

COMPACT STELLAR X-RAY SOURCES

X-ray astronomy provides the main window onto astrophysical compact objects such as black holes, neutron stars and white dwarfs. In the past ten years new observational opportunities have led to an explosion of knowledge in this field. In sixteen chapters, written by leading experts, this book provides a comprehensive overview of the observations and astrophysics of X-ray emitting stellar-mass compact objects.

Topics discussed in depth include the various phenomena exhibited by compact objects in binary systems such as X-ray bursts, relativistic jets and quasi-periodic oscillations, as well as gamma-ray burst sources, super-soft and ultra-luminous sources, isolated neutron stars, magnetars and the enigmatic fast transients. The populations of X-ray sources in globular clusters and in external galaxies are discussed in detail. This is an invaluable reference for both graduate students and active researchers.

WALTER LEWIN is Professor of Physics at MIT. A native of The Netherlands, Professor Lewin received his Ph.D. in Physics from the University of Delft (1965). In 1966, he went to MIT as a postdoctoral associate in the Department of Physics and was invited to join the faculty as Assistant Professor later that same year. He was promoted to Associate Professor of Physics in 1968 and to full Professor in 1974. Professor Lewin's honors and awards include the NASA Award for Exceptional Scientific Achievement (1978), twice recipient of the Alexander von Humboldt Award (1984 and 1991), a Guggenheim Fellowship (1984), MIT's Science Council Prize for Excellence in Undergraduate Teaching (1984), the W. Buechner Teaching Prize of the MIT Department of Physics (1988) and the Everett Moore Baker Memorial award for excellence in undergraduate teaching (2003). In 1997, he was the recipient of a NASA Group Achievement Award for the Discovery of the Bursting Pulsar. He is a corresponding member of the Royal Netherlands Academy of Arts and Sciences (elected 1993) and Fellow of the American Physical Society.

MICHEL VAN DER KLIS is Professor of Astronomy at the Astronomical Institute Anton Pannekoek of the University of Amsterdam and winner of the NWO Spinoza Prize (2004) for his pioneering research into X-ray radiation from binary stars. He gained his Ph.D. in 1983 from the University of Amsterdam for his observations of X-ray stars. Following this, he held various positions, including a period at the European Space Research and Technology Centre in Noordwijk. In 1989, he returned to the University of Amsterdam as a senior lecturer and he became a professor there in 1993. In 1987, he received the Bruno Rossi Prize, the highest international award in high-energy astrophysics and in 1990 the Zeldovitch Award for Astrophysics from Space of the International Committee of Space Research (COSPAR). Since 2002 he has been a member of the Royal Academy of Arts and Sciences.

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[More information](#)

Contributors

Lars Bildsten
Kavli Institute for Theoretical Physics
University of California, Santa Barbara
Santa Barbara, CA 93106
USA

P. A. Charles
School of Physics & Astronomy
University of Southampton
Highfield
Southampton SO17 1BJ
UK

M. J. Coe
School of Physics & Astronomy
University of Southampton
Highfield
Southampton SO17 1BJ
UK

S. G. Djorgovski
Palomar Observatory
California Institute of Technology
Pasadena, CA
USA

G. Fabbiano
Harvard-Smithsonian Center for
Astrophysics
60 Garden St.
Cambridge, MA 02138
USA

Rob Fender
Astronomical Institute Anton Pannekoek
University of Amsterdam
Kruislaan 403
1098 SJ Amsterdam
Netherlands

Alice K. Harding
Sciences and Exploration Directorate
NASA Goddard Space Flight Center
Greenbelt, MD 20771
USA

John Heise
Space Research Organization Netherlands &
Astronomical Institute, Universiteit Utrecht
Sorbonnelaan 2
3584 CA Utrecht
Netherlands

E. P. J. van den Heuvel
Astronomical Institute Anton Pannekoek
University of Amsterdam
Kruislaan 403
1098 SJ Amsterdam
Netherlands

K. Hurley
Space Sciences Laboratory
7 Gauss Way
University of California, Berkeley
Berkeley, CA 94720-7450
USA

xii *List of contributors*

Jean in 't Zand
 Space Research Organization Netherlands &
 Astronomical Institute, Universiteit Utrecht
 Sorbonnelaan 2
 3584 CA Utrecht
 Netherlands

P. Kahabka
 Max-Planck-Institut für extraterrestrische
 Physik
 Giessenbachstrasse
 85741 Garching
 Germany

Victoria M. Kaspi
 Physics Department, McGill University
 Rutherford Physics Building
 3600 University Street
 Montreal, QC H3A 2T8
 Canada

A. R. King
 Theoretical Astrophysics Group
 University of Leicester
 Leicester LE1 7RH
 UK

M. van der Klis
 Astronomical Institute Anton Pannekoek
 University of Amsterdam
 Kruislaan 403
 1098 SJ Amsterdam
 Netherlands

Erik Kuulkers
 ISOC, ESAC/ESA
 Apartado 50727
 28080 Madrid
 Spain

Walter H. G. Lewin
 Physics Department
 Kavli Institute for Astrophysics and
 Space Research
 Massachusetts Institute of Technology
 Cambridge, MA 02139
 USA

Jeffrey E. McClintock
 Harvard-Smithsonian Center for
 Astrophysics
 60 Garden St.
 Cambridge, MA 02138
 USA

Andrew Norton
 Department of Physics & Astronomy
 The Open University
 Walton Hall
 Milton Keynes MK7 6AA
 UK

Dimitrios Psaltis
 Department of Physics
 University of Arizona
 Tucson, AZ 85721
 USA

Ronald A. Remillard
 Center for Space Research
 Massachusetts Institute of Technology
 Cambridge, MA 02139
 USA

Mallory S. E. Roberts
 Physics Department, McGill University
 Rutherford Physics Building
 3600 University Street
 Montreal, QC H3A 2T8
 Canada

R. Sari
 Department of Theoretical Astrophysics
 California Institute of Technology
 Pasadena, CA
 USA

Axel Schwope
 Astrophysikalisches Institut Potsdam
 An der Sternwarte 16
 11482 Potsdam
 Germany

List of contributors

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Tod Strohmayer
Laboratory for High Energy Astrophysics
NASA Goddard Space Flight Center
Greenbelt, MD 20771
USA

Brian Warner
Department of Astronomy
University of Cape Town
Rondebosch 7700
South Africa

T. M. Tauris
Astronomical Observatory
Niels Bohr Institute
Copenhagen University
Denmark

N. E. White
NASA Goddard Space Flight Center
Code 660
Greenbelt, MD 20771
USA

C. Thompson
Canadian Institute for Theoretical
Astrophysics
60 George St.
Toronto, ON
Canada

P. M. Woods
Universities Space Research Association
National Space Science and Technology
Center
Huntsville, AL
USA

Frank Verbunt
Astronomical Institute
Universiteit Utrecht
Postbus 80125
3508 TA Utrecht
Netherlands

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Preface

Extra-solar X-ray astronomy began with the historical paper in *Physical Review Letters* by Giacconi, Gursky, Paolini, and Rossi (1962). Now, more than four decades later, X-ray astronomy is central to many aspects of astronomy. In 2002, Riccardo Giacconi was awarded the Nobel Prize in Physics “for pioneering contributions to astrophysics, which have led to the discovery of cosmic X-ray sources”. In the decade since the publication of *X-ray Binaries* – the predecessor of the present book – the study of compact stellar X-ray sources has received enormous impetus from observations with the BeppoSAX, Rossi X-ray Timing Explorer (RXTE), Chandra, and XMM-Newton X-ray observatories. In addition, many exciting new results on these X-ray sources have also been produced in the radio, infrared, optical and ultraviolet bands. Highlights include the discovery in low-mass X-ray binaries of millisecond X-ray pulsations, confirming the connection with the millisecond radio pulsars. Millisecond and sub-millisecond quasi-periodic oscillations (QPO) were discovered that are thought to provide a direct view of regions of strong-field gravity near neutron stars and black holes. The discovery of X-ray, optical and radio afterglows of gamma-ray bursts (GRB) firmly established their long-suspected cosmological distances. Super-luminal motion of radio jets was discovered in accreting black-hole binaries. Dozens of ultra-luminous X-ray sources (ULX) have been detected in many galaxies. Their origin is still not clear; some may be accreting intermediate-mass (i.e., of order $10^3 M_{\odot}$) black holes (IMBH). Great progress was also made in our understanding of the soft gamma-ray repeaters (SGR) and anomalous X-ray pulsars (AXP). We now know that they are “magnetars”, neutron stars with magnetic dipole fields of enormous strength ($10^{14} - 10^{15}$ G). This book is a comprehensive and up-to-date survey on compact stellar X-ray sources written by leading experts in the field. It covers in detail the recent developments in X-ray and multi-wavelength observations, and the theory behind them.