

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.

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Star-Formation Rates of Galaxies

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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,

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.