New Concepts in Imaging: Optical and Statistical Models
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Foreword

This book is a collection of 19 articles which reflect the courses given at the Collège de France/Summer school "Reconstruction d'images – Applications astrophysiques" held in Nice and Fréjus, France, from June 18 to 22, 2012.

The articles presented in this volume share a common point: they all address emerging concepts and methods that are useful in the complex process of improving our knowledge of the celestial objects, including Earth.

In the spirit of a school, several articles underline using historical elements how essential have been instruments of high angular resolution, mathematical description of the observations, transmission of knowledge and reliance on long term research projects to our current representation of the Universe. Many articles can be read as tutorials of the specific research field they address.

The book contains three parts.

The first part is titled **"Physical bases and new challenges in high resolution imaging"**. In these articles, the strategy followed for attacking such challenges relies on a careful description of the electromagnetic waves emitted by the celestial sources, and of their perturbations. This part draws a picture of some of the high angular resolution instruments of the near to far future, and of the issues to overcome to make this picture real. It deals with hypertelescopes, optical interferometry, adaptive optics, wavefront coding, and with polychromatic astrophysical models.

The point of view of the articles of the second part, titled **"Physical models and data processing"**, is twofold. Of concern to these articles are not only the data description using physical modeling of electromagnetic waves, but also the resulting data processing. These articles address issues such as sampling, information modeling and restoration in radio and optical interferometry, including hypertelescopes.

The third part is titled **"Statistical models in signal and image processing"**. These contributions cover past and recent developments in multiresolution analysis, Bayesian modeling, sparsity and convex optimization. The last three papers deal specifically with hyperspectral data of Earth and of the deep Universe, images recorded at hundreds of wavelengths resulting in massive data. This last part illustrates the benefits brought by a careful data processing, and comes perhaps in contrast to the conventional wisdom which claims that too much information kills information.

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While the volume is divided in three parts to clarify which topics are covered and where, the issues addressed in the first and third parts are in reality connected by the observation instruments. These connections are mentioned at various places, and especially in the articles of the second part, which is a hyphen. As it goes, the alert reader will notice many more such connections.

Obviously, the successful realization of more powerful observation technologies and the best extraction of the astrophysical information encapsulated in their data involve the joint expertise of several research communities. The various articles collected in this book may contribute to such a synergy.