Mathematica for Theoretical Physics: Electrodynamics, Quantum Mechanics, General Relativity and Fractals

2006 J. Phys. A: Math. Gen. 39 15311

(http://iopscience.iop.org/0305-4470/39/49/B01)

J. Phys. A: Math. Gen. **39** (2006) 15311–15312 www.iop.org/Journals/ja

Book reviews

Mathematica for Theoretical Physics: Electrodynamics, Quantum Mechanics, General Relativity and Fractals
G Baumann
2005 Springer
410pp £54.00 (hardback) ISBN 0-387-21933-1

The main focus of the second, enlarged edition of the book *Mathematica for Theoretical Physics* is on computational examples using the computer program Mathematica in various areas in physics. It is a notebook rather than a textbook. Indeed, the book *is* just a printout of the Mathematica notebooks included on the CD. The second edition is divided into two volumes, the first covering classical mechanics and nonlinear dynamics, the second dealing with examples in electrodynamics, quantum mechanics, general relativity and fractal geometry.

The second volume is not suited for newcomers because basic and simple physical ideas which lead to complex formulas are not explained in detail. Instead, the computer technology makes it possible to write down and manipulate formulas of practically any length.

For researchers with experience in computing, the book contains a lot of interesting and non-trivial examples. Most of the examples discussed are standard textbook problems, but the power of Mathematica opens the path to more sophisticated solutions. For example, the exact solution for the perihelion shift of Mercury within general relativity is worked out in detail using elliptic functions.

The virial equation of state for molecules' interaction with Lennard-Jones-like potentials is discussed, including both classical and quantum corrections to the second virial coefficient. Interestingly, closed solutions become available using sophisticated computing methods within Mathematica. In my opinion, the textbook should not show formulas in detail which cover three or more pages—these technical data should just be contained on the CD. Instead, the textbook should focus on more detailed explanation of the physical concepts behind the technicalities. The discussion of the virial equation would benefit much from replacing 15 pages of Mathematica output with 15 pages of further explanation and motivation. In this combination, the power of computing merged with physical intuition would be of benefit even for newcomers.

In summary, this book shows in a convincing manner how classical problems in physics can be attacked with modern computing technology. The second volume is interesting for experienced users of Mathematica. For students, the textbook can be very useful in combination with a seminar.

Stefan Heusler
Duisburg-Essen University, 47057 Duisburg, Germany

doi:10.1088/0305-4470/39/49/B01

Modern Supersymmetry
J Terning
2005 Oxford University Press
336pp £55.00 (hardback) ISBN 0-19-856763-4

We have spent more than twenty years applying supersymmetry (SUSY) to elementary particle physics and attempting to find an experimental manifestation of this symmetry. Terning's monograph demonstrates the strong influence of SUSY on theoretical elaborations in the field of elementary particles. It gives both an overview of modern supersymmetry in elementary particle physics and calculation techniques.

The author, trying to be closer to applications of SUSY in the real world of elementary particles, is also anticipating the importance of supersymmetry for rigorous study of nonperturbative phenomena in quantum field theory. In particular, he presents the 'exact' SUSY β function using instanton methods, phenomena of anomalies and dualities.

Supersymmetry algebra is introduced by adding two anticommuting spinor generators to Poincaré algebra and by presenting massive and massless supermultiplets of its representations. The author prefers to use mostly the component description of field contents of the theories in question rather than the superfield formalism. Such a style makes the account closer to physical chartacteristics.

Relations required by SUSY among β functions of the gauge, Yukawa and quartic interactions are checked by direct calculations as well as to all orders in perturbation theory, thus demonstrating that SUSY survives quantization.

0305-4470/06/4915311+02$30.00

A discussion is included of the hierarchy problem of different scales of weak and strong interactions and its possible solution by the minimal supersymmetric standard model. Different SUSY breaking mechanisms are presented corresponding to a realistic phenomenology.

The monograph can also be considered as a guide to 'duality' relations connecting different SUSY gauge theories, supergravities and superstrings. This is demonstrated referring to the particular properties and characteristics of these theories (field contents, scaling dimensions of appropriate operators etc). In particular, the last chapter deals with the AdS/CFT correspondence.

The author explains clearly most of the arguments in discussions and refers for further details to original papers (with corresponding arXiv numbers), selected lists of which appear at the end of each chapter (there are more than 300 references in the book).

Considered as a whole the book covers primers on quantum fields, Feynman diagrams, renormalization procedure and renormalization groups, as well as the representation theory of classical linear Lie algebras. Some necessary information on irreducible representations of $su(N)$, $so(N)$ and $sp(2N)$ is given in an appendix.

There are in the text short historical and biographical notes concerning those scientists who made important contributions to the subject of the monograph: S Coleman, Yu Golfand, E Witten and others.

Most of the seventeen chapters contain a few exercises to check the reader's understanding of the corresponding material.

This monograph will be useful for graduate students and researchers in the field of elementary particles.

Petr P Kulish
Steklov Mathematical Institute, Fontanka 27, 191023 St Petersburg, Russia

doi:10.1088/0305-4470/39/49/B02