Available online at www.sciencedirect.com

SCIENCE DIRECT®

European Journal of Mechanics B/Fluids 23 (2004) 381

EUROPEAN JOURNAL OF MECHANICS B/FLUIDS

Book review

Geometry, Mechanics and Dynamics – Volume in Honor of the 60th Birthday of J.E. Marsden
Paul Newton, Philip Holmes & Alan Weinstein, eds., Springer, 2002, 571 pp. + xvii

Jerry Marsden's 60'th was celebrated by a symposium with the same title as this volume, held at the Fields Institute for Research in the Mathematical Sciences of which Marsden was the founding director. The three editors invited several of Marsden's colleagues, collaborators and scientific admirers to contribute articles in their areas of specialization for this volume, which thus appears as a *Festschrift*. The articles span a remarkable range that encompasses analysis (including numerical analysis), dynamical systems, elasticity, fluid mechanics, "geometric mechanics", control theory, relativity and quantum mechanics. They trace Marsden's influence in establishing a new language of inquiry in these various areas, a language that is often highly sophisticated mathematically.

The type of research presented in this volume is (typically) not what the physicist or engineer would think of as the pioneering derivation of a new set of equations elucidating a basic phenomenon of nature. If we think of the field of dynamics, for example, the work in question is not about dynamics at the level of Newton's laws but rather the elaboration, sophistication and systematization that took place in the decades and centuries following Newton's work, and that resulted in the edifice built by Lagrange, Poisson, Hamilton, Routh, Kelvin, Poincaré and others. Indeed, the papers in this book add several layers of mathematical sophistication to what would pass for a graduate level treatment in a standard text on mathematical physics. Similarly, we are often concerned more with the systematic derivation of equations that have arisen in diverse fields and that, when viewed from an advanced mathematical point of view, can be seen in retrospect to arise from a coherent methodology applied across quite diverse physical systems. For example, the article by Holm, entitled "Euler–Poincaré Dynamics of Perfect Complex Fluids", demonstrates how equations of motion for systems as diverse as ideal fluids, liquid crystals, and superfluid He-3 can be derived from a unified set of principles. Such unification has consistently been necessary in science in order to prepare for advances to "the next level". It is typically an arduous process involving a large number of participants relative to the small number of "pioneers" who first wrote down these laws using a mix of mathematics and physical intuition. Maybe the article by Goubitsky and Stewart on "Patterns of Oscillations in Coupled Cell Systems" comes closest to the "pioneering spirit". It deals with models in biomathematics that generalize the Hodgkin–Huxley equations, and it explains how to set up such models in a systematic way using various symmetry groups to delineate the couplings to be included in the model.

There are, to be sure, phenomena that require, if not demand, the level of mathematical precision that characterizes the body of work reported in this volume. The study by Knobloch and Vega of inviscid Faraday waves, the paper by Chenciner, Gerver, Montgomery and Simó on "choreographic" motions of N bodies (interacting via Newtonian gravitational interaction), Littlejohn and Mitchell's study of small vibrations of polyatomic molecules, or the paper by Bloch and Leonard entitled "Symmetries, Conservations Laws and Control" are all excellent examples.

Some of the articles are immediately readable by anyone with an appreciation for early 20th century mathematical notation, symbolism and general vocabulary. Other articles require assimilation of concepts such as "symplectic manifold", "Casimir", "Riemannian curvature", "Banach space", and "Noether's theorem", not to mention "commutative diagram", "Morse–Whitney stratification", or "Poincaré–Dulac scenario". Much of this vocabulary restricts the audience that might benefit from the insights obtained in this work. This is a pity since many of the results potentially have important practical applications.

The book is nicely executed. Apart from the articles the editors provide personal reminiscences of how and when they encountered Jerry Marsden and his work. The book concludes with Marsden's CV, current as of the date of publication, and with contact information for all contributors. The volume will be a valuable addition to the library of anyone interested in the subjects mentioned at the beginning of this review treated from an advanced mathematical level, and to the many who have admired Marsden's extensive, elegant contributions over the years.

Hassan Aref
Dean of Engineering, Reynolds Metals Professor
Virginia Polytechnic Institute & State University
333 Norris Hall, Blacksburg, VA 24061-0217, USA
E-mail address: haref@vt.edu

0997-7546/2003 Published by Elsevier SAS.
doi:10.1016/j.euromechflu.2003.09.003