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REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

The numbers in brackets are assigned according to the American Mathematical Society classification scheme. The 2000 Mathematics Subject Classification can be found in print starting with the 1999 annual index of *Mathematical Reviews*. The classifications are also accessible from `www.ams.org/msc/`.

1[65P10, 65Lxx, 70Fxx, 70H05]—*Simulating Hamiltonian dynamics*, by Benedict Leimkuhler and Sebastian Reich, Cambridge Monographs on Applied and Computational Mathematics, Vol. 14, Cambridge University Press, Cambridge, 2004, 379+xvi pp., hardcover, US$75.00, ISBN 0-521-77290-7

The numerical treatment of ordinary differential equations essentially developed in three periods—nonstiff, stiff, and structure-preserving integrators. The third of these topics, which is also known under the name "geometric numerical integration", is the most recent one, and comprehensive textbooks on this subject are still rare. The subject gives rise to many beautiful mathematical theories, and it has applications in all sciences concerned with conservative dynamical systems. It is particularly important for long-time simulations in celestial mechanics and in molecular dynamics.

Written by two experts in the field, the book under review is intended for a broad audience of scientists and assumes only basic knowledge in calculus, linear algebra, and differential equations. It is therefore not only accessible for mathematicians and physicists, but also for engineers who want to learn more about the methods they use for their simulations. Furthermore, this book avoids difficult proofs and technical details, but gives suitable hints to the literature for additional reading. This makes it possible to cover in about 350 pages a wide range of interesting topics in the field of geometric numerical integration.

The book starts on a very elementary level with a short discussion of N-body problems as they arise in astronomy and molecular modeling. It explains the basic concepts of one-step integration methods for ordinary differential equations and discusses Hamiltonian problems with constant structure matrix. It further introduces symplectic and time-reversible one-step discretizations with emphasis on splitting methods, it presents the main ideas of backward error analysis and its importance for getting insight into the long-time behaviour of geometric integrators, and it briefly discusses higher-order symplectic methods: splitting and composition, (partitioned) Runge–Kutta methods, methods based on generating functions, and variational integrators. Starting with Chapter 7, the book discusses more special questions: constrained Hamiltonian systems with application to rigid body dynamics, the use of variable step sizes with geometric integrators, and the treatment of Hamiltonian systems with highly oscillatory solutions. Particular attention is paid to simulations in molecular dynamics and to multisymplectic discretizations of partial differential equations.

Everyone interested in the long-time simulation of conservative dynamical systems will find this monograph very useful as an introduction to the subject and as a complement to the existing literature.

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