

# Preface

Optical, infrared, and radio astronomies are the historical pillars of astrophysics. They are continuing to contribute a large part of the astrophysical information and are the prerequisite for observations with highenergy information carrier. The investigation of the astrophysical properties of the targets triggers the building of the large observational facilities and shapes their characteristics. The textbook is organized from the point of view of the science targets, tackling optical, infrared, and radio astronomies as scientific research areas. In place of presenting the observational techniques and showing how they could be used in different domains of the electromagnetic spectrum, the textbook is focused on the science targets and the measurement of their fluxes and spectra, providing a link between observational techniques and astrophysical science.

The textbook has grown up out of several years of teaching the courses of astrophysical techniques to graduate students at the University of Pisa who were specializing in astrophysics. The text shows the state of the art and the future evolution of instrumentation and observational methods. The aim of the work is to be a comprehensive guide through the steps needed to acquire and analyze optical, infrared, and radio data: planning the observation, choosing the signal-to-noise ratio, selecting a telescope or radio telescope with the suitable instrumentation to observe the selected object at the proper epoch, performing the observations, securing the calibration data, and extracting the astrophysical information as fluxes or spectra. Thus, for each astronomy research area investigated in the book, the relevant orders of magnitudes are firstly presented. Then, the physical principles of the telescopes, the detectors, and the components needed for flux and spectra measurements are discussed. The signal-to-noise ratio of the observations and the limits of instrumentation are discussed in detail in view of writing proposals for telescope observing time. Finally, the data analysis techniques are presented. The bibliography at the end of each chapter suggests monographs of interest for the reader. Web links are provided for the instrumentation.

The first part of the textbook is devoted to the basics of astronomical observations: the electromagnetic radiation and its interactions, the effect of the atmosphere on observations, and the observational windows (Chap. 1). Then, the ingredients

needed to point an instrument for observations are presented: the celestial coordinates, the measure of time, the astronomical nomenclature, and the source catalogs, the steadily increasing Internet resources available for observers (Chap. 2). The second part of the text is devoted to the techniques of optical astronomy. Firstly, the optical telescopes and the involved aberrations are discussed, together with the configurations of reflector instruments that are the core of large observing facilities (Chap. 3). The ground-based optical telescopes are later discussed, investigating the effects of the atmosphere on the quality of images and discussing the operation of telescopes in space (Chap. 4). The radiation collected by optical telescopes is measured by light detectors; among them, the charge-coupled devices that have revolutionized observational astronomy are discussed in detail (Chap. 5). The measurement of the optical fluxes by the technique of optical photometry is discussed in Chap. 6, with a focus on photometry with CCDs. The measurement of optical spectra, mainly using dispersing elements, is discussed in Chap. 7. The third part of the book is devoted to the low-energy side of classical astronomy. Infrared astronomy, the domain of thermal emission, is presented, with a discussion of the specific observational techniques in the different wavelength regions (Chap. 8). The techniques and the instruments for data collection in radio astronomy, the first astronomy after the optical one, are discussed later (Chaps. 9 and 10). The fourth part of the book deals with the combination of optical telescopes and radio telescopes in interferometric arrays to achieve a high angular resolution (Chaps. 11 and 12). The fifth part of the text is devoted to present the preparation and execution of observations (Chap. 13) and the data analysis techniques (Chap. 14).

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