X-ray binaries are some of the most varied and perplexing systems known to astronomers. The compact object, which accretes mass from its companion star, may be a white dwarf, a neutron star, or a black hole, whereas the donor star can be a 'normal' star or a white dwarf. The various combinations differ widely in their behaviour. This timely volume provides a unique and up-to-date reference of our knowledge of all of them.

Fifteen specially written chapters by a team of the world's foremost researchers in the field explore all aspects of X-ray binaries. They cover the X-ray, ultraviolet, optical and radio properties of these violent systems and address key issues such as: how were these systems formed, and what will their fate be; how can we understand X-ray bursts and quasi-periodic oscillations; what is the connection between millisecond radio pulsars and low-mass X-ray binaries; and how does the magnetic field of a neutron star decay?

This long awaited review provides graduate students and researchers with the standard reference on X-ray binaries for many years to come.

X-ray binaries

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Preface

In the decade since the publication of *Accretion Driven Stellar X-ray Sources* – the predecessor of the present book – the study of X-ray binaries has received an enormous impetus due to observations over a very large range of photon energies. Particularly in the X-ray range, a host of new observing facilities has become available: for example, EXOSAT, Ginga, ROSAT, the MIR station, Granat and GRO. These observatories, and also a large variety of observatories working in the radio, optical and ultraviolet parts of the electromagnetic spectrum, have produced many new results that have transformed our picture of these intriguing binary systems. Of major importance has been the understanding of the change in the evolutionary framework. These binary systems are now considered to be the parent population from which recycled millisecond radio pulsars, both single and those in binaries, are generated. Globular clusters seem to be ideal birth places for these millisecond pulsars; 12 have been found in 47 Tuc alone! The importance of the millisecond pulsars was recently highlighted when Russell Hulse and Joseph Taylor were awarded the Nobel Prize for Physics for their discovery in 1974 of the binary millisecond pulsar PSR 1913+16; this system provided the first observational evidence for the existence of gravitational radiation, which manifests itself in the form of a decreasing orbital period. A crucial change has also occurred in our ideas on the decay of the magnetic field of neutron stars. It is no longer believed that magnetic fields decay spontaneously on a time scale of a few million years. This had been the party line for almost two decades. Instead, the present consensus is that non-accreting neutron stars may have *no* field decay at all, and that the field decay of a neutron star in an accreting binary depends on the accretion or its spin-period history. The discovery of quasi-periodic oscillations has led to some welcome order in the confusion that before had plagued our understanding of the irregular variability of low-mass X-ray binaries. On the basis of their correlated fast-variability and spectral properties, two types of low-mass X-ray binaries have been recognized: the *Z* and *atoll* sources. Several of the components found in the power spectra of these low-mass X-ray binaries appear also to be present in the power spectra of black-hole candidates and X-ray pulsars. This may lead to a unification of the variability properties of all types of accreting compact stars. A decade ago, the orbital periods of only a few low-mass X-ray binaries were known. This number has since increased enormously, thanks to dedicated searches by many researchers for periodic variations of the optical and X-ray brightness of these objects. In particular EXOSAT – due to its special Earth orbit, which allowed for long uninterrupted observations – has been very productive in finding orbital periods of low-mass X-

ray binaries, particularly through the detection of the so-called *dipping* sources. In addition, great progress has been made in our ability to distinguish accreting neutron stars from accreting black holes on the basis of their X-ray spectra alone. To date, more than two decades after the discovery of γ-ray bursts, their origin is still a mystery. In comparison, the origin of X-ray bursts (all the ins and outs of which are thoroughly covered in this book) was well understood within only three years of their discovery. During the past few years (after Dr Hurley had been invited to write a review for this book), the theory of γ-ray burst sources has come a long way. Most scientists now believe that they are at cosmological distances as opposed to very nearby (only a few hundred parsec) within our Galaxy. This book is by far the most comprehensive survey ever written on this subject. It covers in great detail the most recent developments in multi-wavelength observations, as well as the theory of X-ray binaries.

Walter H. G. Lewin, Jan van Paradijs,
and Edward P. J. van den Heuvel