A more accurate title, perhaps, would be *Lectures on Geometric Mechanics*. Specifically, this book summarizes work mostly since 1980 on geometric formulations of Hamiltonian mechanical systems with symmetry, largely as developed by Marsden and his students and coauthors. Few of the results are new, but some ideas have matured since they first appeared and are more accessible as gathered here. Regrettably, few connections are made to modern work by other schools of mechanics; the field is ripe for a critical comparison and, hopefully, linkage of various approaches. However, extensive references to the primary literature make this book an excellent springboard into this view of mechanics.

As presented here, the geometric approach to symmetric mechanical systems is based largely on the idea of the "mechanical connection," a geometrical construct on a configuration space with a symmetry group. This connection facilitates comparison of different level sets for the momentum in phase space. It has appeared in various guises in the literature; the presentation here serves as a good entry to these various previous uses, but there is still a sizable chunk of machinery to master. Using this connection, the author explains the "energy momentum method" and geometric phases. The former leads to a block diagonal normal form, useful for studying stability and bifurcation. The double spherical pendulum serves to illustrate these results. (Another major stability result using this method, only mentioned in the book, is the work of Lewis and Simo (1990) on semirigid bodies.) The idea of geometric phase (or "Berry's phase") is applied to questions of stabilization and control, including an interesting comparison of optimal control to Yang–Mills particle dynamics. A sketchy chapter on "mechanical integrators" (numerical integration schemes that preserve some specified mathematical structure, such as the symplectic form or the momentum) uses the same differential geometric description of mechanics, but otherwise seems only weakly related to the rest of the book.

The intended audience is unclear; the background expected of the reader varies widely through the book, perhaps because it is based on lectures given to different audiences. Much (but not all of) Chapter 1 seems to be aimed at a general mathematical audience: basic notions like cotangent bundle and symplectic form are described as if the reader might not be acquainted with them. A highly motivated graduate student, already acquainted with bundles and connections, could use Chapter 2, "A Crash Course in Geometric Mechanics," to get started in this field. (Unfortunately, the backup reference given, Marsden and Ratiu's book *Symmetry and Mechanics*, is unavailable; as of the writing of this review, the release datę has passed, again, with no sign of the book.) Parts of later chapters are also suited to this highly motivated student (or a researcher from a related field, seeking to learn this one). But many sections will communicate only a few general ideas except to the expert in Hamiltonian dynamics.

The detailed index and extensive list of references (25 pages) are quite useful given the breadth of material covered in the book. References include Jacobi, Riemann, Poincaré, and other giants of the 19th and early 20th centuries, but the majority are to the math and physics literature since 1980. A third to a half are by Marsden, his students, and his coauthors. Unfortunately the utility is reduced by the number of errors and anomalies. Several references mentioned in the text are omitted from the bibliography (or else are stated with the wrong year in one place or other). Locating some terms in the text via the index almost requires clairvoyance on the part of the reader, e.g. "horseshoes" can be found alphabetically under "a" for "admits horseshoes"; and other important terms are omitted altogether.

The book is in general well produced: even small subscripts are readable and the diagrams and figures are clear. But the publisher might consider wider central margins, so that the the pressure needed to open the book wide enough to read is not so close to the spine breaking point!

REFERENCE

D. R. LEWIS AND J. C. SIMO (1990), *Nonlinear stability of rotating psuedo-rigid bodies*, Proc. Roy. Soc. London A, 427, pp. 281–319.

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Handbook of Writing for the Mathematical Sciences. *By Nicholas J. Higham*. Society for Industrial and Applied Mathematics, Philadelphia, PA, 1993. 241 pp. $21.50, softcover. ISBN 0-89871-314-5.

Handbooks for writers are like gardening manuals—filled with sound advice yet often of little use for resolving problems that arise in practice. Mathematical writing presents special technical difficulties, but the best examples share the characteristics of all good scientific exposition, more a reflection of clear thinking than the result of following certain precepts. Reading widely, noting ways the masters achieve their special clarity, remains the key to developing one's own style. Still, for a student preparing to write a thesis or research article, a handbook like this one might put the writing task in perspective. In fact, Higham says his book grew out of notes for a graduate course on mathematical writing he gave at the University of Manchester in 1992.

Chapter 3, Mathematical Writing, contains much useful mathematical folklore such as: "By convention, *if* means *if and only if* in definitions," "When a displayed formula is too long to fit on one line it should be broken before a binary operation," and "It is common practice [in definitions] to italicize the word that is being defined."

Chapter 4, English Usage, is also filled with good advice such as "Try not to begin a sentence with *there is* or *there are*" and "Replace *which* by *that* whenever it sounds right to do so."

Chapter 7 gives many examples of improving sentences, paragraphs, and even a page-long article, by thoughtful revision. Here the author's sharp eye and good sense are evident. I enjoyed playing editor while reading these examples of flawed mathematical writing, and nearly always found when I read Higham's commentary that I had overlooked some defects.

Two special features of this book are Chapter 5, advice to writers for whom English is a foreign language, and Chapter 10, twenty-five pages of information about computer aids for writing and research. Both address matters of concern, but I found them disappointing. The advice to foreign students is well-intentioned, but seems largely self-evident: "Many English words have alternative spellings;" "There can be differences in punctuation between one language and another." The chapter on computer aids would be useful only to a small audience: those familiar with TeX but not yet proficient in its use. One hopes that much of this technical information will soon become obsolete, as better TeX interfaces are developed.

Higham's is the only handbook I know of that treats mathematical matters with sufficient depth and breadth to be suitable as a textbook for a course on mathematical writing. But for my own purposes I would prefer a "little book"—a mathematician's *Elements of Style*, consisting of just the chapters on mathematical writing, English usage, and revising a draft—only 50 pages rather than 240.

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Nonlinearities in Action. *By A. V. Gaponov-Grekhov and M. I. Rabinovich.* Springer-Verlag, New York, 1992. 191 pp. $59.00, cloth. ISBN 0-387-51988-2.

Nonlinear science has emerged as a major development of the latter part of this century, with chaos, fractals, and their associated colored graphics catching the popular imagination. This book has the colored graphics, as well as brief descriptions of a wide range of nonlinear mathematical models, their applications and their properties. The novel feature is that much of the source material is from the former Soviet Union, often offering different perspectives on topics from those available elsewhere.

The book begins with a chapter on nonlinear oscillations and waves, subtitled classical results, where "classical" means typically the 1960s and 1970s. Topics covered include solitons, bifurcations, and modulation. The topic translated as self-excited oscillations would be better named natural oscillations because the oscillations do need an outside agency for their excitation. The example given is that of a willow stalk oscillating at the bottom of a flowing river. Contrary to the caption, both parts of Fig. 2.46 illustrate recurrence, the difference between the two being in the number of linearly unstable modulation harmonics. These are only minor criticisms, and the chapter does succeed in its aim of reviewing the wide range of nonlinear periodic phenomena and the methods used for describing them.

The generation and averaged structure of chaos are described next by way of examples, both Hamiltonian and dissipative. The Lorenz attractor is used as an example with particular reference to the motion of a fluid in a vertical toroidal tube heated from below. The detailed physical description of the roles of temperature and velocity in the fluid oscillations complements the mathematical description of the attractor.

The next chapter examines the structures that occur in chaos, from the weak randomness of the