Contemporary Physics

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tcph20

Fluctuating Nonlinear Oscillators: From Nano-Mechanics to Quantum Superconducting Circuits, edited by Mark I. Dykman

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Published online: 06 Jun 2013.

To cite this article: Alexander Korotkov (2013): Fluctuating Nonlinear Oscillators: From Nano-Mechanics to Quantum Superconducting Circuits, edited by Mark I. Dykman, Contemporary Physics, DOI:10.1080/00107514.2013.800137

To link to this article: http://dx.doi.org/10.1080/00107514.2013.800137

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BOOK REVIEW


Rather unexpectedly, nonlinear oscillators have become quite a hot topic in condensed matter physics in the last decade and even more so in the last few years. To a large extent, this happened because of rapid experimental progress in nano-mechanical systems and solid-state quantum computing. Nonlinear resonators play a major role in these systems, so many researchers had to learn and understand the basic approaches to nonlinear oscillator dynamics. New experiments also posed new theoretical questions, many of them related to the role of classical and quantum fluctuations, especially near the bifurcation points. This has lead to rapid progress in the field in recent years, which was also sped up by the importance of present-day and future applications.

This book presents a snapshot of the modern development in the field of fluctuating nonlinear resonators. There are 15 chapters written by the leading experts in the field; six of them are theoretical, eight of them discuss both theory and recent experiments and one chapter is mostly experimental. Each chapter is intended to be a concise review of a sub-field, directly related to the research of its author(s), so that a reader can learn various subjects firsthand without needing to scan through many journal papers. Indeed, most chapters present well-written reviews, some of them in a quite pedagogical style, though some chapters look more like journal articles.

Almost half of the book (seven chapters out of 15) is devoted to superconducting systems based on Josephson junctions. Two chapters review the recent progress in nano- and micro-mechanical resonators, two chapters discuss resonators made of carbon nanotubes and graphene, one chapter is devoted to nano-magnetic oscillators and one chapter focuses on cold atom systems. Two of the theoretical chapters discuss the general properties of nonlinear oscillators, including quantum heating, quantum activation, power spectra and collective dynamics in arrays of nonlinear resonators. Even though each chapter is fully independent (in particular, notations in different chapters are different), the book to a significant extent feels unified, possibly due to significant communication between the authors and the Editor. The Editor's own research in the last four decades strongly affected the modern development of the field and this serves as one of the unifying themes of the book (the Editor also contributed a chapter to the book).

For me, personally, one of the most interesting subjects covered in five chapters of the book is the modern development of nearly quantum-limited microwave amplifiers based on Josephson junctions that include linear and bifurcation amplifiers. These amplifiers revolutionised the measurement of superconducting qubits in the last few years and will certainly have many applications in the future. The book is a convenient source to learn about the operational principles and various designs of such superconducting microwave amplifiers.

Overall, I think the book is very good and will be useful to many people, including experts and people who wish to learn about the modern developments in the field of nonlinear resonators, especially related to superconducting quantum computing, nano-mechanical resonators and carbon nanotube resonators. The book is well produced and it is certainly more pleasant to read than a multitude of original papers downloaded over the Internet. An added convenience is provided by the Index. Since the chapters review modern progress in the field, the book is mainly intended to be read within the next few years. However, I hope that at least a few chapters will remain interesting to readers for several decades.

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http://dx.doi.org/10.1080/00107514.2013.800137