Star-Formation Rates of Galaxies

Star-formation is one of the key processes that shape the current state and evolution of galaxies. This volume provides a comprehensive presentation of the different methods used to measure the intensity of recent or ongoing star-forming activity in galaxies, discussing their advantages and complications in detail. It includes a thorough overview of the theoretical underpinnings of star-formation rate indicators, including topics such as stellar evolution and stellar spectra, the stellar initial mass function, and the physical conditions in the interstellar medium. The authors bring together in one place detailed and comparative discussions of traditional and new star-formation rate indicators, star-formation rate measurements in different spatial scales, and comparisons of star-formation rate indicators probing different stellar populations, along with the corresponding theoretical background. This is a useful reference for students and researchers working in the field of extragalactic astrophysics and studying star-formation in local and higher-redshift galaxies.

Andreas Zezas is Professor at the University of Crete. He studies the X-ray emission from galaxies and its connection with their current and past star-forming activity. He has co-authored over 200 refereed publications and has been awarded an ERC Consolidator grant.

Véronique Buat is Professor of Astrophysics at Aix-Marseille University and Senior Member of the Academic Institute of France (IUF). She works on large multi-wavelength galaxy surveys and develops models to study star formation and interstellar obscuration from the local to the distant universe.
Star-Formation Rates of Galaxies

Edited by

ANDREAS ZEZAS
University of Crete

VÉRONIQUE BUAT
Aix-Marseille University
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Contributors

Samuel Boissier
Laboratoire d’Astrophysique de Marseille (LAM), CNRS, Aix-Marseille University, France

Médéric Boquien
Astronomy Centre (CITEVA), University of Antofagasta, Chile

Denis Burgarella
Laboratoire d’Astrophysique de Marseille (LAM), CNRS, Aix-Marseille University, France

Daniela Calzetti
Department of Astronomy, University of Massachusetts, Amherst, USA

Andrew Cole
School of Natural Sciences, University of Tasmania, Hobart, Australia

Daniel Dale
Department of Physics and Astronomy, University of Wyoming, Laramie, USA

J. J. Eldridge
Department of Physics, University of Auckland, New Zealand

John. S. Gallagher III
Department of Astronomy, University of Wisconsin–Madison, USA

Karl D. Gordon
Space Telescope Science Institute, Baltimore, USA
Sterrenkundig Observatorium, Ghent University, Ghent, Belgium

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List of Contributors

Brent Groves
International Centre for Radio Astronomy Research, University of Western Australia, 7 Fairway, Crawley, WA 6009, Australia

Tereza Jerabkova
ESTEC/SCI-S
Keplerlaan 1
2200 AG Noordwijk
Netherlands

Pavel Kroupa
Helmholtz Institute for Radiation and Nuclear Physics, Bonn, Germany
Faculty of Mathematics and Physics, Astronomical Institute, Charles University, Prague, Czech Republic

Cristina Popescu
Jeremiah Horrocks Institute, University of Central Lancashire, Preston, UK
Astronomical Institute of the Romanian Academy, Bucharest, Romania

Giulia Rodighiero
Department of Physics and Astronomy “G. Galilei”, University of Padova, Italy

Elena Sabbi
Space Telescope Science Institute, Baltimore, USA

E. R. Stanway
Department of Physics, University of Warwick, Coventry, UK

Andreas Zezas
Department of Physics, University of Crete, Heraklion, Greece
Institute of Astrophysics, Foundation for Research and Technology–Hellas, Heraklion, Greece
Preface

Star formation is one of the main mechanisms of energy production in the universe and one of the key processes that are linked to the evolution of galaxies. Over the past two decades we have witnessed an explosion of data from local and distant galaxies across the entire electromagnetic spectrum. These observations gave us an unprecedented picture of the star-forming activity in galaxies, the parameters it depends on (e.g. gas content, physical conditions in the interstellar medium, dynamical state of galaxies), and its evolution over cosmic time. The common denominator in all these studies is the use of diverse techniques for quantifying the recent star-forming activity in the different environments.

Indeed, the availability of a wealth of data in combination with advances in stellar astrophysics, astrophysics of the interstellar medium and radiative transfer modelling, and numerical simulations has led to the development of a variety of methods for measuring the intensity of star-forming activity using proxies such as direct detection of stars or their remnants, direct measurement of their stellar light, and measurements of the reprocessed stellar emission by the interstellar medium.

The purpose of this book is to provide an up-to-date and comprehensive review of the methods used to measure the intensity of star-forming activity in galaxies (their star-formation rates). However, a presentation of these relevant methods would be incomplete without discussing their astrophysical foundation, and the different factors that affect their precision and accuracy.

Therefore, in Part I of this book we present a detailed account of the stellar Initial Mass Function, stellar populations and their evolution, and absorption of stellar radiation by the interstellar medium. Special care is taken to discuss how these factors influence our measurements of star-formation rates. In Part II of this volume, we present the different methods for measuring star-formation rates: resolved stellar populations, broad-band photometry, emission lines, spectral energy distributions, and emerging indicators such as high-energy emission and gravitational-wave sources. Special care is taken to discuss the advantages and limitations of different indicators, as well as their cross-calibration in galaxy-wide and sub-galactic scales.

Although the subject of this volume is rather technical (but relevant to most aspects of extragalactic astrophysics), we tried to give an overview of the latest advances in the field,
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Preface

while providing the relevant introductory material. The book is written at the advanced undergraduate/starting graduate level, expecting from the reader familiarity with astrophysics terminology, and at least basic knowledge of stellar evolution and astrophysics of the interstellar medium and galaxies. We hope that this volume will be a useful resource for graduate students and researchers who would like to learn more about how we can measure one of the most characteristic properties of galaxies, and the factors affecting these measurements.

We would like to thank all the contributors in this volume for their excellent presentation of the different topics relevant to the measurement of star-forming activity in galaxies. Also, we would like to thank the Cambridge University Press editorial staff for their help in the preparation of the manuscript and their patience during the lengthy editing process.