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The Intriguing Life of Massive Galaxies

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Daniel Thomas

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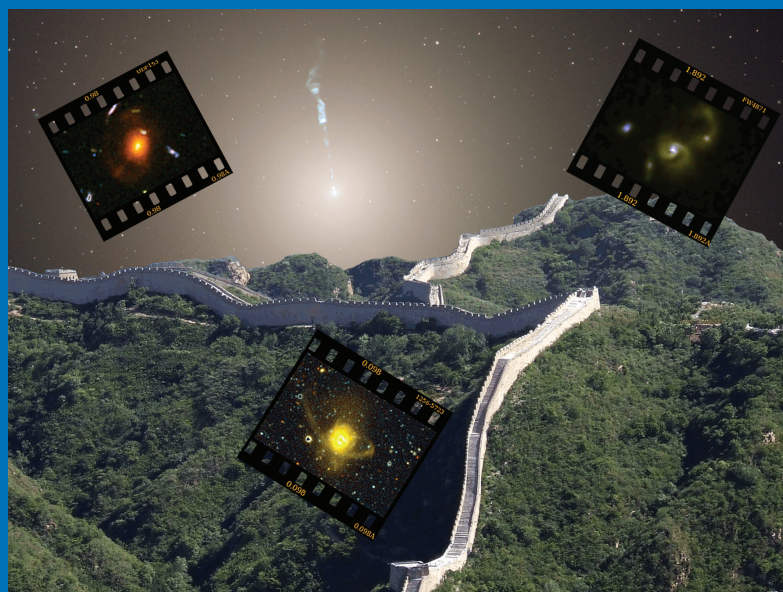
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THE INTRIGUING LIFE OF MASSIVE GALAXIES

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COVER ILLUSTRATION: CONFERENCE POSTER

The cover picture is the official conference poster of the IAUS295. It shows a reproduction of the Great Wall in China, meant to symbolise the path of life of galaxies. The background image is a picture of the elliptical galaxy M87 (Courtesy NASA/ESA and the Hubble Heritage Team). The movie cut outs show galaxy mergers that form key events in the evolution of galaxies.

The picture illustrates the aim of the symposium to discuss the lives of massive galaxies in the real time direction from the highest redshifts to the local Universe both from an observational and theoretical perspective.

The life of a massive galaxy is like walking along the Great Wall. It is an exhausting up and down. You get squeezed and squashed in the beginning just like in a massive galaxy's early life, which is full of mergers and violent star formation. But suddenly, after only a few billion years this phase is over, and the massive galaxy begins to evolve passively without further major perturbations. Just like on the Great Wall, when the dense crowd of tourists thins out the more you walk along.

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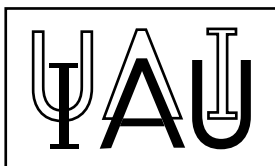
THIERRY MONTMERLE, IAU General Secretary
*Institut d'Astrophysique de Paris,
98bis, Bd Arago, 75014 Paris, France
montmerle@iap.fr*

Editor

PIERO BENVENUTI, IAU Assistant General Secretary
*University of Padua, Dept of Physics and Astronomy,
Vicolo dell'Osservatorio, 3, 35122 Padova, Italy
piro.benvenuti@unipd.it*

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THE INTRIGUING LIFE OF MASSIVE GALAXIES

PROCEEDINGS OF THE 295th SYMPOSIUM
OF THE INTERNATIONAL ASTRONOMICAL
UNION HELD IN BEIJING, CHINA
AUGUST 27–31, 2012

Edited by

DANIEL THOMAS

University of Portsmouth, UK

ANNA PASQUALI

University of Heidelberg, GERMANY

and

IGNACIO FERRERAS

University College London, UK



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Preface

Massive galaxies live an exciting and eventful life. Most of them are “dead” by today and their morphology is typical of early-type galaxies. But they might have looked very different in the past. While their predecessors in the very early Universe might well have been small, they must have soon become massive, vigorously star forming objects. Just shortly after this violent phase, possibly triggered by galaxy mergers, star formation in massive galaxies got quenched, followed by a long phase of passive evolution. Following their genealogical/merger tree, they get quenched and rejuvenated, they get strangulated, they starve, they cannibalise their smaller neighbours and merge with their peers. Massive galaxies are responsible for most of the chemical enrichment in the Universe, and many eventually end their lives clustered together. The most amazing fact about massive galaxies is that they constitute, today, a surprisingly homogeneous class of objects. Today’s massive galaxies are almost featureless with elliptical morphology, they have little or no gas, and show no signs of significant star formation activity, while their cores are often characterised by surprisingly complex kinematics.

We know little about the significance of transitions in the formation and evolution of massive galaxies. Clearly, star formation activity needs to be quenched somewhere along the evolutionary path of a galaxy and its progenitors. But what is the physical mechanism of this quenching? What are the relative roles of feedback from supernovae and super-massive black holes? Where does the environment and galaxy mergers come in? Does cold accretion at high redshift solve the problem by boosting the formation of stars in massive galaxies? Each of these scenarios have their successes and pitfalls in shaping massive galaxies along their travels through cosmic time. Do we need a combination of these? Or remains the true mechanism yet to be discovered?

The observational key lies in detailed studies of both the fossil record in the population of today’s massive galaxies and galaxy properties as a function of redshift. However, the further we get back in time with our observations, the more we have to worry about the link to the present galaxy population, a problem known as the progenitor bias. In a cold dark matter dominated Universe we expect galaxies to evolve along a merger tree throughout their life, that fans out as soon as we go back in time. We coin terms for galaxy populations mostly by the selection criteria we use to observe them at any given epoch. We still do not know how well EROs, DRGs, or heavily star forming galaxies such as SCUBA sources qualify as the progenitors of today’s massive galaxies. The evolution of which objects do we actually trace when we climb up the redshift ladder? What galaxies do we need to pick if we want to trace the life of a massive galaxy? When did today’s massive galaxies assemble? The major challenge for observations of galaxies at high redshift is exactly to establish this link to the local galaxy population that we ultimately want to understand.

If we want to understand the intriguing life of massive galaxies, we need to map their entire evolution over cosmic time, and this requires very different observational and theoretical approaches. However, the links between the various research groups that study different evolutionary stages of massive galaxies at different redshifts are loose. After the overwhelming progress in observational and theoretical studies of galaxy evolution over the past decade, the time was ripe to bring these communities together, both theorists and observers. Recent and near-future advances in telescope technology and computer power for large-scale simulations, as well as the launch of massive galaxy surveys will lead to a further leap in our understanding of galaxy formation. Revolutionary new observatories such as the James Webb Space Telescope or the next generation of

ground-based Extremely Large Telescopes are within reach, and it was exciting to discuss both theoretical predictions and expected advances in observational astronomy.

The IAUS 295 has brought together observers and theorists to discuss recent progress in the field and to plan ahead for future challenges. The symposium covered the life of massive galaxies from the formation of the first galaxies in the early Universe, through their evolution with redshift to massive galaxies in the local Universe touching upon all kinds of issues relates to the life of massive galaxies including gas accretion and star formation, feedback and quenching, black hole growth, mass assembly, galaxy mergers and interactions, chemical enrichment and stellar populations, dark matter, galaxy environment, galaxy haloes, and satellite accretion both from a theoretical and observational perspective.

We believe that the excellent presentations and lively discussions at the symposium have shed light on the intriguing life of massive galaxies. We hope that these proceedings will provide a useful summary of the many topics discussed at the meeting. We are very grateful to all participants for their contributions, in particular to those who have contributed to this book.

*Daniel Thomas, Anna Pasquali, and Ignacio Ferreras, co-chairs SOC,
Portsmouth (UK), Heidelberg (Germany), London (UK), April 18, 2013*

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An attentive audience at the IAUS 295.



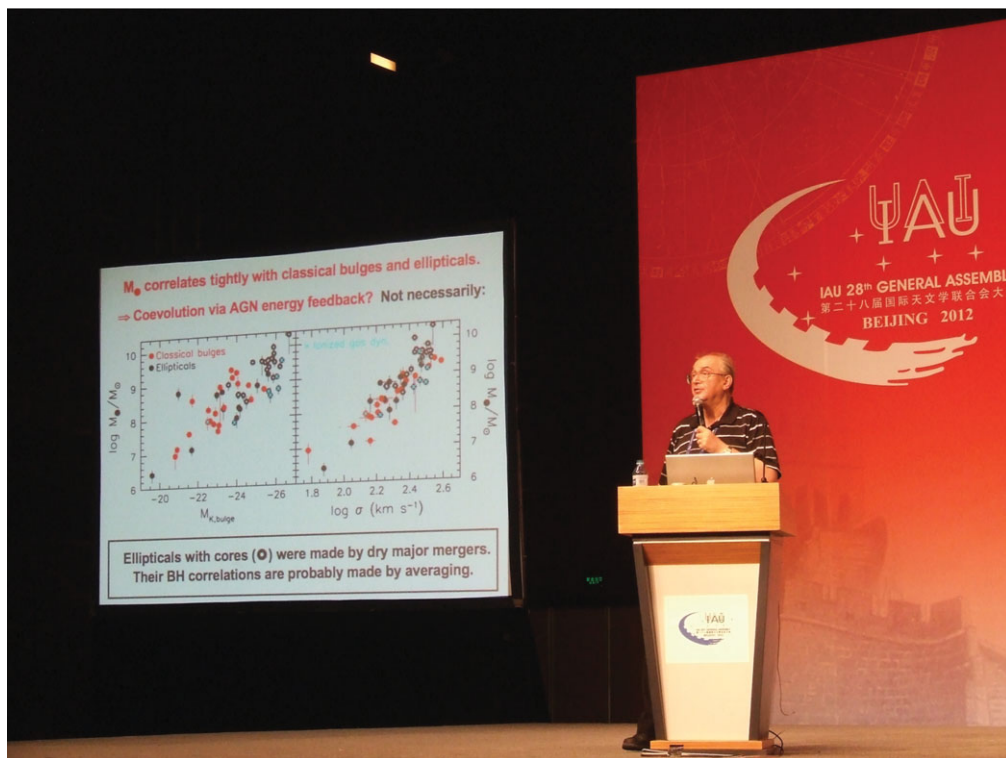
Oleg Gnedin and Simon Lilly.



Bianca Poggianti.



Simon Driver and Oleg Gnedin.



John Kormendy during his plenary talk on black holes.



John Kormendy and Daniel Thomas.

Participants

- Paula **Aguirre**, PUC/UNAB, Chile
 aguirre.paula@gmail.com
- Philippe **Amram**, Laboratoire d'Astrophysique de Marseille, France
 Philippe.Amram@oamp.fr
- Jacob **Arnold**, UCSC, United States
 jacob@ucolick.org
- Zhongrui **Bai**, NAOC, China
 zhrbai@gmail.com
- Guillermo **Barro**, University of California Santa Cruz, United States
 gbarro@ucolick.org
- Carlton **Baugh**, Durham University, United Kingdom
 c.m.baugh@durham.ac.uk
- Richard **Beare**, Monash Centre for Astrophysics, Australia
 beares@beares.net
- Rachel **Bezanson**, Yale University, United States
 rachel.bezanson@yale.edu
- Paolo **Bonfini**, University of Crete, Greece
 paolo@physics.uoc.gr
- Rycharld **Bouwens**, Leiden Observatory, Netherlands
 bouwens@strw.leidenuniv.nl
- Rebecca **Bowler**, Institute for Astronomy, University of Edinburgh, United Kingdom
 raab@roe.ac.uk
- Gabriel **Brammer**, European Southern Observatory, Chile
 gbrammer@gmail.com
- Volker **Bromm**, University of Texas at Austin, United States
 vbromm@astro.as.utexas.edu
- Sarah **Brough**, AAO, Australia
 sb@ao.gov.au
- Michael **Brown**, Monash University, Australia
 michael.brown@monash.edu
- Victoria **Bruce**, Institute for Astronomy, University of Edinburgh, United Kingdom
 vab@roe.ac.uk
- Gustavo **Bruzual**, CRYA, Morelia, Mexico Mexico
 g.bruzual@crya.unam.mx
- Fernando **Buitrago**, University of Edinburgh, United Kingdom
 fb@roe.ac.uk
- Martin **Bureau**, University of Oxford, United Kingdom
 bureau@astro.ox.ac.uk
- Claire **Burke**, Liverpool John Moores University, United Kingdom
 cb@astro.livjm.ac.uk
- Diego **Capozzi**, ICG, University of Portsmouth, United Kingdom
 diego.capozzi@port.ac.uk
- Michele **Cappellari**, University of Oxford, United Kingdom
 cappellari@astro.ox.ac.uk
- Evelyn **Caris**, Swinburne, University Australia
 ecaris@astro.swin.edu.au
- Marcio **Catelan**, Pontificia Universidad Catolica de Chile, Chile
 mcatelan@astro.puc.cl
- Chin-Wei **Chen**, Academia Sinica Taiwan, China
 chinwei.chen@asiaa.sinica.edu.tw
- Ke-Jung **Chen**, Kavli Institute for Theoretical Physics, UC Santa Barbara, USA
 chen1399@umn.edu
- Yanmei **Chen**, NJU, China
 chenym@nju.edu.cn
- Ana **Chies-Santos**, University of Nottingham, United Kingdom
 Ana.Chies_Santos@nottingham.ac.uk
- Igor **Chilingarian**, CFA / SAI MSU, United States
 igor.chilingarian@cfa.harvard.edu
- Hyejeon **Cho**, Yonsei University, South Korea
 hyejeon.cho@gmail.com
- Andrew **Cooper**, Max-Planck Institute For Astrophysics, Germany
 acooper@mpa-garching.mpg.de
- Enrico Maria **Corsini**, Dipartimento di Fisica e Astronomia,
 Università di Padova, Italy
 enricomaria.corsini@unipd.it
- Jorge **Cuadra**, PUC, Chile
 jcuadra@astro.puc.cl
- Emanuele **Daddi**, CEA Saclay, France
 edaddi@cea.fr
- Elena **Dalla Bontà**, Department of Physics and Astronomy,
 University of Padua, Italy
 elena.dallabonta@unipd.it
- Claudio **Dalla Vecchia**, MPE, Germany
 cavius@mpe.mpg.de
- Ivana **Damjanov**, Harvard-Smithsonian Center for Astrophysics, United States
 idamjanov@cfa.harvard.edu
- Roger **Davies**, University of Oxford United Kingdom
 rld@astro.ox.ac.uk
- Timothy **Davis**, European Southern Observatory, Germany
 tdavis@eso.org
- Sperello **di Serego Alighieri**, INAF, Osservatorio Astrofisico di Arcetri, Italy
 sperello@arcetri.astro.it
- Simon **Driver**, UWA/St Andrews, Australia
 simon.driver@icrar.org
- Cuihua **Du**, College of Physical Sciences, Graduate university of China
 ducuihua@gucas.ac.cn
- Pierre-Alain **Duc**, AIM Paris-Saclay, France
 paduc@cea.fr
- Allan **Ernest**, Charles Sturt University, Australia
 aernest@csu.edu.au
- Renato **Falomo**, INAF- Osservatorio Astronomico di Padova, Italy
 renato.falomo@oapd.inaf.it
- Lulu **Fan**, University of Science and Technology of China, China
 llfan@ustc.edu.cn
- Mirian **Fernandez Lorenzo**, IAA-CSIC, Spain
 mirian@iaa.es
- Anna **Ferre-Mateu**, Instituto de Astrofisica de Canarias, Spain
 aferre@iac.es
- Ignacio **Ferreras**, University College London, United Kingdom
 ipf@mssl.ucl.ac.uk
- Duncan **Forbes**, Swinburne University, Australia
 dforbes@swin.edu.au
- William **Forman**, SAO, United States
 wrf@cfa.harvard.edu
- Sebastien **Foucaud**, National Taiwan Normal University Taiwan, China
 foucaud@ntnu.edu.tw
- Carlos **Frenk**, Institute for Computational Cosmology,
 Durham University, United Kingdom
 c.s.frenk@durham.ac.uk
- Hai **Fu**, University of California, Irvine United States
 haif@uci.edu
- Mattia **Fumagalli**, Leiden Observatory, Netherlands
 fumagalli@strw.leidenuniv.nl
- Jared **Gabor**, CEA Saclay, France
 jared.gabor@cea.fr
- Dimitri **Gadotti**, ESO, Germany
 dgadotti@eso.org
- Jesus **Gallego**, Dpto. Astrofisica y CC de la Atmosfera
 Universidad Complutense de Madrid, Spain
 j.gallego@fis.ucm.es
- Ortwin **Gerhard**, gerhard@mpe.mpg.de MPE, Germany
 gerhard@mpe.mpg.de
- Karl **Glazebrook**, Swinburne, Australia
 karl@astro.swin.edu.au
- Oleg **Gnedin**, University of Michigan, United States
 ognedin@umich.edu
- Leith **Godfrey**, ICRAR/Curtin University, Australia
 l.godfrey@curtin.edu.au
- Oleksiy **Golubov**, ARI, Heidelberg University, Germany
 golubov@ari.uni-heidelberg.de
- Thiago **Goncalves**, Universidade Federal do Rio de Janeiro, Brazil
 tsg@astro.ufrj.br
- Rosa **Gonzalez Delgado**, IAA (CSIC), Spain
 rosa@iaa.es
- Alister **Graham**, Swinburne University of Technology, Australia
 agramham@astro.swin.edu.au
- Sebastian **Haan**, CSIRO ATNF, Australia
 sebastian.haan@csiro.au
- Yunkun **Han**, Yunnan Observatory, China
 hanyk@yao.ac.cn
- Will **Hartley**, University of Nottingham, United Kingdom
 will.hartley@nottingham.ac.uk
- Mike **Hudson**, Univ. of Waterloo, Canada
 mhudson@uwaterloo.ca
- Thomas **Hughes**, KIAA/PKU, China
 tmhughes@pku.edu.cn
- Bernd **Husemann**, Leibniz-Institute for Astrophysics Potsdam, Germany
 bhusemann@aip.de
- Woong-Seob **Jeong**, KASI, South Korea
 jeongws@kasi.re.kr
- Linhua **Jiang**, Arizona State University, United States
 linhua.jiang@asu.edu
- Yipeng **Jing**, Shanghai Astronomical Observatory, China
 yjpj@shao.ac.cn
- Jonas **Johansson**, Max-Planck Institute for Astrophysics, Garching, Germany
 jonasj@mpa-garching.mpg.de
- Peter H. **Johansson**, University of Helsinki, Finland
 peter.johansson@helsinki.fi
- Christine **Jones**, Harvard-Smithsonian CFA, United States
 cjones@cfa.harvard.edu
- Marios **Karouzos**, CEOU-Seoul National University, South Korea
 mkarouzos@astro.snu.ac.kr
- Sugata **Kaviraj**, Imperial College London, United Kingdom
 s.kaviraj@imperial.ac.uk
- Ryan **Keenan**, ASIAA, Taiwan
 rykeenan@gmail.com
- Simon **Kemp**, Instituto de Astronomia, Universidad de Guadalajara, Mexico
 snk@astro.iam.udg.mx
- Jae-Woo **Kim**, Seoul National University, South Korea
 kjw0704@googlemail.com
- Anatoly **Klypin**, NMSU, United States
 aklypin@nmsu.edu
- Tadayuki **Kodama**, Subaru Telescope, NAOJ, Japan
 t.kodama@nao.ac.jp
- Yutaka **Komiyama**, National Astronomical Observatory of Japan, Japan
 yutaka.komiyama@nao.ac.jp
- Xu **Kong**, Center for astrophysics,
 University of Science and Technology of China, Anhui, China
 xkong@ustc.edu.cn

- John **Kormendy**, University of Texas at Austin, United States
 Ralf **Kotulla**, University of Wisconsin-Milwaukee, United States
 Renee **Kraan-Korteweg**, University of Cape Town, South Africa
 Davor **Krajinovic**, ESO, Germany
 Michal **Krizek**, Institute of Mathematics, Academy of Sciences, Prague, Czech Republic
 Ivo **Labbe**, Leiden Observatory, Netherlands
 Cedric **Lacey**, ICC, Durham University, United Kingdom
 Myung Gyoon **Lee**, Seoul National University, South Korea
 Joel **Leja**, Yale University, United States
 Cheng **Li**, Shanghai Astronomical Observatory, China
 Yanchun **Liang**, NAOC, China
 Simon **Lilly**, ETH Zurich, Switzerland
 YenTing **Lin**, Institute of Astronomy and Astrophysics,
 Academia Sinica Taiwan, China
 Lukas **Lindroos**, Chalmers University of Technology, Sweden
 Gaochao **Liu**, NAOC, China
 Xin **Liu**, Harvard College Observatory, United States
 Colin **Lonsdale**, MIT Haystack Observatory, United States
 Ilani **Loubser**, North-West University, South Africa
 He **Ma**, National Astronomical Observatory, China
 Christina **Magoulas**, University of Melbourne, Australia
 Claudia **Maraston**, Institute of Cosmology and Gravitation,
 University of Portsmouth, United Kingdom
 Esther **Marmol-Queralto**, Instituto de Astrofísica de Canarias, Spain
 Davide **Martizzi**, Institute for Theoretical Physics, University of Zurich, Switzerland
 Richard **McDermid**, Gemini Observatory, United States
 Karin **Menendez-Delmestre**, Valongo Observatory,
 Federal University of Rio de Janeiro, Brazil
 Attila **Meszáros**, Charles University, Czech Republic
 Areg **Mikaelian**, Byurakan Astrophysical Observatory (BAO), Armenia
 Mireia **Montes**, IAC, Spain
 Christopher **Moody**, UC Santa Cruz, United States
 Mark **Mozena**, University of California-Santa Cruz, United States
 Thorsten **Naab**, Max-Planck-Institute for Astrophysics, Germany
 Taira **Oogi**, Hokkaido University, Japan
 Alvaro **Orsi**, Pontificia Universidad Católica de Chile, Chile
 Ludwig **Oser**, Max-Planck-Institute for Astrophysics, Germany
 Jamie **Owensworth**, University of Nottingham, United Kingdom
 Nelson **Padilla**, Universidad Católica de Chile, Chile
 Anna **Pasquali**, ARI-Heidelberg, Germany
 Xiyang **Peng**, Graduate University of the Chinese Academy of Sciences, China
 Yingjie **Peng**, Institute of Astronomy, ETH Zurich, Switzerland
 Pablo G. **Perez-Gonzalez**, UCM, Spain
 Bianca **Poggianti**, INAF-Astronomical Observatory of Padova, Italy
 Lauren **Porter**, University of California, Santa Cruz, United States
 Michael **Pracy**, Sydney University, Australia
 Leila **Powell**, MPE, Germany
 Ando **Ratsimbazafy**, University of the Western Cape, South Africa
 Rhea-Silvia **Remus**, University Observatory Munich / MPE, Germany
 Elena **Ricciardelli**, Universitat de Valencia, Spain
 Brigitte **Rocca-Volmerange**, Institut d'Astrophysique de Paris, France
 Margarita **Rosado**, UNAM, Mexico
 Anna **Saburova**, Sternberg Astronomical Institute,
 Moscow State University, Russian Fed
 Jose Ramon **Sanchez-Gallego**, Instituto de Astrofísica de Canarias, Spain
 Utane **Sawangwit**, National Astronomical Research Institute of Thailand, Thailand
 Andreas **Schulze**, Kavli Institute for Astronomy and Astrophysics, China
 Xu **Shao**, NAOC, China
 Maryam **Shirazi**, Leiden Observatory, Netherlands
 Yiping **Shu**, University of Utah, United States
 Chiara **Spiniello**, Kapteyn Astronomical Institute, Groningen, Netherlands
 Daniel **Stark**, University of Arizona, United States
 Oliver **Steele**, Institute of Cosmology and Gravitation,
 University of Portsmouth, United Kingdom
 Veronica **Strazzullo**, CEA-Saclay, France
 Daniel **Szomoru**, Leiden Observatory, Netherlands
 Qinghua **Tan**, CEA Saclay, France
 Thomas **Targett**, Institute for Astronomy, University of Edinburgh, United Kingdom
 James **Taylor**, University of Waterloo, Canada
 Daniel **Thomas**, Institute of Cosmology and Gravitation,
 University of Portsmouth, United Kingdom
 Sune **Toft**, Dark Cosmology Centre, Denmark
 Chiara **Tonini**, Centre for Astrophysics and Supercomputing,
 Swinburne University, Australia
 Tommaso **Treu**, UCSB, United States
 Ignacio **Trujillo**, IAC, Spain
 Jesse **van de Sande**, Leiden Observatory, Netherlands
 Sjoert **van Velzen**, Radboud University Nijmegen
 Jozsef **Varga**, Department of Physics of Complex Systems,
 Eotvos Lorand University, Hungary
 Daniel **Viljoen**, North-West University, South Africa
 Jakob **Walcher**, Leibniz Institute for Astrophysics (AIP), Germany
 Li Wei **Wang**, China
 Zhonglue **Wen**, NAO, CAS, China
 Gillian **Wilson**, University of California Riverside, United States
 Stijn **Wuyts**, MPE, Germany
 Renbin **Yan**, New York University, United States
 Haibo **Yuan**, Kavli Institute for Astronomy and Astrophysics,
 Peking University, China
 Yu **Zhang**, Yunnan Observatory, China
 Zhitai **Zhang**, NAOC, China
 XianZhong **Zheng**, Purple Mountain Observatory, CAS, China
 kormendy@astro.as.utexas.edu
 kotulla@uwm.edu
 kraan@ast.uct.ac.za
 dkrajinov@eso.org
 krizek@cesnet.cz
 ivo@strw.leidenuniv.nl
 cedric.lacey@durham.ac.uk
 mglee@astro.snu.ac.kr
 joel.leja@yale.edu
 leech@shao.ac.cn
 ycliang@bao.ac.cn
 simon.lilly@phys.ethz.ch
 ytl@asiaa.sinica.edu.tw
 lindroos@chalmers.se
 xinliu@cfa.harvard.edu
 cj1@haystack.mit.edu
 ilani.loubser@nwu.ac.za
 joker.mahe@gmail.com
 c.magoulas@pgrad.unimelb.edu.au
 claudia.maraston@port.ac.uk
 emq@iac.es
 mardtav@physik.uzh.ch
 rmcdermid@gemini.edu
 kmd@astro.ufrj.br
 meszaros@cesnet.cz
 aregmick@yahoo.com
 mmontes@iac.es
 cemoody@ucsc.edu
 mmozena@ucolick.org
 naab@mpa-garching.mpg.de
 oogi@astro1.sci.hokudai.ac.jp
 aaorsi@astro.puc.cl
 oser@mpa-garching.mpg.de
 ppxj1@nottingham.ac.uk
 npadilla@astro.puc.cl
 pasquali@ari.uni-heidelberg.de
 pengxian09@mails.gucas.ac.cn
 peng@phys.ethz.ch
 ppperez@fis.ucm.es
 bianca.poggianti@oapd.inaf.it
 laporter@ucsc.edu
 laporter@ucsc.edu
 lpowell@mpe.mpg.de
 raljha.a@gmail.com
 rhea@usm.lmu.de
 elena.ricciardelli@uv.es
 rocca@iap.fr
 margarit@astro.unam.mx
 saburovaann@gmail.com
 jrsg@iac.es
 utane@narit.or.th
 aschulze@pku.edu.cn
 xshao@nao.cas.cn
 shirazi@strw.leidenuniv.nl
 yiping.shu@utah.edu
 spiniello@astro.rug.nl
 dpstark@email.arizona.edu
 oliver.steele@port.ac.uk
 veronica.strazzullo@cea.fr
 szomoru@strw.leidenuniv.nl
 qinghua.tan@cea.fr
 tat@roe.ac.uk
 taylor@uwaterloo.ca
 daniel.thomas@port.ac.uk
 sune@dark-cosmology.dk
 ctonini@astro.swin.edu.au
 vt@physics.ucsb.edu
 trujillo@iac.es
 jesse.vd.sande@gmail.com
 s.vanvelzen@astro.ru.nl
 varga@caesar.elte.hu
 20569513@nwu.ac.za
 jwalcher@aip.de
 wlw001@163.com
 zhonglue@nao.cas.cn
 gillianw@ucr.edu
 swuyts@mpe.mpg.de
 yanrenbin@gmail.com
 yuanhb4861@pku.edu.cn
 zhy@ynao.ac.cn
 ztzhang@nao.cas.cn
 xzzheng@pmo.ac.cn