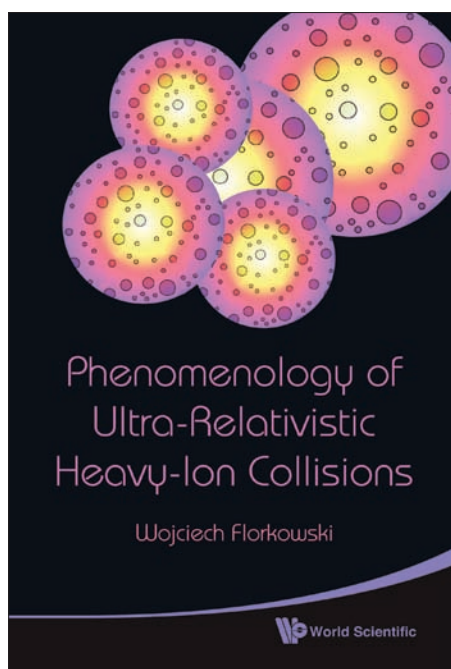


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Phenomenology of Ultra-Relativistic Heavy-Ion Collisions

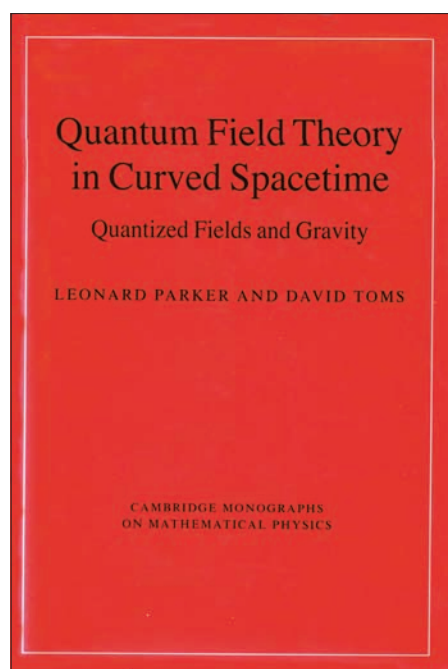
By Wojciech Florkowski

World Scientific

Hardback: £66 \$96

Wojciech Florkowski's book on ultra-relativistic heavy-ion collisions appears right at the beginning of a new era in the field. In 2010, two new experimental heavy-ion programmes started at CERN. First, lead nuclei were accelerated to the highest ever energy – 1.38 TeV per nucleon – at the LHC and rich experimental results were released by the ALICE, ATLAS and CMS collaborations, even during the first data-taking period in November/December 2010. Second, in parallel, a new fixed-target heavy-ion programme at CERN's Super Proton Synchrotron (SPS) was launched with the acceleration of lead beams to the lowest-ever energy in the SPS, namely 13.9 GeV per nucleon. This was to study the use of the fragment separator in producing secondary light-ion beams for the NA61/SHINE experiment. These two research programmes are perfectly complementary. The one at the LHC aims at a systematic investigation of hot and dense quark-gluon plasma. The one at the SPS, on the other hand, will search for the critical point of strongly interacting matter and study the properties of the onset of deconfinement.

This book by Florkowski is highly relevant for all participants in the new programmes at CERN. I am convinced that



it may also help all non-heavy-ion physicists involved in experiments at CERN to understand the language and excitement of their heavy-ion colleagues.

Furthermore, it gives an excellent introduction to and an in-depth review of the standard theoretical framework that is used to interpret the heavy-ion data. It provides a clear, logical and unified description of statistical, hydrodynamical and kinetic models. All this is illustrated by a selection of the most relevant experimental results of the past programmes at Brookhaven's Alternating Gradient Synchrotron and Relativistic Heavy Ion Collider, as well as at the SPS. Finally, there are various exercises in each chapter for use as a textbook in a graduate course.

All in all, this book is highly recommendable both for heavy-ion and non-heavy-ion physicists.

● Marek Gazdzicki, *Universities of Frankfurt and Kielce.*

Quantum Field Theory in Curved Spacetime: Quantized Fields and Gravity

By Leonard Parker and David Toms

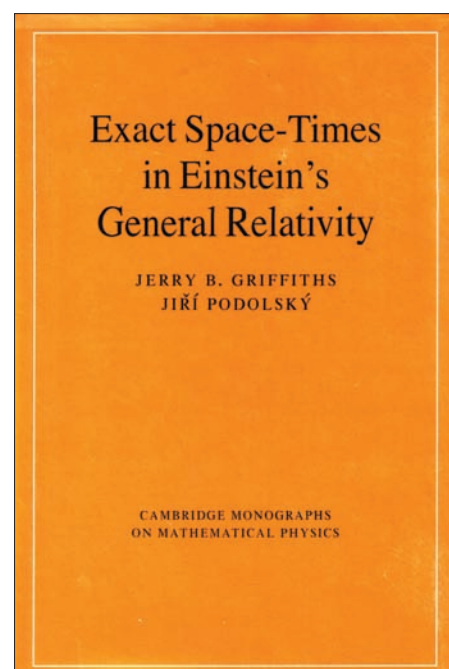
Cambridge University Press

Hardback: £48 \$83 E-book: \$64

Exact Space-Times in Einstein's General Relativity

By Jerry B Griffiths and Jiří Podolský

Cambridge University Press



Hardback: £80 \$129 E-book: \$100

Long ago, more or less immediately after Einstein's formulation of general relativity, one of the dreams of physics was to understand why flat space-time is so special. Why are quantum mechanics and field theory formulated in flat space while their curved-space analogues are sometimes ill defined, at least conceptually? Can we hope, as Richard Feynman speculated, to quantize gravity in flat space-times and then construct all of the most complicated geometries as coherent states of gravitons?

The dreams of a more coherent picture of gravity and of gauge interactions in flat space are probably still there, but nowadays theorists invest a great deal of effort in understanding the subtleties of the quantization of fields, particles, strings and (mem)branes in geometries that are curved both in space and in time. Cambridge University Press was one of the first publishers to voice these attempts with the classic *Quantum Fields in Curved Space* by N B Birrel and P C W Davies, which is now well known to many students since its first edition in 1982. Leonard Parker (distinguished professor emeritus at the University of Wisconsin) and David Toms (reader in mathematical physics and statistics at the University of Newcastle) were both abundantly quoted in the book by Birrel and Davies and they have now published *Quantum Field Theory in Curved Spacetime*, also with Cambridge. While

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readers of Birrel and Davies will certainly like this new book, newcomers and students will appreciate the breadth and the style of a treatise written by two well known scientists who have dedicated their lives to the understanding of the treatment of quantum fields in a fixed gravitational background.

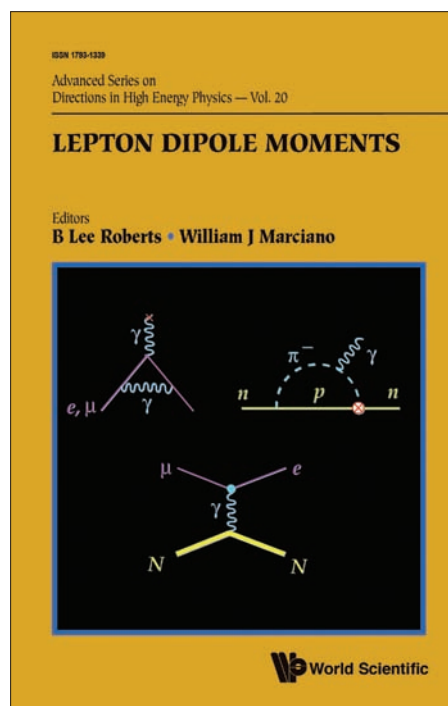
The book consists of seven chapters spread evenly between pure theory and applications. One of its features is the attention to the introductory aspects of a problem: students and teachers will like this aspect. The introductory chapter reminds the reader of various concepts arising in field theory in flat space–time, while the second chapter introduces the basic aspects of quantum field theory in curved backgrounds. After the central chapters dealing with useful applications (including the discussion of pair creation in black-hole space–times) the derivation of effective actions of fields of various spins is presented, always by emphasizing the curved-space aspects.

A rather appropriate companion volume is *Exact Space–Times in Einstein’s General Relativity* by Jerry Griffiths and Jiří Podolský, published by Cambridge in late 2009. Here, the interested reader is led through a review of the monumental work performed by general relativists over the past 50 years. The book also complements (and partially extends) the famous work by Dietrich Kramer, Hans Stephani, Malcolm MacCallum and Eduard Herlt, *Exact Solutions of Einstein’s Field Equations*, first published, again by Cambridge, in 1980.

Like its famous ancestor, the book by Griffiths and Podolský will probably be used as a collection of exact solutions by practitioners. However this risk is moderated to some extent by a presentation in the style of an advanced manual of general relativity (GR). The 22 chapters cover in more than 500 pages all of the most important solutions of GR. After two introductory chapters the reader is guided on a tour of the most important spatially homogeneous and spatially inhomogeneous, four-dimensional background geometries, starting from de Sitter and anti-de Sitter space–times but quickly moving to a whole zoo of geometries that are familiar to theorists but which may sound rather arcane to scientists who are not directly working with GR.

Both books reviewed here can also be recommended because they tell of the achievements of a generation of theorists whose only instruments were, for a good part of their lives, a pad of paper and a few pencils.

● Massimo Giovannini, CERN and INFN (Milan-Bicocca).



Lepton Dipole Moments

By B Lee Roberts and William J Marciano (eds.)

World Scientific

Hardback: £113 \$164 E-book: \$213

In December 1947, Julian Schwinger wrote a letter to the editor of *Physical Review*, wherein he reports in a mere five paragraphs that he has found “an additional magnetic moment associated with the electron spin”. He gives the value as $\alpha/2\pi=0.00116$ and states that it is “the simplest example of a radiative correction” in the new theory of QED.

We have come a long way since Schwinger’s letter. Toichiro Kinoshita has computed the anomalous magnetic moment of the electron up to the tenth order. Nature has revealed further mysteries in the intervening years, including the existence of the muon, with which to test our theories. Famously, the Brookhaven measurement of the anomalous magnetic moment of the muon shows an approximately 3σ deviation from the theoretical prediction of the Standard Model. Experiments have been searching for the CP-violating electric dipole moment as well, with many more experiments coming.

Lepton Dipole Moments, a review volume edited by Lee Roberts and William Marciano, begins with a historical perspective by Roberts and is followed by many excellent review articles. Articles are written by leaders of the field: Andrzej Czarnecki and Marciano on new physics and dipole moments, Michel Davier on g-2 vacuum polarization issues, Dominik

Stoeckinger on new physics in g-2, Yasuhiro Okada on models of lepton-flavour violation, Eugene Commins and David DeMille on the electric dipole moment of the electron, and many more.

One reason that lepton moments are interesting to pursue, even during these heady times of high-energy LHC collisions, is their sensitivity to “chirality enhanced” contributions from new physics. In the case of supersymmetry, some large-tan β theories can yield parametrically larger supersymmetric contributions than Standard Model contributions, increasing sensitivity to higher scales than usual electroweak precision tests allow. An analogous situation occurs for theories with large, new flavour- or CP-violating effects. Lepton dipole moment experiments are reaching levels of sensitivity that will make or break theories. For example, even theories of baryogenesis, which seem far remote at first thought from the vagaries of lepton dipole moments, “will be put to the ultimate test with the next generation of experiments”, as Maxim Pospelov and Adam Ritz rightly explain.

The energy frontier is not the only place to put fundamental physics under extreme test, as this volume attests. Roberts and Marciano have put together an excellent survey of lepton dipole moments and their certain power to change our world view whatever may come.

● James Wells, CERN.

Fundamental Interactions: A Memorial Volume for Wolfgang Kummer

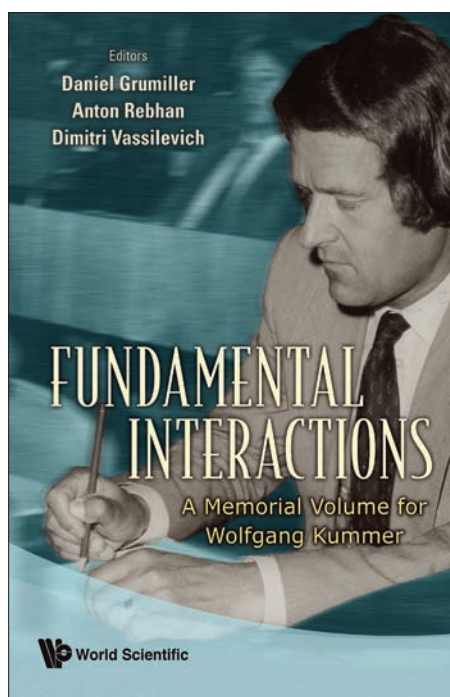
By Daniel Grumiller, Anton Rebhan and Dimitri Vassilevich (eds.)

World Scientific

Hardback: £76 \$111 E-book: \$144

It is nice that through this book homage is rendered to Wolfgang Kummer – a great physicist, a great administrator of European science, a warm personality and an excellent pianist, singer and skier. It is impossible for me to review in detail all of the contributions. I may know the field of quarkonium relatively well but it is not the case for gauge fixing or supergravity. However, I can see that the contributors all have a high reputation, which in turn proves the high level of Kummer’s research work.

I was particularly interested by Herwig Schopper’s contribution, which shows the important role that Kummer played at CERN, in particular when he was president of the CERN Council. It also helps to understand why the proposals of the Abragam commission that were followed by the CERN Council only in



part, i.e. early retirement but not additional funding to compensate it, have contributed to the current difficult situation with the CERN pension fund. I also appreciated Jack Steinberger's contribution, which summarizes the problems of global warming and energy resources, a subject that was dear to Kummer.

I would like to add just one remark: if, like me, you are satisfied by the CERN health insurance, Uniq (formerly Austria), you can be thankful to Wolfgang Kummer.

I can only recommend reading this book.

● André Martin, CERN.

Books received

Particle Dark Matter: Observations, Models and Searches

By Gianfranco Bertone (ed.)

Cambridge University Press

Hardback: £70 \$115 E-book: \$92

Aimed at graduate students and researchers, this book describes the theoretical and experimental aspects of the dark matter problem in particle physics, astrophysics and cosmology. Featuring contributions from 48 leading theorists and experimentalists,

it starts with an introduction to the observational evidence for dark matter together with a detailed discussion of the state-of-the-art in numerical simulations and alternative explanations in terms of modified gravity. It then moves on to the candidates arising from theories beyond the Standard Model and the prospects for detection at accelerators. It concludes by looking at direct and indirect searches and the prospects for detecting the particle nature of dark matter with astrophysical experiments.

Supersymmetric Solitons

By M Shifman and A Yung

Cambridge University Press

Hardback £64 \$116 E-book \$96

In the past decade methods and techniques based on supersymmetry have provided deep insights into QCD and other non-supersymmetric gauge theories at strong coupling. This book summarizes major advances in critical solitons in supersymmetric theories and their implications for understanding basic dynamical regularities of non-supersymmetric theories. The authors focus on three topics: non-Abelian strings and confined monopoles, reducing the level of supersymmetry, and domain walls as D-brane prototypes. They also provide a thorough review of issues at the cutting edge, such as non-Abelian flux tubes.

Quantum Mechanics Using Computer Algebra: Includes Sample Programs in C++, SymbolicC++, Maxima, Maple, and Mathematica (2nd edition)

By Willi-Hans Steeb and Yorick Hardy

World Scientific

Hardback £43 \$62

In this book, the authors implement methods in quantum mechanics using two popular computer algebra packages, SymbolicC++ and Maxima. The programs and outputs are accompanied with text that explains the underlying mathematics and physics in detail. Selected problems have also been implemented using two other popular packages – Mathematica and Maple – while some problems are implemented in C++. Modern developments in quantum theory are covered extensively and new research

topics added to this second edition include entanglement, teleportation, coupled Bose–Fermi systems and super-Lie algebras.

Non-Perturbative Field Theory: From Two-Dimensional Conformal Field Theory to QCD in Four Dimensions

By Yitzhak Frishman and Jacob Sonnenschein

Cambridge University Press

Hardback £75 \$130 E-book \$104

Providing a new perspective on quantum field theory, Yitzhak Frishman and Jacob Sonnenschein give a pedagogical and up-to-date exposition of non-perturbative methods in relativistic quantum field theory, introducing the reader to modern research work in theoretical physics. They describe in detail non-perturbative methods in quantum field theory and explore two- and four-dimensional gauge dynamics using those methods. The book concludes with a summary emphasizing the interplay between two- and four-dimensional gauge theories. Aimed at graduate students and researchers, it covers topics such as affine Lie algebras, solitons, integrable models, bosonization, four-dimensional conformal invariance, large N expansion, Skyrme model, monopoles and instantons.

Quantum Electronics for Atomic Physics

By Warren Nagourney

Oxford University Press

Hardback £45 \$85

While this book covers the usual topics, such as Gaussian beams, cavities, lasers, nonlinear optics and modulation techniques, it extends to areas not usually found in a textbook on quantum electronics. It includes such practical matters as the enhancement of nonlinear processes in a build-up cavity, impedance matching into a cavity, laser frequency-stabilization (including servomechanism theory), astigmatism in ring cavities and atomic/molecular spectroscopic techniques for the generation of a discriminant for laser frequency-locking. A number of very recent developments are also discussed, such as fibre lasers and frequency metrology using femtosecond lasers. Graduate students and researchers in atomic physics, as well as university lecturers, will find this a useful resource.

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