

Bookshelf

COMPILED BY VIRGINIA GRECO, CERN

From Stars to States: A Manifest for Science in Society

By Thierry Courvoisier

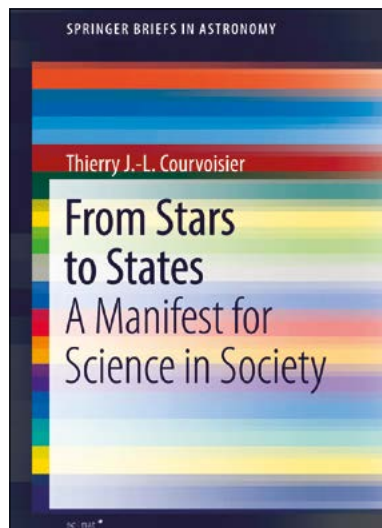
Springer

This book is a curiosity, but like many curiosities, well worth stumbling across. It is the product of a curious, roving mind with a long and illustrious career dedicated to the exploration of nature and the betterment of society. Pieced together with cool scientific logic, it takes the reader from a whistle-stop tour of modern astronomy through the poetry collection of Jocelyn Bell-Burnell, to a science-inspired manifesto for the future of our planet. After an opening chapter tracing the development of astronomy from the 1950s to now, subsequent chapters show how gazing at the stars, and learning from doing so, has brought benefit to people from antiquity to modern times across a wide range of disciplines.

Astronomy helped our ancestors to master time, plant crops at the right moment, and navigate their way across wide oceans. There's humour in the form of speculation about the powers of persuasion of those who convinced the authorities of the day to build the great stone circles that dot the ancient world, allowing people to take time down from the heavens. These were perhaps the Large Hadron Colliders of their time, and, in Courvoisier's view, probably took up a considerably larger fraction of ancient GDP (gross domestic product) than modern scientific instruments. John Harrison's remarkable clocks are given pride of place in the author's discussion of time, though the perhaps even more remarkable Antikythera mechanism is strangely absent.

By the time we reach chapter three, the beginnings of a virtuous circle linking basic science to technology and society are beginning to appear, and we can start to guess where Courvoisier is taking us. The author is not only an emeritus professor of astronomy at the University of Geneva, but also a former president of the Swiss Academy of Sciences and current president of EASAC, the European Academies Science Advisory Council. For good measure, he is also president of the H Dudley Wright Foundation, a charitable organisation that supports science communication activities, mainly in French-speaking Switzerland. He is, in short, a living, breathing link between science and society.

In chapter four, we enjoy the cultural benefits of science and the pleasure of knowledge for its own sake. We have a glimpse of what in Swiss German is



delightfully referred to as Aha Erlebnis – that eureka moment when ideas just fall into place. It reminded me of the passage in another curious book, Kary Mullis's *Dancing Naked in the Mindfield*, in which Mullis describes the Aha Erlebnis that led to him receiving the Nobel Prize in Chemistry in 1993. It apparently came to him so strongly out of the blue on a night drive along a California freeway that he had

to pull off the road and write it down. Einstein's famous 1% inspiration may be rare, but what a wonderful thing it is when it happens.

CERN is the resulting evidence for the good that comes when science and policy come together.

Chapter five begins the call to action for scientists to take up the role that their field demands of them in society. “We still need to generate the culture required to [...] bring existing knowledge to places where it can and must contribute to actions fashioning the world.” Courvoisier examines the gulf between the rational world of science and the rather different world of policy – a gulf once memorably described by Lew Korwarski in his description of the alliance between scientists and diplomats that led to the creation of CERN. “It was a pleasure to watch the diplomats grapple with the difference between a cyclotron

and a plutonium atom,” he said. “We had to compensate by learning how to tell a subcommittee from a working party, and how – in the heat of a discussion – to address people by their titles rather than their names. Each side began to understand the other's problems and techniques; a mutual respect grew in place of the traditional mistrust between egg-headed pedants and pettifogging hair-splitters.” CERN is the resulting evidence for the good that comes when science and policy come together.

As we reach the business end of the book, we find a rallying call for strengthening our global institutions, and here another of Courvoisier's influences comes to the fore. He's Swiss, and a scientist. Scientists have long understood the benefits of collaboration, and if there is one country in the world that has managed to reconcile the nationalism of its regions with the greater need of the supra-cantonal entity of the country as a whole, it is Switzerland. It would be a gross oversimplification to say that Courvoisier's manifesto is to apply the Swiss model to global governance, but you get the idea.

Originally published in French by the Geneva publisher Georg, if there's one criticism I have of the book, it's the translation. It made Catherine Bréchnac, who speaks with fluidity in French, come across as rather clunky in her introduction, and on more than one occasion I found myself wondering if the words I was reading were really expressing what the author wanted to say. Springer and the Swiss Academy of Sciences are to be lauded for bringing this manifesto to an Anglophone audience, but for those who read French, I'd recommend the original.

● James Gillies, CERN.

Third Thoughts

By Steven Weinberg

The Belknap Press of Harvard University Press

When Nobel laureates offer their point of view, people generally are curious to listen. Self-described rationalist, realist, reductionist and devoutly secular, Steven Weinberg has published a new book reflecting on current affairs in science and beyond. In *Third Thoughts*, he addresses themes that are of interest for both laypeople and researchers, such as the public funding of science.

Weinberg shared the Nobel Prize in Physics in 1979 for unifying the weak interaction and electromagnetism into the electroweak theory, the core of the Standard Model, and has made many other significant contributions to physics. At the same time,

Weinberg has been and remains a keen science populariser. Probably his most famous work is the popular-science book *The First Three Minutes*, where he recounts the evolution of the universe immediately following the Big Bang.

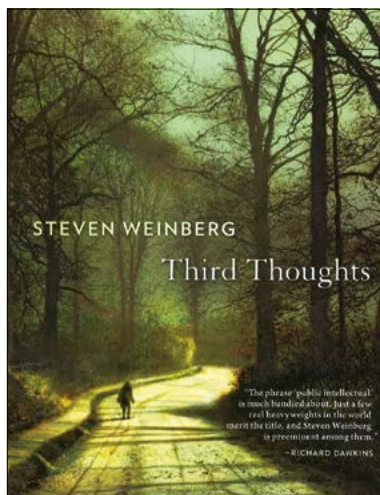
Third Thoughts is his third collection of essays for non-specialist readers, following *Lake Views* (2009) and *Facing Up* (2001). In it are 25 essays divided into four themes: science history, physics and cosmology, public matters, and personal matters. Some are the texts of speeches, some were published previously in *The New York Review of Books*, and others are released for the first time.

The essays span subjects from quantum mechanics to climate change, from broken symmetry to cemeteries in Texas, and are pleasantly interspersed with his personal life stories. Like his previous collections, Weinberg deals with topics that are dear to him: the history of science, science spending, and the big questions about the future of science and humanity.

The author defines himself as an enthusiastic amateur in the history of science, albeit a “Whig interpreter” (meaning that he evaluates past scientific discoveries by comparing them to the current advancements – a method that irks some historians). Beyond that, his taste for controversy encourages him to cogitate over Einstein’s lapses, Hawking’s views, the weaknesses of quantum mechanics and the US government’s financing choices, among others.

Readers who are interested in US politics will find the section “Public matters” very thought-provoking. In particular, the essay “The crisis of big science” is based on a talk he gave at the World Science Festival in 2011 and later published in the *New York Review of Books*. He explains the need for big scientific projects, and describes how both cosmology and particle physics are struggling for governmental support. Though still disappointed by the cut of the Superconducting Super Collider (SSC) in the early 1990s, he is excited by the new endeavours at CERN. He reiterates his frank opinions against manned space flight, and emphasises how some scientific obstacles are intertwined in the historical panorama. In this way, Weinberg sets the cancellation of the SSC in a wider problematic context, where education, healthcare, transportation and law enforcement are under threat.

The author condenses the essence of what physicists have learnt so far about the laws of nature and why science is important. This is a book about asking the right questions, when time is ripened to look for the answers. He explains that the question



“What is the world made of?” needed to wait for chemistry advances at the end of the 18th century. “What is the structure of the electron?” needed to wait for quantum mechanics. While “What is an elementary particle?” is still waiting for an answer.

The essays vary in difficulty, and some concepts and views are repeated in several essays, thus each of them can be read independently. While most are digestible for readers without any background knowledge in particle physics, a general understanding of the Standard Model would help with grasping the content of some of the paragraphs. Having said that, the general reader can still follow the big picture and logically-argued thoughts.

Several essays talk about CERN. More specifically, the “The Higgs, and beyond” article was written before the announcement of the Higgs boson discovery in 2011, and briefly presents the possibility of technicolour forces. The following essay, “Why the Higgs?”, was commissioned just after the announcement in 2012 to explain “what all the fuss is about”.

One of the most curious essays to explore is number 24. Citing Weinberg: “Essay 24 has not been published until now because everyone who read it disagreed with it, but I am fond of it so bring it out here.” There, he draws parallels between his job as a theoretical physicist and the one of creative artists.

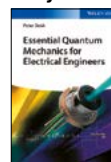
Not all scientists are able to write in such an unconstrained and accessible way. Despair, sorrow, frustration, doubt, uneasiness and wishes all emerge page after page, offering the reader the privilege of coming closer to one of the sharpest scientific minds of our era.

● *Letizia Diamante, CERN.*

Books received

Essential Quantum Mechanics for Electrical Engineers

By Peter Deak
Wiley-VCH



The most recent and upcoming developments of electronic devices for information technology are increasingly being based on physical phenomena that cannot

be understood without some knowledge of quantum mechanics (QM). In the new hardware, switching happens at the level of single electrons and tunnelling effects are frequently used; in addition, the superposition of electron states is the foundation of quantum information processing. As a consequence, the study of QM, as well as informatics, is now being introduced in undergraduate electric and electronic engineering courses. However, there is still a lack of textbooks on this subject written specifically for such courses.

The aim of the author was to fill this gap and provide a concise book in which both the basic concepts of QM and its most relevant applications to electronics and information technologies are covered, making use of only the very essential mathematics.

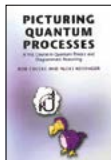
The book starts off with classical electromagnetism and shows its limitations when it comes to describing the phenomena involved in modern electronics. More advanced concepts are then gradually introduced, from wave–particle duality to the mathematical construction used to describe the state of a particle and to predict its properties. The quantum well and tunnelling through a potential barrier are explained, followed by a few applications, including light-emitting diodes, infrared detectors, quantum cascade lasers, Zener diodes, flash memories and the scanning tunnelling microscope. Finally, the author discusses some of the consequences of QM for the chemical properties of atoms and other many-electron systems, such as semiconductors, as well as the potential hardware for quantum information processing.

Even though the mathematical formulation of basic concepts is introduced when required, the author’s approach is oriented at limiting calculations and abstraction in favour of practical applications. Applets, accessible on the internet, are also used as a support, to ease the computational work and quickly visualise the results.

Bookshelf

Picturing Quantum Processes: A First Course in Quantum Theory and Diagrammatic Reasoning

By Bob Coecke and Aleks Kissinger
Cambridge University Press



"This book is about telling the story of quantum theory entirely in terms of pictures," declare the authors of this unusual book, in which quantum processes are explained using diagrams and an innovative method for presenting complex theories is set up. The book employs a unique formalism developed by the authors, which allows a more intuitive understanding of quantum features and eliminates complex calculations. As a result, knowledge of advanced mathematics is not required.

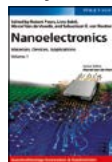
The entirely diagrammatic presentation of quantum theory proposed in this (bulky) volume is the result of 10 years of work and research carried out by the authors and their collaborators, uniting classical techniques in linear algebra

and Hilbert spaces with cutting-edge developments in quantum computation and foundational QM.

An informal and entertaining style is adopted, which makes this book easily approachable by students at their first encounter with quantum theory. That said, it will probably appeal more to PhD students and researchers who are already familiar with the subject and are interested in looking at a different treatment of this matter. The text is also accompanied by a rich set of exercises.

Nanoelectronics: Materials, Devices, Applications (2 volumes)

By R Puers, L Baldi, M Van de Voorde and S E van Nooten (editors)
Wiley-VCH



This book aims to provide an overview of both present and emerging nanoelectronics devices, focusing on their numerous applications such as memories, logic circuits, power devices and sensors.

It is one unit (in two volumes) of a complete series of books that are dedicated to nanoscience and nanotechnology, and their penetration in many different fields, ranging from human health, agriculture and food science, to energy production, environmental protection and metrology.

After an introduction about the semiconductor industry and its development, different kinds of devices are discussed. Specific chapters are also dedicated to new materials, device-characterisation techniques, smart manufacturing and advanced circuit design. Then, the many applications are covered, which also shows the emerging trends and economic factors influencing the progress of the nanoelectronics industry.

Since nanoelectronics is nowadays fundamental for any science and technology that requires communication and information processing, this book can be of interest to electronic engineers and applied physicists working with sensors and data-processing systems.



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