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NEW BOOKS

Geometric Mechanics, Part I: Dynamics and Symmetry. By Darryl D. Holm, World Scientific, 2008, xx+354 pp., $88, pbk $58

The origin of this book is as a text for a course in geometric mechanics taught to third-year undergraduates at Imperial College, London. It is more than that, however: it is also a highly original and beautifully written account of the principles of mechanics from an advanced, unified, geometric viewpoint, using Lie-group symmetries as the perfect method for applying Poincaré's geometric approach. The only prerequisites are linear algebra, calculus and some familiarity with the Euler-Lagrange variational principles and canonical Poisson brackets in classical mechanics at the beginning undergraduate level. There are many exercises and worked answers. The book is organised into six chapters and an appendix with example problems. Chapter 1 treats Fermat's principle for ray optics in refractive media as a detailed example that lays out the strategy of Lie symmetry reduction in geometric mechanics to be applied in the remainder of the text. Chapter 2 treats the geometry of rigid-body motion from the viewpoints of Newton, Lagrange and Hamilton, respectively. This treatment of rigid body motion sets the stage for the introduction of the flows of Hamiltonian vector fields and their Lie-derivative actions on differential forms in Chapter 3, where Lie symmetry reduction is discussed in the language of the exterior calculus of differential forms. The strategy of Lie symmetry reduction laid out in Chapter 1 in the example of ray optics is applied to the problem of a single, polarised, optical laser pulse propagating as a travelling wave in an unisotropic, cubically nonlinear, lossless medium in Chapter 4. Chapter 5 treats the swinging spring, or elastic spherical pendulum, from the viewpoint of Lie-symmetry reduction. Chapter 6 treats the Maxwell-Bloch equations for laser excitation of matter. There is a bibliography of about 170 items.