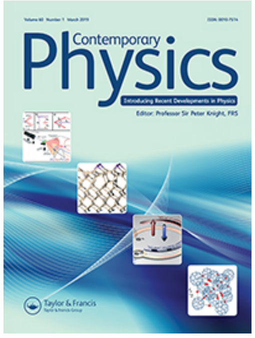

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Some critical questions in biological physics: a guided tour around the bugbears

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evolution by explaining the results in terms of simple physical arguments. I later adapted his course along similar lines, and gave it successfully on several occasions. Many of the ideas drew on a long seminal article by Robert F Stein, 'Stellar Evolution: a survey with analytic models', published in 1966 in the proceedings of a 1963 conference on Stellar Evolution, edited by Stein and A.G.W. Cameron.

Although all subsequent textbooks on stellar evolution have to some extent used physical and analytical arguments to explain the results of complex calculations, I am not aware of any previous book that draws so comprehensively on simplified arguments as the present volume by Lamers and Levesque. It is the natural modern successor to Stein's article, and is able to explain clearly and effectively how – and why – stars evolve as they do. With a book length at their disposal, and drawing on more than fifty years of developments in the field since Stein's article, they are also able to cover many details of evolution that were still unclear in the 1960s.

Pedagogically, the book is generally well designed: each of the 30 chapters starts with an overview of its contents, and ends with a summary of the results that have been obtained. Each chapter also has challenging questions for the reader at critical points in the argument, and a set of exercises at the end. I only have two small complaints: there is no index for the book (although there is a very full contents list at the beginning), and the references are at the ends of each chapter; that does make each chapter self-contained, but if one is looking to see whether a particular source has been cited, the references are harder to find than if they had all been together at the end of the book.

The ordering of topics is conventional but logical: after a brief scene-setting chapter, the authors first introduce the main observed stellar properties before going on to discuss hydrostatic equilibrium, the physics of gases, radiation, energy transport and energy production. They describe the methods of calculating stellar evolution, take a brief look at polytropic models and then start to discuss the results of stellar evolution from the star formation phase through the main sequence to post-main-sequence evolution, including that of massive stars. Topics discussed at various points include stellar mass loss, white dwarfs and neutron stars, pulsating stars, the effects of rotation, supernovae, binary star evolution and chemical products of stellar evolution.

Generally, the authors do a good job of providing clear descriptions and explanations of complicated processes. The simplified arguments are mostly helpful and are not too over-simplified. There are a few places where a caveat might have been useful; for example, in the discussion of why a star's outer envelope expands once shell-burning has started. The virial theorem is a commonly used explanation, but strictly speaking the star is not in equilibrium, so the virial theorem is not strictly valid. The reasons for the envelope expansion have been argued over for decades, and most practitioners would agree that there are many factors involved and there is not one simple explanation. Clearly all those arguments cannot be rehearsed in a textbook or lecture course, but a brief nod to the fact that the phenomenon is more complicated than appears in Chapters 13 and 14 would have been good. There are several other places where complicated details have been rather swept under the carpet in favour of a simple statement; this was probably inevitable to keep the book a reasonable length but again a few caveats would have been useful to alert students. An example is the discussion of mixing by meridional circulation, where there is no mention of possible instabilities or turbulence in the flow. Another example, which has implications for historical precedence, is the statement that the Algol paradox (Chapter 29) was solved in 1967 by Kippenhahn and Weigert. Their paper was probably the first detailed calculation specifically mentioning the Algol paradox, but it was preceded by a seminal paper in 1960 by Don Morton (the content of his Princeton PhD thesis) showing that mass transfer on a faster than thermal timescale could account for puzzling observations of lower mass subgiants with more massive main-sequence companions.

There are few typos, but there are some (about one every 10 pages, on average), and although many will be easily spotted by the attentive reader and will not cause confusion, some do matter. For example, Equation (5.3) is actually incorrect, because of the omission of an integration over frequency in the 2nd and 3rd expressions for F.

Despite my various criticisms, I feel that this is an excellent book. It aims to promote understanding of what is going on as stars evolve, and mostly it succeeds very well in its aim. This would be a very useful textbook to give to new graduate students in stellar evolution, and should stimulate them to go beyond the text to become experts in the field.

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Some critical questions in biological physics: a guided tour around the bugbears, by Thomas Waigh, Bristol, IOP Publishing, 2018, 203 pp., £99.00 (hardback), ISBN: 9780750313759. Scope: textbook. Level: non-specialists, postgraduate, early career researcher, researcher, scientist.

The interest of physicists to investigate the life sciences is not new. Erwin Schrödinger played a decisive role by writing his renowned book 'What is life?'. Moreover, there was a generation of physicists, from where we can mention Leo Szilard and Max Delbrück, who started working in biology problems becoming some of the pioneers in the, at the time, nascent discipline of molecular biology. Another field where physicists have been attracted is brain science.

Among them, I want to mention Leon Cooper, 1972 Physics Nobel laureate for the BCS theory in superconductivity. Theoretical ecology is another field where physicists have devoted their attention, as is the case among others of Robert May whose work has greatly contributed to the development of theoretical ecology. The present book is written by an experimental physicist working in biological physics in the School of Physics and Astronomy of the University of Manchester. And the main goal of the book is to present the case of biological physics, as a separate branch of physics as atomic physics, high-energy physics, optical physics or any other that in principle nobody discusses as legitimate disciplines.

From this point of view, this is a unique book in the sense that it is not a standard book on biological physics at all, but rather attempts to convince the reader on the value of biological physics. Certainly, there are several excellent textbooks where undergraduates can learn biological physics, and actually, the author has written a couple of them such as *Applied Biophysics* (Wiley, 2007) and *The Physics of Living Processes: a Mesoscopic Approach* (Wiley, 2014). This book is different. In some occasions, the author describes personal anecdotes and experiences on various research topics to illustrate the thread of the narrative. One of the most outstanding aspects of the book is the attention given to a selection of unsolved and open problems that are listed in each of the chapters, with different levels of difficulty. The objective in doing that is to show the kind of problems that biological physics attempts to solve, contributing in this way to better define the field and advocating for it.

The structure of the book is rather simple, what facilitates its reading. Each one of the 18 chapters is divided into three sections. The first one contains a brief essay where a chosen biology problem is discussed in detail. The second section suggests some introductory and advanced reading with well-chosen references. And the third section focuses on technical details, where the physics of the problem under discussion is described, or simply the key concepts are summarised, also offering further references on more specialised topics. Among the contents, we find exciting topics encompassing molecular communication, how brains work, elastic turbulence, synthetic biology, microrheology, experimental techniques, genetics, many-body problems, quantum phenomena in biology, or the activity of the heart.

Various areas of physics appear in the discussion of the biological problems, such as statistical physics, fluid physics, condensed-matter physics, chemical physics, nonlinear dynamics, optics, and several experimental techniques. Interesting comments along the text highlight the relevance of nonlinear phenomena, fractals, and fractional differential equations. I particularly was impressed by the neat description made to emphasise the influence of new experimental techniques in the advance of the field, and by the broad scope shown on numerous fields of physics. In any case, the general purpose is to highlight the interdisciplinary nature of the field. However, the intention of the book is not to teach physics neither biology, but rather to present a case to persuade physicists to engage in frontier and open problems of research in the field of biological physics.

The author has succeeded in writing an enjoyable, engaging and exciting book that provides an excellent overview of biological physics. He shares his enthusiasm with the field and ends with a perspective on the influence that biological physics can play in the predicted new scientific revolution concerning new discoveries in biology. I believe that it can be appealing to a broad range of readers who might be interested in the application of physics to biological problems. Certainly, a background of biology that most graduates in physics do not have is needed to appreciate it. However, it can be useful to graduate students who want to enter the field. But also to physicists who wish to have a flavour of the approach and the topics biological physicists investigate. Even biological physicists can enjoy the book, given the broad overview offered by the book as well as the challenges that arise on the open problems described.

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Symmetry relationships between crystal structures: applications of crystallographic group theory in crystal chemistry, by Ulrich Müller, Oxford, Oxford University Press, 2017, 332 pp., £29.99 (paperback), ISBN: 9780198807209. Scope: advanced monograph and reference. Level: postgraduate and early stage researchers.

Crystallography is one of the foundational subjects in a wide variety of scientific fields including solid state physics, solid state chemistry, biology, metallurgy, materials science and earth sciences. The best and most appropriate tool to describe the symmetry associated with the arrangements of atoms and molecules in any given crystal structure is group theory. Hence, crystallographic group theory is an important subject of study for structural crystallographers.

Ulrich Müller's book on symmetry relationships between crystal structures is number 18 in the IUCr texts on crystallography and deals with crystallographic group theory in a detailed, mathematically rigorous and application-oriented fashion. It is broadly divided into two (nearly equal) sections, namely, crystallographic foundations and the application of group theory to problems in crystal chemistry. The crystallographic foundations section of the text deals with basics of crystallography and group theory; these