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BOOK REVIEWS

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From Photon to Neuron: Light, Imaging, Vision. Philip Nelson. 512 pp. Princeton U.P., Princeton, NJ, 2017. Price: $109.98 (cloth). ISBN 978-0-691-17518-8; $26.65 (paper). ISBN 978-0-691-17519-5. (Sönke Johnsen, Reviewer.)

Despite the best efforts of many, biophysics is still the awkward new relative at the holiday table, whom everyone wants to meet but not sit beside. Interdisciplinarity is of course all the rage, researchers drawn to it by the promise of new ideas (and universities perhaps by the promise of new funding), but when it comes down to it, we're more comfortable sitting next to the people we know, sharing old stories and jokes told in a common language.

In the natural sciences, perhaps the most strained of marriages (to continue the familial metaphor just a bit longer) is between biology and physics. After all, mating a field with almost infinite diversity and complexity, and where every rule is immediately overwhelmed by exceptions, with one that is so tidy that it can be described using mathematics, might produce only monsters. This is all made worse by the fact that what biophysics is depends on who is doing it. In physics departments, biophysics is the study of the physics of a particular biological system. In biology departments, biophysics is the use of tools borrowed from physics to answer a biological question. The difference is subtle but deep enough that the two groups are often trained in different places, go to different meetings, and publish in different journals. I, raised as a physicist, jumped to biology at the start of graduate school, and—despite using enough math and physics to keep many biologists from reading the actual meat of my research papers—am firmly entrenched in the biology world. This is not due to lack of interest, I still love physics more than I do biology, but to the difficulty of crossing the divide between the two.

Which bring me to the importance of books. After all, why do we even bother to keep writing them? They're a tremendous chore, and—as any eight-year-old will tell you—everything you ever wanted to know is on the internet. My former dean told me in 2002 that the library of the future will be a computer terminal. I suppose now it will be a smart phone. However, I still wander my university's library shelves, tracing the call numbers as they rise in their lumpy fashion, looking for that special volume, because a good book by someone you trust is gold. In our maze-like world of "truthiness" and "fake news," a book is a map, a guide, a wise friend. To paraphrase Jean Baptiste Perrin, it shows the simple invisible that underlies the complex visible. In the case of biophysics, a book can help a student bridge the divide between the two parent fields. However, even in vision science, a field that has always lent itself to a biophysical approach, a single book can only go halfway. From the biology side, we have books like "Animal Eyes" and "Visual Ecology" that introduce biologists to the optics underlying vision. From the physics side, we now have the excellent "From Photon to Neuron" by Professor Nelson that introduces physics students to a quantitative understanding of the intricacies of imaging and visual perception.

The title, which links canonical concepts from physics and biology (the photon and the neuron) shows the ambition of the author, and it is indeed a thorough and sweeping tour from the fundamental physics of light to the neurobiology of the retina, with many asides into modern advances in imaging. Lavishly illustrated and carefully explained, this book is obviously a labor of love. It covers the typical subjects one might expect in a book of this sort—geometric and environmental optics, biophotonics, color vision, ocular morphology, and retinal physiology—but also includes chapters on less-covered topics such as imaging via diffraction and using inferential methods to break the diffraction limit. The chapter on inferential methods is my favorite, perhaps because it introduces Bayesian inference and shows how much can be learned from so little.

The book has problem sets at the end of each chapter and the form of a textbook, but I enjoyed reading it as a standalone book, primarily because the author's enthusiasm for the material, so often lacking in textbooks, is clear on almost every page. I would have been excited to have this as a text for one of my courses when I was in college. I do have to disagree with the author though that this book can be appreciated by anyone who has had calculus and a year of university-level physics. While technically true, it's my experience that most life science students make it through their physics courses by the skin of their teeth and thus would feel that they were unable to handle the level of mathematical detail found in many of the chapters. This is not a flaw of the book, but of our mathphobic educational and social system. The book itself is a gem, and I'm happy it sits on the shelf behind my desk, always ready to me show something new if I ask it.

Sönke Johnsen is a Professor of Biology at Duke University. He studies vision, biophotonics, environmental optics, with the occasional foray into magnetoreception. He is the author of The Optics of Life: A Biologist's Guide to Light in Nature.

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Atoms, Mechanics, and Probability: Ludwig Boltzmann's Statistico-Mechanical Writings—An Exegesis. Olivier Darrigol. 638 pp. Oxford U.P., New York, 2018. Price: $60 (hardcover) ISBN 978-0-19-881617-1.

Beyond the Dynamical Universe: Unifying Block Universe Physics and Time as Experienced. Michael Silberstein, W. M. Stuckey, and Timothy McDevitt. 443 pp. Oxford U.P., New York, 2018. Price: $75 (hardcover) ISBN 978-0-19-880708-7.

Ethics and Practice in Science and Education. Susanna Priest, Jean Goodwin, and Michael F. Dahlstrom (eds.). 316 pp. University of Chicago Press, Chicago, 2018. Price: $40 (paper) ISBN 978-0-226-49781-5.

Geometry of Quantum States: An Introduction to Quantum Entanglement (2nd ed.). Ingemar Bengtsson and Karol Życzkowski. 629 pp. Cambridge U.P., New York, 2017. Price: $89.99 (hardcover) ISBN 978-1-107-02625-4.

Geophysical Fluid Dynamics: Understanding (Almost) Everything with Rotating Shallow Water Models. Vladimir Zeitlin. 507 pp. Oxford U.P., New York, 2018. Price: $105 (hardcover) ISBN 978-0-19-880433-8.

Quantized Detector Networks: The Theory of Observation. George Jaroszkiewicz. 387 pp. Cambridge U.P., New York, 2017. Price: $155 (hardcover) ISBN 978-1-107-13623-6.

Spacetime Fundamentals Intelligibly (Re)learnt: Special Relativity's Cosmographicum. Brian Coleman. 202 pp. BCS, Moyard, Ireland, 2018. Price: $39 (paper) ISBN 978-1-9998410-1-0.

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