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Book reviews

A Short Introduction to Quantum Information and Quantum Computation, by M. Le Bellac, Cambridge University Press, Cambridge, 2006, pp. x + 167, £30.00, hardback (ISBN 0 521 86056 3). Scope: textbook. Level: undergraduate.

In the last 10 years quantum information has emerged as a highly active and interdisciplinary area of science. Due to the relative youth of the field the number of textbooks is still limited. The most comprehensive and still unsurpassed book, written by Nielsen and Chuang, was published some years ago by the same publisher as the book by LeBellac. Although the two books have almost identical titles they could not be more different. Nielsen and Chuang spend nearly 700 densely packed pages to build the foundations of quantum information and computation and explore in great detail their consequences. Their book is of the highest quality but its sheer size will frighten off one or the other potential reader. A shorter introductory text to the subject such as the one by Le Bellac is therefore welcome. Le Bellac explains the basic rules and formalism of quantum mechanics and then moves on to present some basic phenomena in quantum information such as quantum cryptography, the no-cloning principle, quantum teleportation, superdense coding and quantum error correction. A chapter is dedicated to the presentation of some basic quantum algorithms and another chapter briefly presents some very basic aspects of implementations. Clearly the book was aimed to be short and this shows the depth to which the various topics have been analysed. Some basic concepts have not been treated. This includes for example entanglement swapping (indeed Le Bellac claims, not quite correctly, that two particles can only be entangled if they have interacted) or entanglement and its local manipulation which provides the foundation of a great deal of quantum information. Some further reading has been provided but a more detailed list of references and articles for further reading might have been helpful for the inquisitive reader. A more experienced researcher browsing the book may also become alert to a very basic historical mistake in the Foreword. There it is claimed that quantum state teleportation was discovered in 1995 after Shor's factoring algorithm. A mistake such as this so early on will be spotted by many and does not add confidence as to the accuracy of material in the remainder of the book. A second edition will hopefully correct this and some other minor shortcomings to an otherwise solid text.

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Astronomical Spectroscopy: An Introduction to the Atomic and Molecular Physics of Astronomical Spectra, by J. Tennyson, Imperial College Press, London, 2006, pp. x + 192, £17.00, paperback (ISBN 1 8609 4529 5). Scope: textbook. Level: undergraduate and postgraduate.

Imaging in astronomy can be informative, but it is usually with spectroscopy that we can begin to understand the physics of astronomical objects and events. Jonathan Tennyson's *Astronomical Spectroscopy* is the most engaging introductory spectroscopy book I know of. This brief text emerged from a course Professor Tennyson gave to third-year undergraduates at University College London over several years. Chapter titles illustrate the plan of the book: The Nature of Spectra, Atomic Hydrogen, Complex Atoms, Helium Spectra, Alkali Atoms, Spectra of Nebulae, X-Ray Spectra, Molecular Structure, and Molecular Spectra.

The book is an introduction to spectroscopic physics with illustrations from and applications to astronomy. Only the most basic acquaintance with the ideas of quantum mechanics is assumed. It is intelligently written and the explanations are lucid. The explanation of spectroscopic notation for labelling energy states and transitions, e.g. $X^1\sum_g^+$, is the simplest and clearest I have ever seen. At several points possible confusion is anticipated and then addressed. The physical ideas are always immediately illustrated by astronomical applications. The book is replete with examples of astronomical spectra, and the entire electro-magnetic spectrum, from X-ray to radio, is represented. A good number of worked numerical examples are sprinkled throughout the text. Problems that give the reader a chance to apply the ideas are given at the end of each chapter, and model solutions are printed at the end of the book.

Without a doubt *Astronomical Spectroscopy* is the best book to read for anyone who is embarking on research in astronomical spectroscopy, as well as being the obvious

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text for an introductory course. It should certainly be on the shelves of every university and observatory library.

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Biological Physics of the Developing Embryo, by G. Forgacs and S.A. Newman, Cambridge University Press, Cambridge, 2005, pp. vii + 337, £35.00, hardback (ISBN 0 521 783372). Scope: textbook. Level: undergraduate and postgraduate.

Physicists usually take it as an article of faith that, at least in principle, all science must ultimately be explicable in terms of the laws of physics. Chemists, understandably irritated by the condescension inherent in this world picture are apt to retort: 'Yes, maybe, and in that case the useful parts of physics are called chemistry'. The reality, as usual, is far more complex, especially in the case of the connections between physics and biology. Even the simplest living system is so complicated that the application of physics seems at first sight unlikely to be helpful. Even knowing that only electromagnetic forces are involved, with some effect from gravity in particular cases, the sheer complexity of life seems at first sight overwhelming. Physicists usually work with simplified models of reality. They are unaccustomed to matter that displays goal-directed behaviour, for example, although it is absolutely normal and to be expected in living systems that have evolved with an ability and drive to reproduce. It is now understood, however, there are many cases where physics can in fact be applied directly to gain deeper understanding. This is still so, even at much higher levels of modelling than that of atoms and molecules where physics and chemistry and biology are well understood to meet together in their common discussion of DNA. The importance of physics in accounting for e.g. the operation of molecular motors, the architecture of biological individual cells, and the biomechanical properties of tissues is now widely appreciated by biologists.

Gabor Forgacs and Stuart Newman—respectively professors of biological physics and of cell biology and anatomy—have joined forces to produce a book about how physics can usefully be applied to biology, intended to be accessible to both biologists and physicists. It is an ambitious enterprise. As their exemplar they take the developing embryo, starting from a single cell, because it undergoes such an extraordinary series of changes with, correspondingly, many different stages where physics is of importance. As the authors point out, the role of physics is especially obvious in constraining and influencing the outcome during early development.

The book opens by introducing the eukaryotic cell (with a nucleus, the kind of cell of which plants and animals are made) in simple terms, but in sufficient detail to bring out its huge complexity. Relevant physical concepts and processes within the cell are then described, including free diffusion, directed diffusion, osmosis, viscosity, transport, elasticity, and viscoelasticity. The overdamped nature of the internal cell dynamics is emphasized, showing that inertial effects are essentially absent: net motion ceases almost instantly when the force is removed. This introduction sets the scene for most of what follows.

The second chapter describes the processes through which an embryo develops from a single cell to a multicellular aggregate or *blastula*. In the course of this description, many important concepts and definitions are introduced including e.g. DNA, chromosomes, microtubules, mitosis and cytokinesis. Another physical concept, surface tension, is introduced and deployed in modelling the first cleavage.

There follow eight chapters treating different aspects of the physics of the developing embryo including, to mention only a few examples, gene expression, oscillatory processes in cells, diversification, adhesion, cell sorting, gastrulation, neurulation, pattern formation, segmentation, development of the cardiovascular system, branching morphogenesis, vertebrate limb development, fertilization, calcium waves, and an example of an evolutionary transition: segmentation in insects.

There are numerous beautiful coloured illustrations to illuminate the structures and ideas discussed in the text, and are enormously helpful in clarifying some difficult concepts and sequences of events. Detailed material is confined to boxes so as not to break the flow of the narrative. Each chapter closes with a perspective paragraph to summarize what has been said and set it in context. There is a very substantial glossary of technical terms, which is indeed essential in a book of this kind, together with an extensive bibliography and a detailed and seemingly inclusive index.

Have the authors succeeded in their ambitious aim of being comprehensible to both physicists and biologists? I believe that they have. The average physicist will have to work quite hard, but everything he or she needs is there and the illustrations and glossary are a great help. Of course, the book only covers particular examples of the application of physics to biology, but the topics included are both interesting and remarkably diverse. I cannot speak for biologists, but physicists who read to the end will learn a lot. They will enjoy doing so, and they will gain an appreciation of the way in which quite simple physics often underlies the extraordinarily complex behaviour exhibited by living systems.

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Coding Theory and Quantum Computing, edited by D. Evans, J.J. Holt, C. Jones, K. Klintworth, B. Parshall, O. Pfister and H.N. Ward, American Mathematical Society, Providence, Rhode Island, 2005, pp. xiii + 147, paperback (ISBN 0 8218 3600 5). Scope: conference proceedings. Level: specialist.

Quantum information science has grown out of considerations of the impact that the quantum nature of physics has on the concepts of information. The field received a crucial boost by Shor's factorization algorithm which set off a strong growth of interest in the field. But it was Wiesner's idea of conjugate coding and Bennett's discovery of quantum cryptography that addressed communication problems and have led to experimental demonstrations of their ideas. The proceedings *Coding Theory and Quantum Computing* address these two key areas of communication and computation. As with all proceedings the time lag between the actual conference and the publication of the book is quite large. In a rapidly moving field such as quantum information this means that the book will not generally contain the very latest developments in the field, even if the conference itself was at the cutting edge. Nevertheless, this volume is a good one. It starts off with a nice introduction briefly describing the contents and placing them into context. The book itself is split into two parts, Coding Theory and Quantum Computing. The first part is considerably more formal than the second and it seems to address perhaps somewhat more specialized questions. In the second part I enjoyed all contributions including quantum random walks, continuous variable versions of the Shor algorithm, a provocative discussion on photonic entanglement and a discussion of distributed quantum computation. Personally perhaps, I found the work on 'Entanglement beyond subsystems' particularly interesting. Of course, as with most relevant literature in quantum information science most articles in this book may also be found on the E-print arxiv quant-ph. Nevertheless the Editors did add value to the book both with the useful introduction and the collection of interesting challenges and open questions that had emerged from discussions at the meeting. All in all, this is a good conference proceeding.

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Deep Space Probes. To the Outer Solar System and Beyond, 2nd edition, by G.L. Matloff, Springer, Berlin, 2005, pp. xxx + 242, £84.50, hardback (ISBN 3 540 24772 6). Scope: popular survey. Level: general reader.

This is the second edition of a quite fascinating book. The author makes clear in his Preface to this enlarged and updated version that he has multiple goals. The main one is to provide a technical guide to as many aspects as possible of interplanetary and, potentially, interstellar space travel, as they might be undertaken by both humans and robotic systems. However, almost as important is to convey to readers the inherent fragility of planetary environments on various timescales (some of our own making), and the implied desirability of finding a realistic way of getting a sample of the human gene pool permanently off the Earth to help ensure our survival.

A technical guide to current and possible near-term spacecraft propulsion systems forms the core of the book. Topics include conventional reaction rockets, gravity-assist manoeuvres, solar electric drives, and solar sails—all systems that are either in common use or at least have been tested. After an excursion into possible applications of nanotechnology, the author moves on in later chapters to more exotic systems such as nuclear electric and nuclear-pulse propulsion and applications involving nuclear fusion and matter–antimatter annihilation. Finally, some even more speculative ideas are presented, ranging through ramjets and magnetic surfing to systems involving relativistic effects. The range here is extremely great, from the currently commonplace to the very improbable, but the common denominator is that in every case the underlying physics is clearly explained and the mathematical analysis of the potential of the system is given. The final few chapters deal with the search for extra-solar planets, the likelihood of life evolving such bodies, the practical problems associated with long-term travel through a vacuum (and the consequent desirability of sending von Neumann machines rather than people as interstellar explorers), and the chances of making meaningful contacts with extraterrestrials assuming that they exist.

One thing brought home to me by reading the bibliographies in this book (each chapter has one) is the extent to which the more exotic potential spacecraft propulsion systems have been explored. This has been done both theoretically and also in many cases in engineering studies, not only by speculative fiction writers (some of whom 'invented' some of these systems) but also very seriously by various national space agencies. In one sense this book is very technical: it has at least one, often several, quantitative exercises for the reader in every chapter; there are lists of nomenclature and relevant physical constants, and a very useful glossary of terms. However, the work is also very accessible and thought-provoking, and it should find a home with a wide variety of readers with an interest in space technology.

Professor L. Wilson
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Ludwig Boltzmann: The Man Who Trusted Atoms, by C. Cercignani, Oxford University Press, Oxford, 2006, pp. xvii + 329, £19.99, paperback (ISBN 0 198 57064 3). Scope: scientific biography. Level: undergraduate, postgraduate and general reader.

Ludwig Boltzmann was one of the towering figures who marked the transition from nineteenth to twentieth century science. It is not generally realized that in his era the very existence of atoms still remained controversial. Boltzmann was convinced of their reality at an early stage, but was surrounded by distinguished sceptics such as Mach and Ostwald who seemingly regarded atomism as no more than an amusing fairy-story. So he had to fight hard for his ideas. Of course, he was right. Not only was he (at least as much as Gibbs) the father of statistical mechanics, but his ideas exerted strong influence on his contemporaries and successors, including Hilbert, Planck and Einstein. Boltzmann's life was tortured by the mood-swings associated with manic depression, and a restlessness of spirit. Even when already famous, he needlessly changed universities on several occasions, often to a less congenial environment than the one he was leaving. Carlo Cercignani's lovingly crafted book describes all this and works well, on many levels. It is both a personal and a scientific biography. Much interesting technical material (including almost all the equations) is consigned to appendices, so the main text can be read by anybody. Readers will gain a sympathetic understanding of this sensitive, cultured and anguished man as well of his enormous contributions to science. Although the author is properly reticent about the reasons for Boltzmann's suicide while on holiday in Duino near Trieste in 1906—he left no suicide note and nobody knows the specific reason for the act—it becomes clear that his tragic end was in a sense almost inevitable. The author quotes Höflechner's words, that Boltzmann '...switched universities for the last time and entered the one great university of the immortal intellectual giants of science'.

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Mathematical Tools for Physicists, edited by G.L. Trigg, Wiley-VCH Verlag GmbH & Co., Weinheim, 2005, pp. x + 676, £85.00, hardback (ISBN 3 5274 0548 8). Scope: Monograph. Level: advanced students.

Mathematics is the indispensable tool for developing any theory and obtaining any quantitative result in physics, engineering and many other disciplines.

However, the mathematical field and techniques have expanded so much that even a mathematician has problems to contend with the whole branch. For a physicist or an engineer the knowledge of mathematics and its methods is fundamental, but he cannot embrace all of it. So he finishes up specializing his knowledge to those aspects that are the most useful for his work. But there is an entire world that remains out and could help if known and mastered.

This book is intended to give in an accessible, user oriented way the fundamentals of a number of different fields of mathematics omitting in general demonstrations, but giving the results in a simple, understandable and useful way.

A number of arguments of importance are treated ranging from fundamentals like algebraic methods (A.J. Coleman), analytic methods (C. Harper), geometrical methods (V.A. Kostelecky), group theory (M. Hamermesh), topology (S.P. Smith) to commonly used techniques like Fourier and other mathematical transforms (R.N. Bracewell), Green's functions (K. Ohtaka), perturbation methods (J. Mardock), special functions (C. Harper), variation methods (G.W.F. Drake). Special arguments which have received large attention in the recent past also have a place like fractal geometry (P. Meakin), stochastic processes (M. Lax), symmetries and conservation laws (G. Segrè). A few arguments which are on the forefront of research like quantum computation (S.L. Branstein) and quantum logic (D.J. Foulis, R.J. Greechie, M.L. Dalla Chiara and R. Giantini) are also presented.

Today great use is made of numerical simulations and calculations. One may find three articles in this book devoted to this: mathematical modelling (K. Hartt), Monte Carlo methods (K. Binder) and numerical methods (C.C. Christera and K.R. Jackson).

The 18 articles also contain a number of examples and applications modelled on physical problems. Each article has been written by a renowned expert in its field. The result will be beneficial for advanced students as well as for the researchers. The first may find a comprehensive introduction which may be very useful for further study and is also good for a synthesis of recently studied matter while the latter may use it as a quick reference.

Fast access to the information is attained by a compressed and well-divided presentation with clear titles for the paragraphs enlightening the different subjects and each article includes a glossary of terms, the essential bibliography and a guide to further reading.

The articles originally appeared in the *Encyclopedia of Applied Physics*, a twenty-three volume set edited by George L. Trigg and published in the 1990s by VHC. Each article in the present volume covers a part of mathematics especially relevant to applications in science and engineering. As a whole the articles give a good overview of the subject in a relatively short space with indications of applications in applied physics. Being separately authored, they fulfill their task in a range of values ranking from excellent to less easy to understand, but as a whole the scope is obtained.

Of course, not all of mathematics can be covered in a single volume and the selection has been done which results is rather good in covering most of the material in more common use. I recommend it to everybody: students or researchers working in physics or engineering.

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Pattern Formation: An Introduction to Methods, by R. Hoyle, Cambridge University Press, Cambridge, 2006, pp. x + 422, £45.00, hardback (ISBN 0 521 81750 1). Scope: textbook. Level: advanced undergraduate and postgraduate.

The natural world is full of patterns, many of which are strikingly beautiful. An intriguing feature is that remarkably similar-looking patterns can arise in entirely different contexts. For example, sand ripples created by the desert wind take much the same form as the stripes on a zebra's flanks; and both resemble convection rolls and the stripe patterns that develop by aggregation in a thin layer of small particles on a horizontally-shaken substrate. In each case there is a pattern of stripes incorporating defects such as dislocations. A strong implication of such correspondences is that the underlying mathematics in each of these examples must also be very similar. A vigorous research activity is in progress to try to understand the formation and evolution of patterns, and the reasons why one kind of pattern is preferred over another in any particular case.

Rebecca Hoyle's book originated in a lecture course that she gave in Cambridge. It is intended to provide an introduction to the range of methods now available for the analysis of natural patterns, at a level suitable for postgraduates or final year undergraduates. Her emphasis is on using symmetries to describe universal classes of pattern, rather than in treating particular physical examples.

The book opens with introductory remarks about what is meant by a pattern—structures that strike the eye as being regular in some way, often being spatially periodic, at least locally. The introductory chapter gives a short survey of the kinds of natural patterns that occur. In addition to stripes, there are, e.g. squares and hexagons, rotating spirals and pulsating target patterns. The author offers several examples including irregular hexagonal patterns on giraffes and in convecting cooking oil (and provides a recipe for the latter experiment), spiral patterns in the Belousov–Zhabotinsky reaction, Turing patterns in reaction–diffusion systems and Faraday waves (standing wave patterns on the surface of a vertically vibrated layer of fluid). The rest of the book is devoted to a more detailed and rigorous devlopment of these initial ideas.

Chapters 2 and 3 provide the necessary background in bifurcation theory and group theory, respectively, both of which are needed for analysis of the patterns. Chapters 4–11 are the real meat of the book. They bring together a number of different methods. The topics covered include bifurcations with symmetry, simple lattice patterns, superlattices and hidden symmetries, spatial modulation, instabilities of stripes, travelling plane waves, spirals, large-aspect-ratio systems and the Cross–Newell equation. The treatment is necessarily detailed and mathematical, but the author goes to considerable lengths to explain what is going on as clearly as possible.

The book is attractively produced and well written in an engaging style. There are exercises for the student at the ends of chapters 2–11, an extensive bibliography, and a good index. I suspect that general physics undergraduates, even in their final year, will find the main part of the text quite demanding; it is more for mathematicians and theoretical physicists. However, any physicist should be able to read the first chapter with interest and enjoyment, and he or she can then dip into the sections of chapters 2–11 relevant to his or her particular interests. The author is to be congratulated on producing a fine book that promises to be of continuing value to the diverse group of scientists and mathematicians interested in pattern formation and, in particular, to PhD students entering this fascinating area of interdisciplinary investigation.

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Physics of Solitons, by T. Dauxois and M. Peyrard, Cambridge University Press, Cambridge, 2006, pp. xii + 422, £40.00, hardback (ISBN 0 521 85421 0). Scope: monograph. Level: undergraduate and postgraduate.

John Scott Russell's 1834 observation of what he called 'The great solitary wave' was a remarkable discovery by an interesting man whose achievements were not appreciated within his own lifetime. He was riding his horse along the Union Canal near Edinburgh, watching a barge being pulled along the narrow channel by a pair of horses. When the barge suddenly stopped, the water that had been moving with it surged on to create a solitary wave—a 'rounded smooth and well defined heap of water' travelling at eight or nine miles per hour, preserving its shape as it moved. On his horse, he was able to follow it, overtake it, watch it as it travelled, and cogitate about it. It made a deep impression on him, and he subsequently performed several experiments on such waves, both on canals and in tanks. His 1844 report summarizing the results for the 14th meeting of the *British Association for the Advancement of Science* was so strongly criticized by Airy and Stokes, however, that he abandoned the research completely (though he continued to excel in other directions in his profession as an engineer). His discovery was successfully re-enacted during a conference at nearby Heriot-Watt University in 1995.

It was not until 1895 that a satisfactory understanding of Russell's observations and experiments was achieved, through the work of Kortweg and de Vries. Their KdV equation has remarkable mathematical properties that encompass the characteristic features of what are now called solitons. For example, there are solutions involving surface waves that travel without change of shape and proceed at supersonic velocity, i.e. exceed the speed of small-amplitude linear surface waves. Since then, it has become evident that solitons and soliton-like phenomena occur widely in physics and in the natural world, e.g. as tsunami and in optical fibres, nonlinear electrical lines, blood pressure waves, ferroelectric materials, ferromagnetism and antiferromagnetism, conducting polymers, Bose–Einstein condensates and perhaps DNA.

Thierry Dauxois and Michel Peyrard have put together an extensive monograph describing the mathematical physics of solitons. Their book consists of 16 chapters grouped into four parts, plus appendices. The text opens with a friendly and interesting introduction to motivate the reader and set the context. The four chapters of Part I cover respectively nontopological solitons and the KdV equation, topological solitons and the sine-Gordon equation, the nonlinear Schrödinger equation, and ion-acoustic waves in a plasma as an example of soliton modelling. Part II consists of three chapters giving an account of the mathematical methods available for treating solitons. There are seven chapters in Part III dealing with a diversity of different applications (and possible applications) of solitons. These include respectively: the 1955 Fermi–Pasta–Ulam (FPU) paradox, which was instrumental in stimulating the rediscovery and modern understanding of solitons; dislocations in crystals; ferroelectric domain walls; incommensurate phases; magnetic systems; conducting polymers; and Bose–Einstein condensates. There are just two chapters in Part IV discussing the possible role of solitons in energy localization/transfer in proteins, and in the statistical physics of DNA. The three appendices provide respectively a derivation of the KdV equation for surface hydrodynamic waves, a synopsis of the main results of Lagrangian and Hamiltonian mechanics for continuous media (which is where, in practice, most systems' soliton-like excitations arise), and a discussion of the coherent states of a harmonic oscillator. The text is very well written, albeit with slightly too many exclamation marks, and should be accessible to a wide readership.

Just before the appendices there is a reflective Conclusion addressing directly the question of whether or not physical solitons can really be considered to exist—which in a sense is a philosophical problem. The discussion is motivated by the 'overselling' of solitons by certain enthusiasts, and by the resultant critical reactions by sceptics. The problem, as the authors point out, is that the equations describing real physical systems are not precisely of soliton form, but may include extra terms. Consequently, their behaviour is soliton-like, rather than being precisely of the form predicted for idealized mathematical solitons. The authors discuss the issue sensitively and cautiously. In doing so, they point out that in treating real systems a choice may sometimes exist between using a linear model and then adding extra terms to reflect reality, or modelling with solitons and, again, adding some extra terms. They suggest, persuasively, that there may be many instances where the latter approach is the more appropriate and revealing.

A great deal of care and attention to detail has gone into making *Physics of Solitons* attractive and interesting on many levels. There are pictures and short vignettes of a dozen of the scientists whose work is featured in the book, including, e.g. Davydov, de Vries, Fermi, Korteweg and Tsingou, as well as John Scott Russell himself. The many illustrations and figures have full and helpful captions, and there are striking photographs of some natural solitons such as internal waves on the Andaman Sea. There is an extensive (though select) bibliography. The authors have taken the opportunity of setting the historical record straight for Mary Tsingou who performed the computing (on MANIAC at Los Alamos) that led to the discovery of the celebrated FPU paradox, but who was not included in the authorship of the famous paper that resulted from her work.

The authors stress that 'The book does not claim to be exhaustive', which is reasonable given the enormous literature on solitons. Nonetheless it is a substantial and carefully considered work with a broad coverage. It seems to me ideal as an introduction to the field for undergraduate or postgraduate physicists, or for any numerate scientist who wishes to learn something about solitons, and it can be recommended very warmly to them all.

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Quantum Information and Computing, edited by L. Accardi, M. Ohya and N. Watanabe, World Scientific, Singapore, 2006, pp. ix + 384, £56.00, hardback (ISBN 981 256 614 7). Scope: conference proceedings. Level: specialist.

There is an ever increasing number of conferences in the area of quantum information science and a certain fraction of such conferences will be accompanied by proceedings. While it is often desirable to document the scientific content of a conference, proceedings usually suffer from a considerable time delay between the conference and the publication of the proceedings. In the case of *Quantum Information and Computing* this delay was a not unusual 3 years. It is thus unavoidable that some contributions will not be as timely at the time of publication as they were on the occasion of the conference. To compensate for this unavoidable problem it would then be desirable that a proceedings volume offer some added value. This could be a careful introduction putting the various contributions into context or perhaps a list of pressing open questions. Unfortunately, this volume does not offer such a feature. The present volume contains 31 contributions with an average length of about 12 book pages. This certainly forced the authors to be concise. The majority of the contributions are concerned with abstract aspects of quantum information processing and their mathematical formulation. The implementation of quantum information processing is less well represented. Two articles are concerned with distillation methods and there is some material on information processing with beam splitters. An interesting piece in that direction discusses 'Logical operations realized on the Ising chain of N qubits' employing the intrinsic dynamics of the Ising chain to support quantum information processing. The contribution on 'Simulating open quantum systems with trapped ions' explains how this system can be used to simulate the paradigmatic model of a damped harmonic oscillator for various bath correlation functions and is of some interest. If you are interested in the formal aspects of quantum information then you will find much more material to interest you but I am less well placed to comment on those. I certainly enjoyed the contribution 'Saturation of an entropy bound and quantum Markov states' and there are various others of interest. Many other contributions are included in the book but despite this I am unsure that I would spend the money for the hardback edition.

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Series Expansion Methods for Strongly Interacting Lattice Models, by J. Oitmaa, C. Hamer and W. Zheng, Cambridge University Press, Cambridge, 2006, pp. x + 327, £70.00, hardback (ISBN 0 521 84242 5). Scope: textbook. Level: postgraduate.

Strongly interacting quantum many body systems are of great importance for example in Statistical Physics and Condensed Matter Physics. Needless to say such models are generally very hard to solve. A few exactly solvable models are known in one spatial dimension but beyond that approximation methods must be used. One such approach is provided by series expansion techniques which are the subject of the book by Oitmaa, Hamer and Zheng. These methods provide a systematic approach to the study of lattice models and have had many successes, for example, in the determination of the position of critical points, critical exponents etc. Needless to say, like all approximation methods, a certain degree of 'black magic' is deployed when working with such methods. This 'black magic' is often hard to learn from papers in refereed journals and it is therefore always important to find a high quality textbook that introduces the novice to the field as well as its tricks of the trade. In the first two chapters of their book, the authors introduce the basic motivation for studying lattice models and present the basic ideas behind series expansion methods. These methods are then applied to a wide variety of models including the Ising and Heisenberg model in one and more spatial dimensions at zero temperature. Extensions of the methods to finite temperatures and the study of excitations are presented. Apart from basic spin models electron models are investigated. Two full sections are devoted to the introduction of lattice gauge models and the application of series expansion methods to these models. Connections to other methods including flow methods are briefly discussed in the last section.

In my own work I recently needed to use results that had been obtained from series expansion methods and I therefore had some exposure to the literature in the field. I have certainly benefitted from reading the present book as some aspects of the area are now much clearer. Generally I find the book by Oitmaa, Hamer and Zheng a useful resource both for results in the field and explanations of basic methods. The level is such that a student that wishes to embark on a PhD in the field would be able to follow the book quite easily and gain a very good introduction to the field.

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The Structure and Properties of Water, in the Oxford Classics Series, by D. Eisenberg and W. Kauzmann, Oxford University Press, Oxford, 2005, pp. xii + 296, £32.50, paperback (ISBN 0 198 57026 0). Scope: monograph. Level: undergraduate and postgraduate.

We are composed mostly of water. Life as we know it depends on liquid water, and most of the Earth's surface is covered with it. Water, or the lack of it, is centrally involved in many human activities and disasters including floods, droughts and wars. So the properties of water are of crucial importance for us all. In the civilised world, most people expect hot and cold running water at the turn of a tap, and they are well familiar with water's phase transitions to ice in their freezers and steam in their kettles. Yet few of them stop to wonder why the specific and latent heats of water are so big, or why ice floats. So this re-issue of the classic text by Eisenberg and Kauzmann is greatly to be welcomed. The authors have pulled together salient information about water from a multiplicity of sources and made it into a coherent whole, concentrating on how its physical properties are related to its structure. There are chapters on the water molecule, its vapour, ice, liquid water, and models of water. Interatomic and intermolecular forces, structure, and thermal and spectral properties are all treated in considerable detail.

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Why does a Ball Bounce? by A. Hart-Davis, Ebury Press, London, 2005, pp. 224, £14.99, hardback (ISBN 0091902681). Scope: popular survey. Level: general reader.

How can one make science interesting for non-scientists and, even more important, for young potential scientists? At a time of disappointing science enrolments in universities, when science often seems to be misunderstood and generally under-appreciated by journalists and opinion-formers in the press and other mass media, and when much of the physics teaching in our schools is having to be carried out by non-physicists, the question is of crucial importance.

One answer is to try to 'wow' the audience by descriptions of the counter-intuitive effects and strange phenomena observed in, and predicted by, modern physics—quantum entanglement, black holes, wormholes in space–time, cosmic strings, and so on. A well-known popular science magazine that formerly provided clearly-written factual articles explaining how things work, is now largely given over to material of this kind. The difficulty of this approach—apart from the often speculative character of the subject matter and the tedium involved in the endless repetition of the same themes in slightly different guises—is that these topics are totally unreal to most of the readers. There is no way they can set them in context, and they lack the basic scientific background to have any intuitive gut-feeling for the significance of what is being presented. They might as well be reading fairy stories, or fantasy novels, because of the utter remoteness of the material from everyday experience. It may provide a form of light entertainment, but it is unlikely to inspire future scientists. Nor does it give the general public much idea of what science is about or of what scientists actually do.

Adam Hart-Davis adopts a totally different approach. He has produced a popular science book that concentrates on observable phenomena, many of which will be familiar to readers from within their own experience. It takes the form of 101 questions and answers, divided into sections covering air, earth, water, fire (i.e. the ancient 'elements') as well as light, ice and rain, mathematics, technology, plants, animals and health. Many of the questions are ones that an inquisitive child might ask, for example: What is the greenhouse effect? How old is the Earth? How are rocks made? How do water drops bounce? Why is a shower warmer in the middle? Why does a match catch fire? What are firework sparks? Why is the sky blue? How do TV programmes travel down a cable? Why does ice cool your drink? Why do some icicles have bubbles in the middle? Why don't knots come undone? How do radar guns work? How do nettles sting? What's the oldest thing alive? Could dinosaurs swim? How do diseases spread? What happens in a cardiac arrest? And many, many others. The answer to each question is given across two pages: one page of text and one with an interesting image or picture in full colour. The words are carefully chosen, easy to read and understand, devoid of jargon, and provide a huge amount of information. Sometimes they diverge interestingly away from a strict answer to the question asked. Additional asides, placed in 'Did you know?' boxes, are often intriguing.

The book is attractively produced in hardback with high quality paper and graphics. Despite the huge scope of the work, the bits I know something about are accurate and well described—and I note from the Acknowledgements that the author had taken the care to have parts of the text checked by an assortment of distinguished experts. There is an excellent index. *Why Does a Ball Bounce?* will make an ideal present for a bright child, with much material to inform as well as to stimulate the scientific imagination. Adult non-scientists will find it equally entertaining and there is not the slightest trace of condescension in the exposition. Above all, the book is fun to read. I suspect it may in practice do as much to help draw school children into science as any number of worthy government initiatives.

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