Preface

All bodies are influenced by gravity in the same way, independent of their mass. In fact, even bodies with no mass are affected by gravity, which acts as any other acceleration vector, following Einstein's "equivalence principle" between gravity and inertial forces. This simple consequence of Einstein's principle yielded the first observational confirmation of the theory of general relativity, with the observation of the apparent displacement of stars seen near the solar limb during a total solar eclipse. This early observation of the phenomenon of *gravitational lensing* marked the beginning of what has now evolved into its own field of astrophysics. Gravitational lensing has even evolved into several sub-fields of astrophysics, and consists of a mature topic studied in detail as a natural phenomenon in itself. It is used to tackle astrophysical problems from a new angle.

Gravitational lensing is starting to be sufficiently well understood that it can be *applied* to other astrophysical areas and can help us to address scientific questions that would otherwise be left without any answer. We have tried to reflect this in the present book, as was done in the selection of topics at the "Dark Matter and Gravitational Lensing" workshop (held in July 2000 in San Pedro de Atacama, Chile) where the writing of the book was initiated. Each chapter covers a "sub-field" of gravitational lensing, with the aim of: describing in a very simple way the basics of the theory, reviewing the most recent developments, and reviewing some of the applications foreseen in the near future.

An introduction to the basics of lens modeling is given in the context of quasar lensing, which is the oldest sub-field of gravitational lensing. The emphasis is put on the cosmological applications, such as the determination of the Hubble parameter H_0. Thanks to the progress with instrumentation and the development of large telescopes working at high angular resolution, the weakest effects of gravitational lensing can now be detected. The so-called "weak gravitational lensing" is the topic of the second chapter. It describes how to weigh galaxy clusters and how to map the – invisible – large scale structures of the Universe thanks to the distortion they produce on very distant objects. Weak lensing has been recently extended to the statistical study of the shape of the dark halo in individual galaxies: "galaxy-galaxy lensing" is the subject of the third chapter. Finally, gravitational lensing is starting to be intensly studied at millimeter wavelengths, and is often used as a natural telescope to unveil faint sources otherwise inaccessible. The last chapter gives a broad overview of the applications of gravitational lensing, at these wavelengths, that are just starting to be explored.

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