FROM LUMINOUS HOT STARS TO STARBURST GALAXIES

Luminous hot stars represent the extreme upper mass end of normal stellar evolution. Before exploding as supernovae, they live out their lives of only a few million years with prodigious outputs of radiation and stellar winds which dramatically affect both their evolution and environments.

A detailed introduction to the topic, this book connects the astrophysics of massive stars with the extremes of galaxy evolution represented by starburst phenomena. A thorough discussion of the physical and wind parameters of massive stars is presented, together with considerations of their birth, evolution, and death. HII galaxies, their connection to starburst galaxies, and the contribution of starburst phenomena to galaxy evolution through superwinds, are explored. The book concludes with the wider cosmological implications, including Population III stars, Lyman break galaxies, and gamma-ray bursts, for each of which massive stars are believed to play a crucial role.

This book is ideal for graduate students and researchers in astrophysics who are interested in massive stars and their role in the evolution of galaxies.

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CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9780521791342

First published 2008

Printed in the United Kingdom at the University Press, Cambridge

A catalog record for this publication is available from the British Library

Library of Congress Cataloging in Publication data
Conti, P. S. (Peter S.)
From luminous hot stars to starburst galaxies / Peter S. Conti, Paul A. Crowther, Claus Leitherer.
p. cm. – (Cambridge astrophysics series ; 45)
Includes bibliographical references and index.
ISBN 978-0-521-79134-2
1. Starbursts. 2. Gamma ray bursts. 3. Stars – Evolution.
4. Stellar winds. I. Crowther, Paul A. II. Leitherer, Claus. III. Title.
QB806.5.C66 2008
523.1′125–dc22

2008031554

ISBN 978-0-521-79134-2 hardback

Cambridge University Press
978-0-521-79134-2 - From Luminous Hot Stars to Starburst Galaxies
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Frontmatter
More information

Dedicated to our supportive wives: Carolyn, Suzie, and Irina.

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More information

Preface

This monograph had its origins about a decade ago when it became apparent that the field of luminous hot stars was rapidly expanding in extent and depth and connections to extragalactic astrophysics, in particular starburst galaxies, were first recognized. At that time a decade had passed since the 1988 *O stars and Wolf–Rayet stars* NASA monograph of Conti and Underhill. Since then, there have been far reaching advances in the astrophysics of these stars and of star-forming galaxies, both locally and at high-redshift, together with the way each affect their surroundings. On the observational side, progress interpreting the spectra of luminous hot stars allows their physical parameters to be derived with unprecedented accuracy. Studies of their ubiquitous stellar winds plus their dependence upon the element abundances has provided the impetus for revised stellar evolutionary model calculations. For the first time, additional physics, such as rotational mixing and magnetic fields, is being considered.

The advent of the Hubble Space Telescope in 1990 provided us with a UV wavelength range of greatly increased sensitivity just where most of the energy of hot stars is emitted. The use of newly commissioned 8-m ground-based telescopes has opened the door to studies of more distant hot stars in external galaxies, with different initial abundances and star formation histories compared to the Milky Way. In addition, techniques for the identification of star-forming galaxies at an epoch when the Universe was as little as one tenth of its present age have been developed, and exploited with these instruments. More recently, the Spitzer Space Telescope has provided a window on the mid-IR wavelengths of these same stars, so they may be studied in their birthplaces. Hot luminous stars form ionized hydrogen regions (HII) which can readily be analyzed in the Milky Way and other galaxies and provide an accurate, albeit indirect, method of determining the properties of their exciting stars.

Astronomers speak of starburst galaxies as those with substantial numbers of hot luminous stars, as evidenced by their extensive and very luminous (giant) HII regions. Typically such star formation activity comes about due to interactions between gas-rich galaxies, or gas collisions within the cores of dwarf irregular galaxies, where the material from each component is mixed and shocked, rapidly forming new stars. Such a mode of massive star formation stretches throughout the history of the Universe, being considerably more important in the earliest times when the Universe was smaller; possibly this mode of star birth dominates the formation of the first stars. The detection of this very first stellar generation is expected to be feasible with the James Webb Space Telescope in the next decade.

It is appropriate to now take stock and to review and summarize all the advances in these intimately related fields. In the past, massive stars were perhaps considered to be a peripheral topic in contemporary astrophysics, due to their rarity. However, developments in a number of fields now make them central to, for example, studies of the first (Population III) stars, which were biased towards high mass stars, and gamma-ray bursts, some of which originated from massive star progenitors. This is, we believe, the first monograph that connects the properties and evolution of massive stars with starburst galaxies. In another decade, these two subdisciplines will each become much too large to include in a single volume.

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Acknowledgements

We are indebted to those who read part of the first draft of the manuscript: Bob Blum, You-Hua Chu, Ed Churchwell, Chris Fryer, Jay Gallagher, Henny Lamers, Andre Maeder, Phil Massey, Paolo Mazzali, Max Pettini, Jo Puls, Daniel Schaerer, and Stan Woosley. Their comments have substantially added to our presentation of the material. Thanks too to James Furness for proof reading chapters, and CUP for letting us piece the manuscript together at our own pace. PSC appreciates nearly continuous support of his research by the National Science Foundation for over three decades. PAC would like to thank the Royal Society for their support through their University Research Fellowship scheme.

