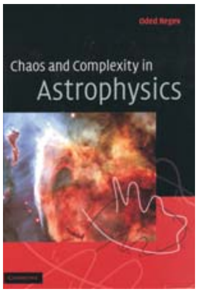

introducing nonspecialists to a wide range of topics in nonlinear dynamics. The first part of the book develops the subject in a methodical, step-by-step manner that is particularly well suited for graduate students. Regev, a professor of physics at Technion–Israel Institute of Technology, gives the essential details of such topics as bifurcation theory, strange attractors, fractals, and Hamiltonian systems in an easy-to-follow style that benefits greatly from the inclusion of representative examples.

In the spirit of a good introductory text, he omits unnecessary details and concentrates on the key points and important concepts, and he directs interested readers to the appropriate references for technical subtleties. Good demonstrations of his commendable approach are provided in discussions of nearly integrable systems and the Kolmogorov-Arnold-Moser theorem, fractal sets and dimensions, and patterns in spatially extended systems.

The second part covers astrophysical applications—and that is where the general topic, not the book itself, becomes somewhat problematic. The point is that, with the exception of a few isolated subfields, chaos theory actually has had a limited impact on most areas of astrophysical research. Such a state of affairs is, in fact, clearly reflected in the contents of Regev's book. Despite its title, almost two-thirds of *Chaos and Complexity in Astrophysics* is devoted to basic explanations of dynamical systems in general, if one includes the discussions of fluid dynamics and convection, and only one-third to concrete applications to astrophysics. The breakdown of the topics is not a consequence of astrophysicists being unaware of developments in nonlinear dynamics. Although Regev implicitly complains about astrophysicists resorting too quickly to brute-force computer simulations in situations in which insights might have been gained using a nonlinear-dynamics approach, reality is often more complex.

Many astrophysical systems are genuinely complicated; they involve numerous processes that operate on a huge range of physical and temporal scales. To pretend that those systems are governed by a simple, underlying mechanism described by a limited set of nonlinear equations is, in many cases, not only unproductive but also untrue. Thus problems such as large-scale structure formation or the dynamics of globular structures do require massive simulations. In those areas in which chaos theory has made significant contributions to astrophysics—for example, in the dynamics of the solar system, the theory of stellar pulsations, and the process of accretion onto compact objects—Regev's description is generally comprehensive and very clear. He justifiably excludes chaotic inflation, in spite of its name, because it has nothing to do with chaos theory. I was, however, slightly disappointed by his omission of the more recent developments in the theory of convection, particularly the extensive works of Juri Toomre, Nic Brummell, and their collaborators.

Despite the relatively minor role that chaos theory has played so far in astrophysics, *Chaos and Complexity in Astrophysics* provides an important service by filling a gap in the description of nonlinear dynamics in existing astrophysical literature. Any researcher interested in dynamical systems in general, and in such systems in astrophysics in particular, will likely find something interesting in Regev's book. And the fact that the text is essentially self-contained makes it attractive for graduate students to use.

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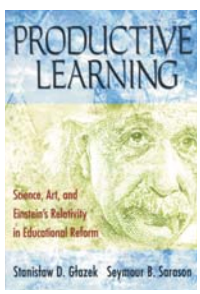
Productive Learning

Science, Art, and Einstein's Relativity in Educational Reform

Stanisław D. Głazek and Seymour B. Sarason
Corwin Press, Thousand Oaks, CA, 2007. $75.95, $35.95 paper (269 pp.). ISBN 978-1-4129-4059-7, ISBN 978-1-4129-4060-3 paper

Productive Learning: Science, Art, and Einstein's Relativity in Educational Reform is a collaboration between a physicist and a psychologist. Stanisław Głazek is a professor of physics at Warsaw University in Poland, and Seymour Sarason is a professor emeritus of psychology at Yale University. The premise is intriguing: Głazek teaches Sarason relativity while Sarason teaches Głazek about productive learning, and their shared educational journey is documented in a book. But such a text must naturally contain two very different voices. Successful ways that other authors have handled this potential problem are to either clearly identify who is speaking in a given section or hire a good editor to harmonize the distinct styles and generate a seamless flow. Unfortunately, Głazek and Sarason chose neither approach.



The first four chapters were probably written by Sarason, because they deal primarily with educational matters at pre-college levels. In later chapters that deal with the physics, the reader regularly bumps up against paragraphs that compare school-based learning to the way scientists make discoveries or that change the focus to issues related to learning and teaching. The effect on the reader is much like the effect on a dancer when the music suddenly stops for an announcement: It takes time to get the rhythm back. As a result, much of the book is hard to read. The authors could have made the reading less jerky by putting the comments related to education in a box, in a footnote, or at the beginning or end of a chapter. The comments interrupt the "storyline," a favorite term of the celebrated physicist and teacher Arnold Arons.

A peculiar aspect of Głazek and Sarason's book is that it seems to have been written in a theoretical vacuum. I am mystified that the authors make no reference to more than 30 years of systematic research in physics education. Thousands of papers have detailed the many conceptual and reasoning difficulties that students have had with a variety of physics principles, and teaching approaches for overcoming those difficulties. The authors also make no reference to the vast science-education and cognitive-science literature on conceptual change, constructivism, and various aspects of cognition. Equally surprising is the almost blanket condemnation of much of the US education system without reference to the numerous innovations in physics curricula or to the many successful education programs and initiatives for science teachers at all levels of the education system. The lack of contextualization of their work, combined with their harsh criticism of US education in general, gives the writing an air of arrogance.

Chapters 1 through 4 and the final chapter, 17, desperately need editing. They are excruciatingly ponderous, repetitive, and patronizing. Few new insights, entwined as they are among the excessive verbiage and over-generalizations, are visible in the discussions. One example of a sweeping generalization is found in the last chapter, in which the authors write that educational reform has been a failure, with a few exceptions that "refer to single classrooms or single schools but never to a whole school system" (page 185). Their analysis is simply untrue. For example, the website sponsored by the department of teacher education at Ohio's Miami University (http://www.units.muohio.edu/eap/departments/ted/centers.html) states that "Ohio's systemic initiative, *Discovery*, has promoted systemic change in science and mathematics teaching and learning by providing high-quality, sustained professional development to teachers and administrators throughout Ohio since 1991."

Głazek and Sarason also write, "On the basis of our experience, we have concluded that the basic problem that has gone unexamined is the concept and process of learning" (page 190). It is a pity that their experience does not extend to reading books such as *How People Learn: Brain, Mind, Experience, and School* (National Academy Press, 1999), edited by John D. Bransford, Ann L. Brown, and Rodney R. Cocking.

The shortcomings mentioned above refer mostly to the portions on education; by contrast, the portions that treat the physics are wonderful. Beginning in chapter 6, readers are taken on a fascinating journey from Nicolaus Copernicus to Albert Einstein in a quest to understand time and other concepts associated with the theory of relativity. We learn who did what and why, how each discovery was built on an earlier one, and what critical questions drove the scientists of the day. Simple explanations of relevant physics concepts and vivid, everyday analogies are woven into the text along the way. The story is engaging, and the writing is easy to understand and fluid, except when interspersed with comments on education.

However fascinating the authors found their experience of working together, *Productive Learning* as a book does not work. It reads like two books glued together. If they could be unglued, I would highly recommend the one about relativity and suggest leaving the other on the shelf.

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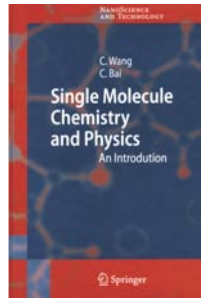
Single Molecule Chemistry and Physics

An Introduction

C. Wang and C. Bai
Springer, New York, 2006. $119.00 (303 pp.). ISBN 978-3-540-25369-3



Chen Wang and Chunli Bai's *Single Molecule Chemistry and Physics: An Introduction* is an ambitious attempt to review the wide variety of experimental techniques applied to studies of single molecules. In the introduction the authors state that they will refer readers to the original papers for details of the experimental methods. Their intent is to focus on what has been learned from those studies and on where future developments may lead. The extent to which Wang and Bai succeed is mixed. Their expertise in scanning probe microscopy is evident in the breadth,