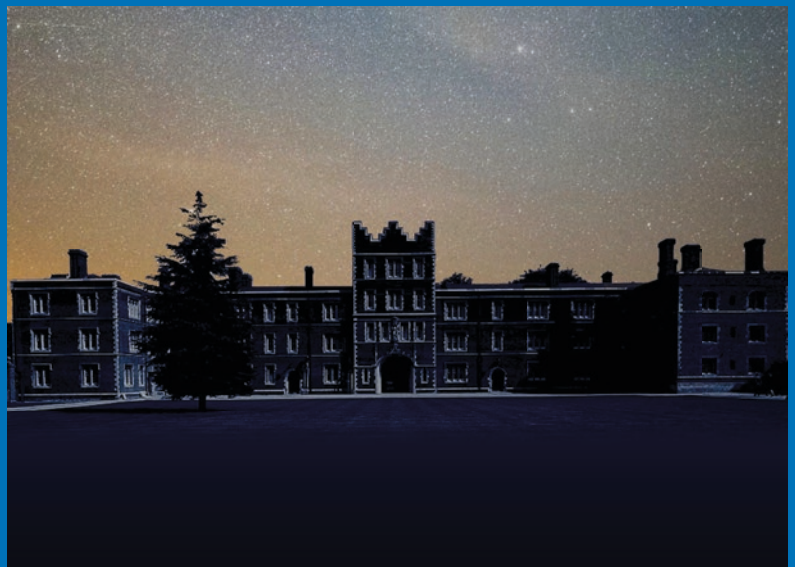
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ISSN 1743-9213

International Astronomical Union



CAMBRIDGE
UNIVERSITY PRESS



LABORATORY ASTROPHYSICS:
FROM OBSERVATIONS TO INTERPRETATION

IAU SYMPOSIUM 350

COVER ILLUSTRATION:

Night sky above Jesus College, Cambridge where the symposium was held (adapted from the Conference poster designed by: D. Benoit, A. Dawes, E. Sciamma-O'Brien, H. Fraser).

http://www.astrochemistry.org.uk/IAU_S350/poster/

IAU SYMPOSIUM PROCEEDINGS SERIES

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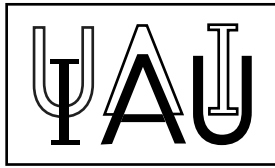
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INTERNATIONAL ASTRONOMICAL UNION
UNION ASTRONOMIQUE INTERNATIONALE

International Astronomical Union



LABORATORY ASTROPHYSICS:
FROM OBSERVATIONS TO
INTERPRETATION

PROCEEDINGS OF THE 350th SYMPOSIUM OF
THE INTERNATIONAL ASTRONOMICAL UNION
HELD IN CAMBRIDGE, UNITED KINGDOM
14–19 APRIL, 2019

Edited by

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CAMBRIDGE UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom
1 Liberty Plaza, Floor 20, New York, NY 10006, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

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First published 2020

Printed in Great Britain by Bell & Bain Ltd, Glasgow

Typeset in System L^AT_EX 2 ϵ

*A catalogue record for this book is available from the British Library Library of Congress
Cataloguing in Publication data*

This journal issue has been printed on FSCTM-certified paper and cover board. FSC is an
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ISBN 9781108482479 hardback
ISSN 1743-9213

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Preface

IAU Symposium 350, “Laboratory Astrophysics: From observations to Interpretation” was held 14–19th April 2019 in Cambridge, UK. This symposium was organized by the IAU Laboratory Astrophysics Commission, B5, and was the *first* topical symposium on Laboratory Astrophysics sponsored by the IAU marking a historical and significant milestone for this research field.

The essential role played by laboratory astrophysics in support of astronomy has long been recognized. Laboratory astrophysics is the Rosetta stone that enables astronomers to understand and interpret the cosmos. Astronomy is primarily an observational science detecting photons generated by atomic, molecular, chemical, and condensed matter processes. Our understanding of the underlying physics and chemistry governing the evolution of the Universe relies on knowledge of the evolution of matter (nuclear and particle physics), of the dynamical processes shaping it (plasma physics) and of the reactions that can take place under the exotic conditions that govern chemistry in space (atomic and molecular physics). Planetary science, involving *in-situ* measurements of solar system bodies, requires knowledge from physics, chemistry, and geology. Exploring the question of life elsewhere in the Universe draws on all the above as well as biology. Hence, our quest to understand the cosmos rests firmly on theoretical and experimental research in many different branches of science. Taken together, these astrophysically motivated theoretical and experimental studies are known as *Laboratory Astrophysics*. Laboratory astrophysics provides the tools to interpret and to guide astronomical observations and delivers the numbers needed to quantitatively model the processes taking place in space; it offers a bridge between observers and modelers. The advent of new space, airborne and ground-based telescopes have largely motivated the tenure of this Symposium.

The active synergy between astronomical observation, laboratory experiment and theoretical modeling has been reinforced at the 2015 IAU General Assembly by the creation of a new IAU Commission (Commission B5) on Laboratory Astrophysics to address the multidisciplinary needs and requirements of modern astronomy and planetary science across the international astronomy community. The creation of the new commission was timely with Astronomy witnessing a new and exciting era of discovery with the advent of new powerful telescopes (e.g., ALMA) and the imminent launch of the James Webb Space Telescope (JWST) in 2021 as well as the construction of the Extremely Large Telescope (EELT), which all promise to push the frontiers of science. It also resulted from the increased recognition of the Astronomy community that advances in Astronomy are not solely the domain of the observational astronomer but rely heavily on the diagnostics and expertise provided by the wider physics and chemistry communities whether through detector development, spectroscopy, models or studies of astrophysical processes.

Recognizing the important progress of this initiative, the new Commission proposed to build on this momentum and organize a symposium dedicated to bridging laboratory astrophysics and astronomy by bringing together active researchers in observational astronomy, space missions, experimental and theoretical laboratory astrophysics and astrochemistry to discuss the major topics and challenges that face today’s Astronomy. The main objective, successfully fulfilled throughout the Symposium as illustrated in this Volume of Proceedings, was that interactions between researchers will result in a solid roadmap for future research that will lead to advances in our understanding of astronomical observations and guide the design of future observational instruments. At the same time, this interdisciplinary meeting provided a stimulus to the many young researchers that entered the field in the last few years as well as opportunities for emerging communities at an international level.

Active researchers in observational astronomy, space missions, experimental and theoretical laboratory astrophysics and astrochemistry were invited to gather and discuss the major topics and challenges that face today's Astronomy.

The meeting was organized along different themes, encompassing a wide variety of different laboratory astrophysical methodologies and linked to state-of-the-art astronomical research. Contributions covered the role of laboratory astrophysics towards the interpretation and understanding as well as the guiding and planning of observations at astronomical flagship facilities. In parallel, observational astronomers presented lectures indicating which data are currently needed for their data interpretation.

The scientific discussions were divided between five major topics that spanned from star- and planet-formation through stellar populations to extragalactic chemistry and dark matter, complemented by chemistry and physics reaching from fundamental atomic and molecular spectroscopy, through surface reaction dynamics, catalysis, nuclear processes and high energy physics, including fundamental processes in some of the most extreme environments we can imagine. Each topic was covered through three thematic areas, laboratory studies, astronomical observations, and theory and modeling encompassing the breadth and the pluridisciplinarity of the field of Laboratory Astrophysics.

The Astronomy Topics covered in the symposium were:

- Star formation and the cosmic matter cycle in the near universe
- Solar System formation and the pre-solar nebula
- Protoplanetary disks, debris disks and solar system
- Stars, stellar populations, and stellar explosions
- Reaching beyond our galaxy: from extra galactic chemistry to dark matter.

In addition to the five astronomy topics, topics of general interest to the field were covered:

- Laboratory techniques: Spectroscopy, imaging, mass spectrometry, plasma, numerical simulations
- Databases
- Education and Public Outreach (EPO)

To aid the discussion, the Scientific Organizing Committee (SOC) identified a total of 31 invited speakers who presented 1 Plenary, 11 Review, and 19 Invited talks. The Scientific Organizing Committee (SOC) reviewed and ranked all submitted abstracts and selected a further 38 contributed oral presentations, taking into account scientific impact, gender, geographical distribution and stage of career. The plenary talk was allocated 40 mins, the reviews 30 mins and the invited oral contributions 15 mins, including discussion time. Moreover 83 poster presentations were accepted. In total, 167 individuals from 27 countries spanning all continents (see attached list of participants) attended with the UK, France and Germany registering the highest numbers of participants. The Symposium had a high gender diversity with close to 39% female participants. Individual sessions were chaired by members of the Scientific Organizing Committee (SOC) and other senior attendees whilst a variety of PDRAs and PhD students supported the logistics throughout the sessions.

The 83 posters were divided into three sessions on Monday, Tuesday and Thursday, lasting 90, 90 and 60 mins, respectively. A small group awarded prizes for the best poster presentations to two individuals, Frederik Doctor Skødt Simonsen and Sascha Zeegers. The two winners were offered 15 minutes each to orally present the winning poster.

Two sessions on public outreach were held with Kimberley Ennico (NASA Ames, USA) and Helen Fraser (Open Univ., UK) who discussed "Dust, Ice and Water" and "How to

Build a Planet in the Lab”, respectively. Sabrina Goertner organized a lively and very popular education outreach event for school children on the afternoon of Wednesday, April 17.

Ewine van Dishoeck (IAU President, Leiden, NL) made a special presentation on the 100 Years of the IAU and the associated events that are being held yearlong to celebrate this important event for astronomy. She also made a presentation on ‘Women in Astronomy’, summarizing the results of the recent IAU survey. She encouraged participants to contact her with any ideas on how the IAU could grow the number of its female members.

On the fourth day, Farid Salama (Chair) moderated a Round Table discussion on *The Future of Laboratory Astrophysics* and the role of IAU Commission B5 to discuss how the commission can best support the laboratory astrophysics community. The central issues discussed were what can the Commission do (within its mandate) and how can it serve as a bridge between local/national laboratory astrophysics communities and help the exchange experiences and approaches. Prefilled questions from the audience were also discussed. The panel included representatives of the IAU Laboratory Astrophysics Commission (Commission B5), NASA Space Mission Directorate (SMD), The Laboratory Astrophysics Division of the American Astronomical Society (AAS/LAD), Europlanet Society, The Programme National de Physique et Chimie du Milieu Interstellaire (PCMI CNRS), The European Conference on Laboratory Astrophysics (ECLA) and a few national programs from Africa/ME/Egypt, China, Japan, and the Netherlands.

In addition to the scientific sessions, the attendees enjoyed a welcome reception on Sunday 14 April and a series of social activities that included punting and walking tours, a visit of the Ely Cathedral and a guided tour of the Mullard Radio Astronomy Tour facility on the afternoon of Wednesday 17 April. The conference gala dinner was held at the Jesus College on Thursday 18 April, after which the Scientific Organizing Committee’s Chair, Farid Salama, opened the ceremony and introduced the distinguished guest speakers of the evening, Peter Sarre (Univ. Nottingham); Chris Lintott (Oxford Univ.) and Paul Woods (Editor Nature Astronomy) who gave after-dinner speeches on laboratory astrophysics and presented prizes to the poster competition winners. The banquet ceremony ended with Farid Salama giving tokens of the SOC’s appreciation to the Local Organizing Committee (LOC) members who have done an outstanding work that largely contributed to the success of the meeting.

The organizers would like to thank a number of institutions for providing organizational and financial support: in particular, the IAU for the award of travel grants to 32 participants (22 male and 10 female), some 19 nationalities based in 20 countries; NASA; OU; PCMI; PPN; Europlanet, ESA and the IoP among others.

The Local Organizing Committee, which was ably chaired by Helen Fraser, who brought her organizational skills to this key role, comprised of David Benoit, Rebecca Coster (administrative support), Anita Dawes, Sabrina Gaertner (Outreach), Dwayne Heard, Sergio Ioppolo, Nigel Mason, Anthony J. Meijer (Web-master), Jennifer Noble, Juliet Pickering, Paul Rimmer, Farid Salama, Ella Sciamma-O’Brien, Catherine Walsh, Mark Wyatt, Giulio Del-Zanna. They performed their duties both before and during the Symposium in a highly effective manner and the fact that the Symposium ran so smoothly is a testament to their professional approach and to the fact that many of the LOC remained on site throughout the duration of the meeting to ensure attendees had a stress-free, enjoyable experience.

Farid Salama, SOC Chair, was greatly aided in his duties by the other members of the Scientific organizing committee, SOC: Paul Barklem, Sweden, Helen Fraser, UK,

Thomas Henning, Germany, Christine Joblin, France, Sun Kwok, China, Harold Linnartz, the Netherlands, Lyudmila Mashonkina, Russia, Tom Millar, UK, Osama Shalabiea, Egypt, Gianfranco Vidali, USA, Feilu Wang, China, Giulio Del-Zanna, UK.

In conclusion, IAU Symposium 350 was envisioned as the first in a series of a ~ 5 -year cycle of IAU symposia. The high and encouraging success that was encountered by the Symposium is a testimony to the energy of the emerging field of Laboratory Astrophysics and the key role it will undoubtedly play in this new and exciting era of discovery that awaits astronomy with the advent of new powerful telescopes and the launch of new space missions, which all promise to push the frontiers of science.

Farid Salama (NASA Ames Research Center, USA)

Harold Linnartz (Leiden Observatory, NL)

Editors

23 February 2020

Editors

Farid Salama
NASA Ames Research Center, USA

Harold Linnartz
Leiden Observatory, the Netherlands

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Helen Fraser	Open University, UK
Thomas Henning	MPI Heidelberg, Germany
Christine Joblin	University of Toulouse, France
Sun Kwok	University of Hongkong, China
Harold Linnartz	Leiden University, the Netherlands
Lyudmila Mashonkina	RAS, Russian Federation
Tom Millar	Queen's University Belfast, UK
Osama Shalabiea	Cairo University, Egypt
Gianfranco Vidali	Syracuse University, USA
Feilu Wang	NAO, China
Giulio Del-Zanna	University of Cambridge, UK

Local Organizing Committee (LOC)

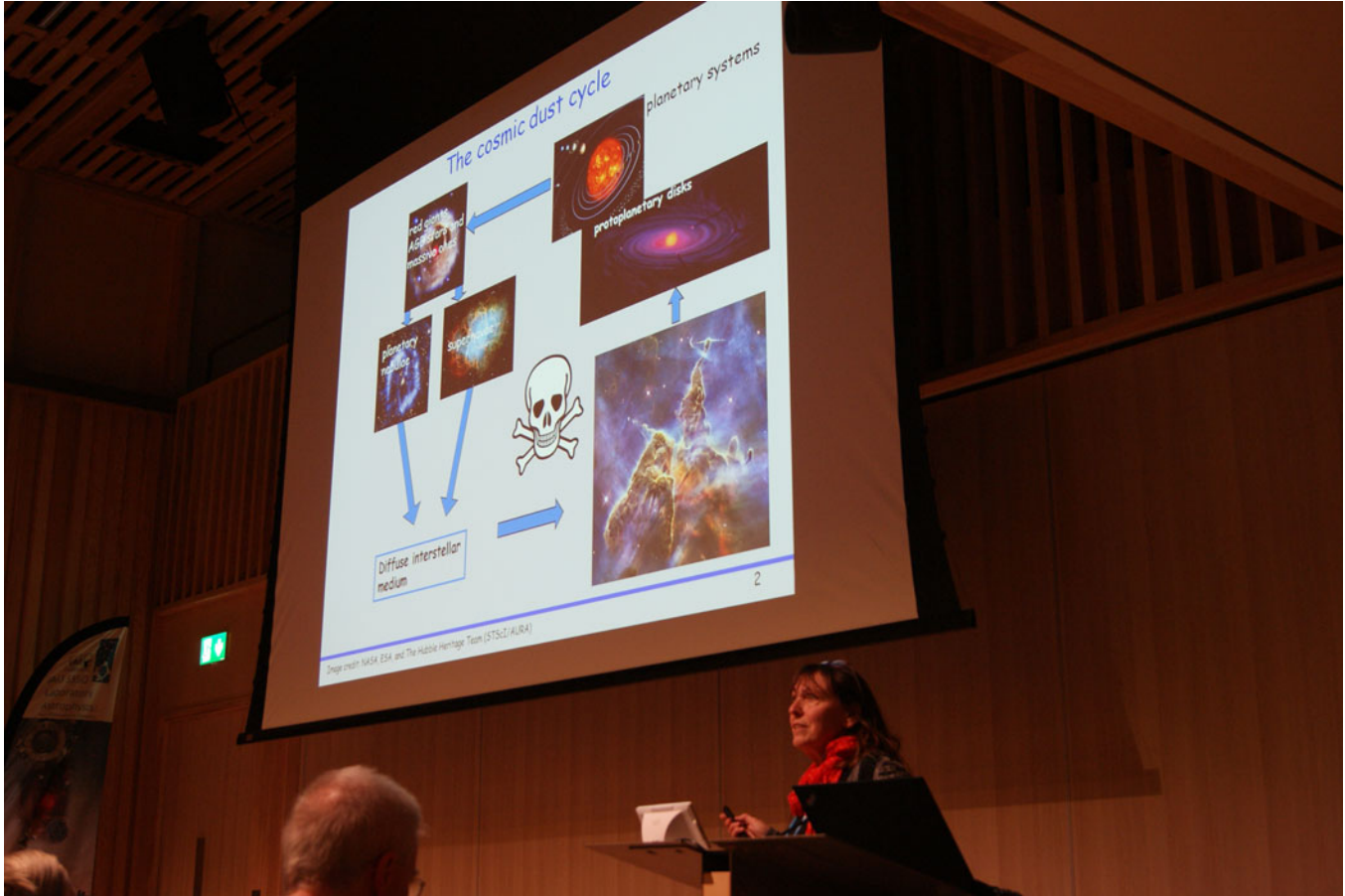
Helen Fraser (Chair)	Open University
David Benoit	University of Hull
Wendy Brown	University of Sussex
Rebecca Coster (admin support)	Open University
Anita Dawes	Open University
Sabrina Gaertner (Outreach)	STFC/RAL
Dwayne Heard	University of Leeds
Sergio Ioppolo	Queen Mary University
Nigel Mason	Open University
Martin McCoustra	Herriot-Watt University
Anthony Meijer (Webmaster)	University of Sheffield
Jennifer Noble	University of Marseille
Juliet Pickering	Imperial College London
Paul Rimmer	University of Cambridge
Farid Salama	NASA/ARC
Ella Sciamma-O'Brien	NASA/ARC
Catherine Walsh	University of Leeds
Mark Wyatt	University of Cambridge
Giulio Del-Zanna	University of Cambridge



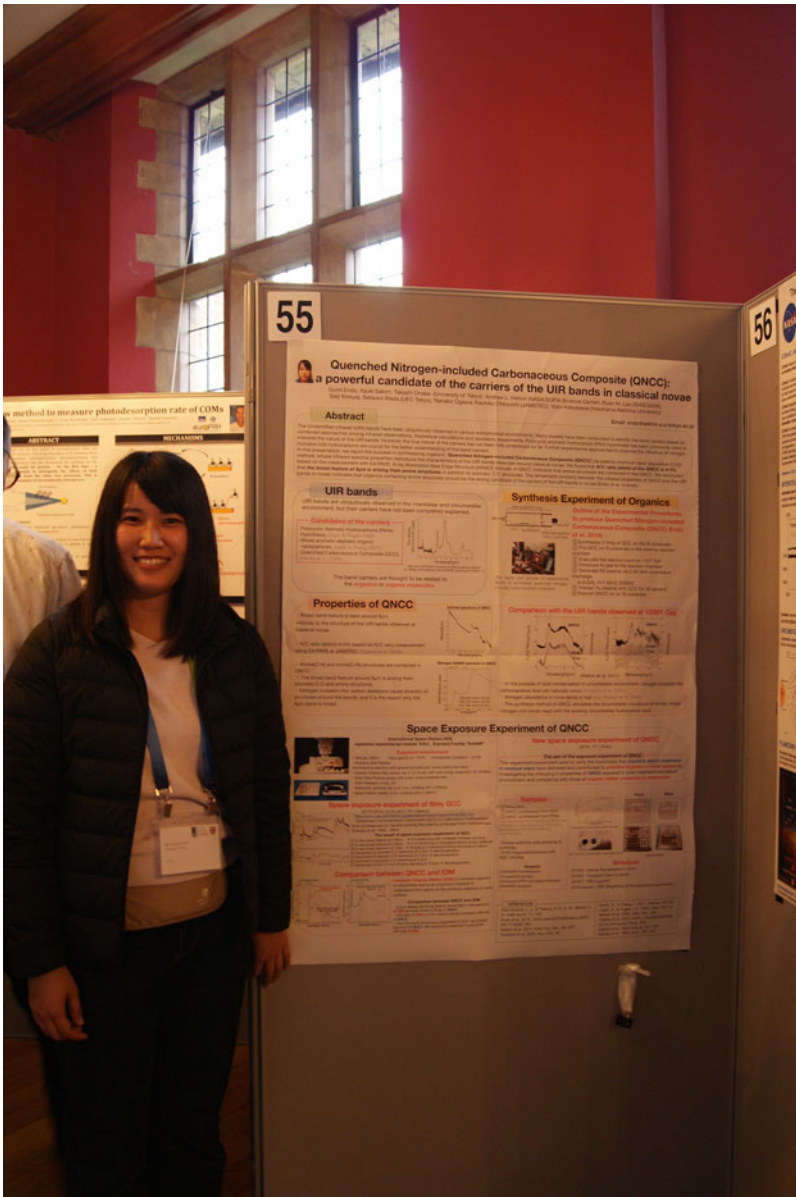
Farid Salama, SOC (NASA Ames, USA), left and Helen Fraser, LOC (Open Univ., UK), right



Olivier Berné (IRAP/CNRS, France)



Cornelia Jäger (MPI/Univ. Jena, Germany)



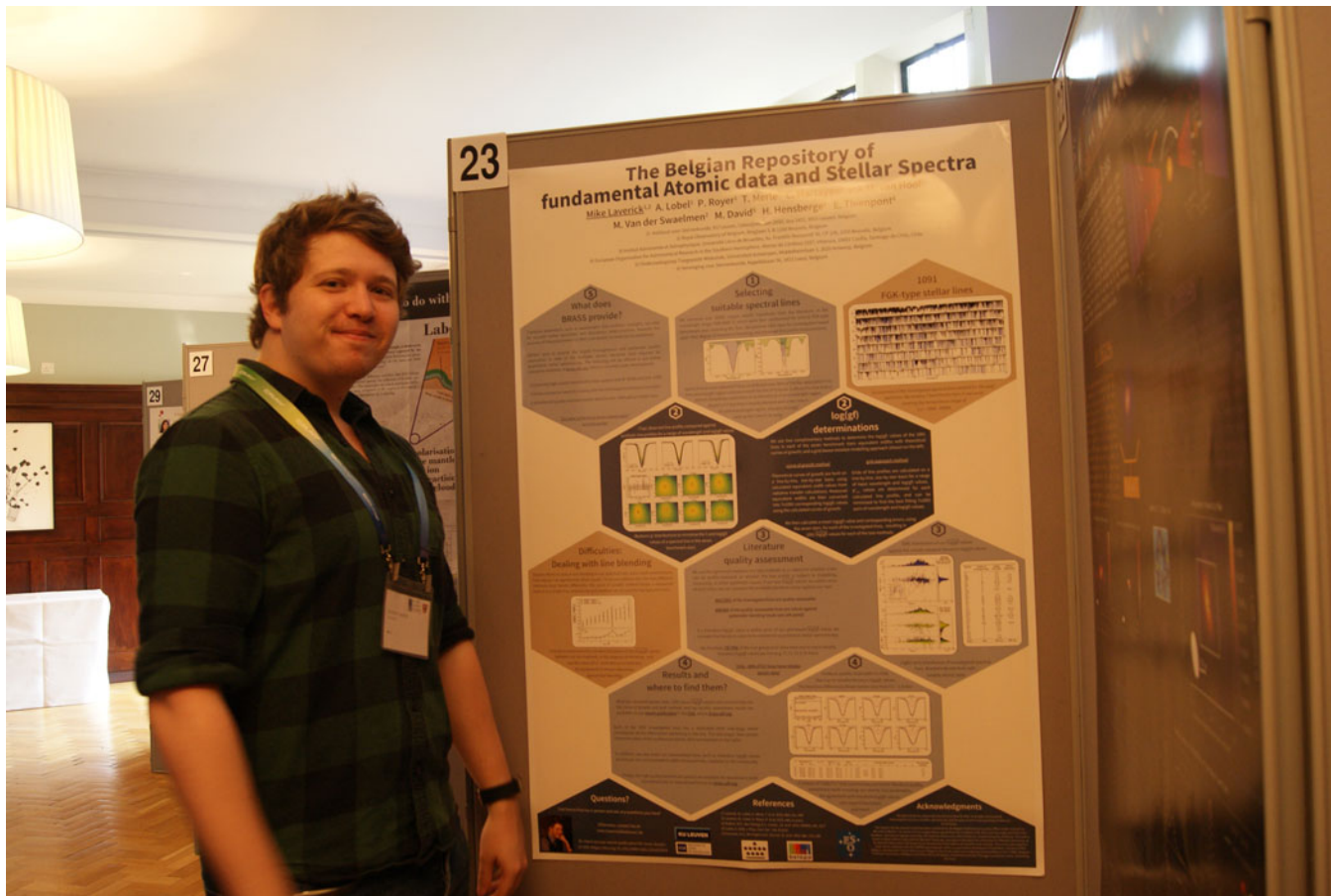
Izumi Indo (Univ. Tokyo, Japan)



Ewine van Dishoeck (Leiden Observatory, the Netherlands)



Zainab Awad (Cairo Univ., Egypt), left and Dwayne Heard (Univ. Leeds, UK), right



Mike Laverick (KU Leuven, Belgium)



Anita Dawes (Open Univ., UK), left and Maria Elisabetta Palumbo (INAF, Italy), right



The participants of the Symposium are enjoying Lunch



Group picture of the participants of IAU Symposium 350

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