

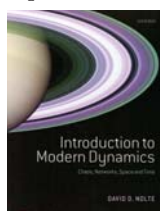
A bold step toward invigorating the physics curriculum

Introduction to Modern Dynamics Chaos, Networks, Space and Time

David D. Nolte
Oxford U. Press, 2015. \$110.00
(448 pp.). ISBN 978-0-19-965703-2

Reviewed by David P. Feldman

In his book *Introduction to Modern Dynamics: Chaos, Networks, Space and Time*, David Nolte has set himself an ambitious task: to modernize and broaden the upper-level undergraduate dynamics course for physics majors. His text covers classical mechanics, special and general relativity, and a host of topics from nonlinear dynamics and complex systems. The unifying theme connecting those topics is a geometric approach to dynamics—studying the time evolution of trajectories through an abstract space such as a state space or a phase space.



Nolte covers a vast amount of material in just over 400 pages. The breadth of coverage, together with Nolte's succinct, straightforward prose, is a strength of the book. However, the book's breadth is also perhaps a limitation, because many topics are given only minimal coverage. The level of abstraction and mathematical sophistication is quite high—another feature that is both a strength and a potential limitation.

The book is divided into four parts. Part 1 (chapters 1–2) is a geometric overview of classical mechanics. Part 2 (chapters 3–5) is on nonlinear dynamics. In part 3 (chapters 6–8) each chapter examines a particular area of complex systems: neural dynamics and neural nets; evolutionary dynamics; and economic dynamics. And part 4 (chapters 9–11) returns to traditional physics topics in its survey of special and general relativity and their associated mathematical machinery. The text of each chapter is followed by 10 to 15 exercises,

both analytic and computational. Matlab code for the exercises is provided on Nolte's webpage (<http://works.bepress.com/ddnolte>).

To me, the strength of Nolte's text is chapters 4 and 5, on network dynamics and synchronization, and the three chapters in part 3. Each of those five consecutive chapters serves as a primer for a particular aspect of dynamics or complex systems. I am not aware of any other text that includes a similar set of topics. The level of mathematics in those chapters remains high, but it strikes me as less forbidding than the level that appears in the earlier chapters. By necessity, the treatments in those five primers are brief; some topics receive just a cursory look. Nevertheless, I think the chapters could serve as effective entry points to the fields they discuss.

Nolte's writing is generally clear and concise; his presentation leaves room for instructors to add details, applications, and points of emphasis to suit their students' needs. I share the author's belief that complex systems and nonlinear dynamics deserve an earlier and more prominent role in the physics curriculum; such a reemphasis would introduce students early on to the excitement of current research and open-ended questions.

Moreover, work in complex systems and nonlinear dynamics involves the interplay of numerical investigation, rigorous mathematics, and clever analytic approximations—a combination that, I believe, is at the heart of physics. Incorporating nonlinear dynamics and complex systems into undergraduate physics coursework will likely be beneficial because the excitement and applicability of the field will draw students in and prepare them to work effectively both in physics and in interdisciplinary collaborations.

Has Nolte succeeded in writing a text that could work for a modern upper-level undergraduate mechanics course emphasizing chaos and complex systems? My thoughts on this question are mixed. I don't think *Introduction to Modern Dynamics* could be a direct replacement for conventional texts: The level of abstraction in parts 1 and 4 is

probably too high for most undergraduates. Some topics are covered briefly early in the book, like the Frenet–Serret formulas and the Einstein summation convention. Also, rigid-body rotation and central-force motion are each covered in short, roughly 10-page sections; in Stephen Thornton and Jerry Marion's well-used *Classical Dynamics of Particles and Systems* (Brooks/Cole, 2007), each is treated in 40- to 50-page chapters. I think chapter 3, on dynamical systems, will also be tough sledding for readers who have not had an initial encounter with dynamics, especially bifurcations. However, more seasoned undergraduates or beginning graduate students would likely be ready for the geometric and abstract approach Nolte takes.

Introduction to Modern Dynamics strikes me as two books in one: a beginning graduate-level modern analytical-mechanics text emphasizing geometric techniques and a survey for advanced undergraduates of some current topics in the dynamics of complex systems. The bifurcation is an understandable consequence of the need to accommodate the perhaps outdated dictates of the traditional advanced undergraduate mechanics course. Nolte's book is a bold attempt toward updating and energizing the physics curriculum. It may not fully achieve that goal, but it is a significant and noteworthy effort. I encourage instructors to give it a look and see if there is a place for it in their teaching.

Physical Models of Living Systems

Philip Nelson
W. H. Freeman, 2015. \$134.99
(384 pp.). ISBN 978-1-4641-4029-7

“Learn from science that you must doubt the experts.” That famous Richard Feynman quote is Philip Nelson's opening invitation to readers of *Physical Models of Living Systems*, a well-written and carefully structured text that's particularly compelling for its smooth integration of biological experiments, physical models, and computational exercises. Readers who complete the text will be well equipped with the

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