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Geometric Mechanics - Part I: Dynamics and Symmetry (2nd Edition)

Darryl D. Holm

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This textbook introduces the tools and language of modern geometric mechanics to advanced undergraduates and beginning graduate students in mathematics, physics and engineering. It treats the fundamental problems of dynamical systems from the viewpoint of Lie group symmetry in variational principles. The only prerequisites are linear algebra, calculus and some familiarity with Hamilton's principle and canonical Poisson brackets in classical mechanics at the beginning undergraduate level.

The ideas and concepts of geometric mechanics are explained in the context of explicit examples. Through these examples, the student develops skills in performing computational manipulations, starting from Fermat's principle, working through the theory of differential forms on manifolds and transferring these ideas to the applications of reduction by symmetry to reveal Lie-Poisson Hamiltonian formulations and momentum maps in physical applications.

The many Exercises and Worked Answers in the text enable the student to grasp the essential aspects of the subject. In addition, the modern language and application of differential forms is explained in the context of geometric mechanics, so that the importance of Lie derivatives and their flows is clear. All theorems are stated and proved explicitly.

The organisation of the first edition has been preserved in the second edition. However, the substance of the text has been rewritten throughout to improve the flow and to enrich the development of the material. In particular, the role of Noether's theorem about the implications of Lie group symmetries for conservation laws of dynamical systems has been emphasised throughout, with many applications.

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