IAU Symposium
295
27 - 31 August 2012
Beijing, China

Proceedings of the International Astronomical Union

The Intriguing Life of Massive Galaxies

Edited by

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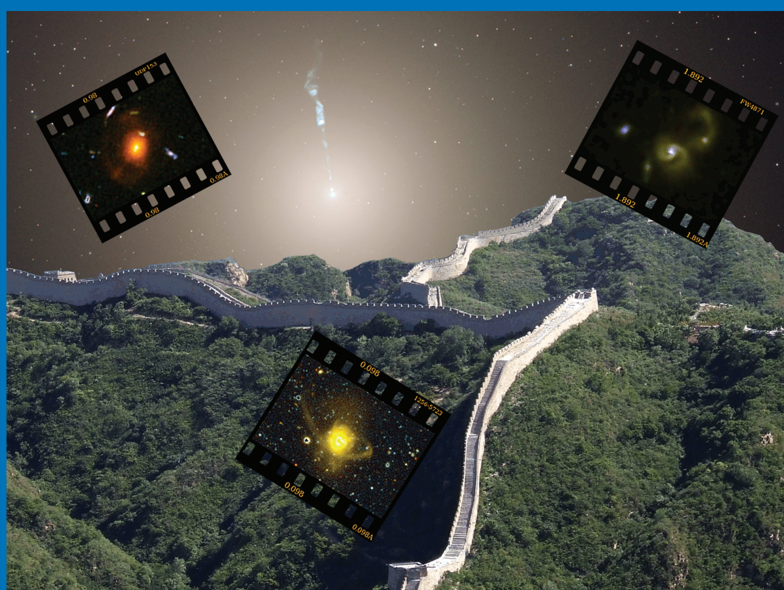

ISSN 1743-9213

International Astronomical Union

Cambridge University Press

https://doi.org/10.1017/S1743921313004079 Published online by Cambridge University Press

THE INTRIGUING LIFE OF MASSIVE GALAXIES

IAU SYMPOSIUM No. 295

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.

IAU SYMPOSIUM PROCEEDINGS SERIES

https://doi.org/10.1017/S1743921313004079 Published online by Cambridge University Press

INTERNATIONAL ASTRONOMICAL UNION

UNION ASTRONOMIQUE INTERNATIONALE

THE INTRIGUING LIFE OF MASSIVE GALAXIES

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

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CAMBRIDGE UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge CB2 2RU, United Kingdom
32 Avenue of the Americas, New York, NY 10013 2473, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

First published 2013

Printed in the UK by Bell & Bain

Typeset in System LaTeX 2ε

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 FSC-certified paper and cover board. FSC is an independent, non-governmental, not-for-profit organization established to promote the responsible management of the worlds forests. Please see www.fsc.org for information.

ISBN 9781107033849 hardback
ISSN 1743-9213

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https://doi.org/10.1017/S1743921313004079 Published online by Cambridge University Press

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https://doi.org/10.1017/S1743921313004079 Published online by Cambridge University Press

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https://doi.org/10.1017/S1743921313004079 Published online by Cambridge University Press

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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Acknowledgements

The symposium is sponsored and supported by the IAU Division VIII (Galaxies & the Universe) and by the IAU Commission No. 28 (Galaxies).

Funding by the
Royal Astronomical Society,
International Astronomical Union,
and
Science, Technology and Facilities Council (UK)
is gratefully acknowledged.

https://doi.org/10.1017/S1743921313004079 Published online by Cambridge University Press

An attentive audience at the IAUS 295.

Oleg Gnedin and Simon Lilly.

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Bianca Poggianti.

Simon Driver and Oleg Gnedin.

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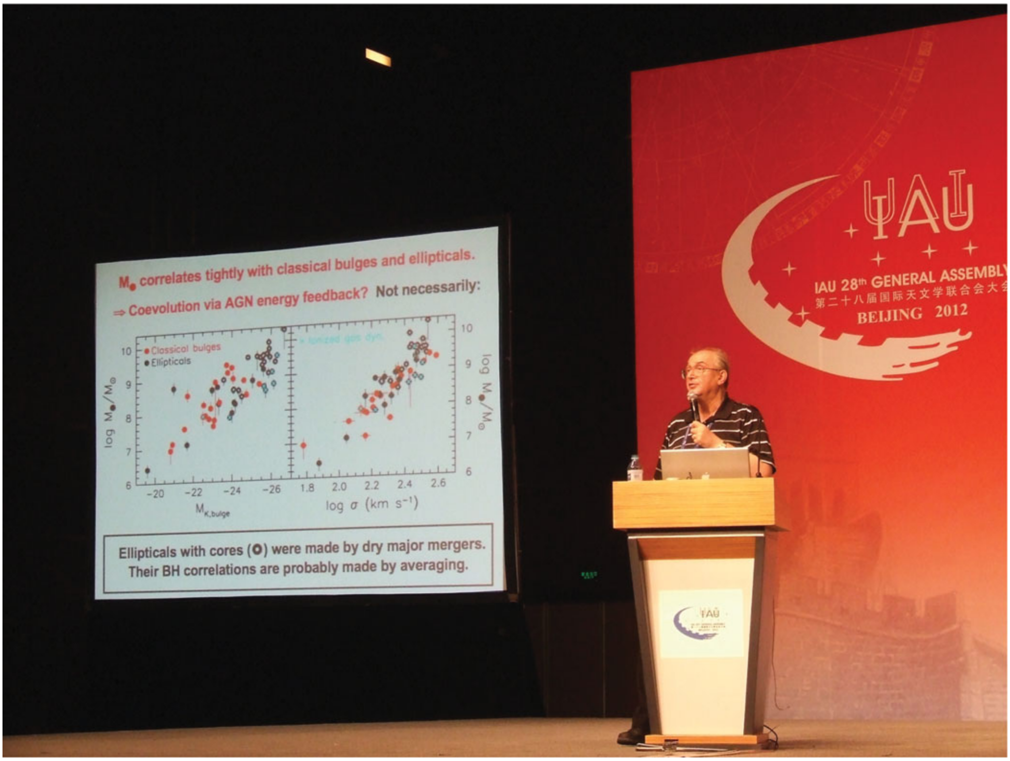

John Kormendy during his plenary talk on black holes.

John Kormendy and Daniel Thomas.

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https://doi.org/10.1017/S1743921313004079 Published online by Cambridge University Press

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