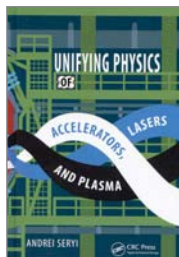


Unifying Physics of Accelerators, Lasers and Plasma

Andrei Seryi

CRC Press, 2016. \$89.95 (288 pp.). ISBN 978-1-4822-4058-0



Accelerators drive lasers, lasers drive plasmas, plasmas drive accelerators—and the reverse processes are true as well. The concept of radiating beams connects the three topics and serves as an organizing principle for Andrei Seryi's thoughtful and delightful text, *Unifying Physics of Accelerators, Lasers and Plasma*.

Seryi's tome, with its overarching motif of unification, reads like an encyclopedic of accelerator science. Since it also features fundamental topics from laser and plasma physics, it should engage a broad range of interests, starting at the senior undergraduate level. It is amazing that Seryi was able to produce a text of such immense breath in fewer than 300 pages. He even ventures into the realm of microbiology: His concise description of DNA molecules' response to radiation is essential for understanding the efficacy of x-ray, ion, and proton therapies.

Seryi is one of the premier accelerator physicists of our time; his leadership at SLAC was instrumental in the establishment of the Facility for Advanced Accelerator Experimental Tests. His involvement in that and many other accelerator projects has given him a unique perspective from which to examine the big picture. He is currently director of the John Adams Institute for Accelerator Science, a research center associated with the departments of physics at Oxford University, Royal Holloway University of London, and Imperial College London.

Unifying Physics of Accelerators, Lasers and Plasma discusses a wide variety of accelerator topics without the complication of advanced mathematics. (Anyone interested in the details of accelerators should check out Helmut Wiedemann's excellent two-volume textbook, *Particle Accelerator Physics*, Springer, 1995 and 1999.) Especially informative are Seryi's historical notes, including credits to physicists from Russia and the other republics of the former Soviet Union. A

plethora of accelerator innovations have emanated from that part of the world, often without receiving proper note.

For example, most accelerator physicists know that Gersh Budker proposed electron beam cooling in 1967 at the Institute of Nuclear Physics in Novosibirsk, but many may not be aware of the 1944 prediction of synchrotron radiation by Dmitri Ivanenko and Isaak Pomeranchuk. That earlier work is especially noteworthy given the international excitement over synchrotron radiation sources. One note in the book needs clarification: The first of the second-generation synchrotron radiation sources was not the Synchrotron Radiation Source (SRS) at Daresbury, England, but Tantalus, which started operations in 1968 at the Synchrotron Radiation Center in Wisconsin (although the SRS was the first to produce x rays).

In his book, Seryi advocates the not-so-well-known TRIZ method, a Russian acronym for "theory of inventive problem solving." Starting in the late 1940s, Soviet engineer and inventor Genrich Altshuller developed TRIZ while studying thousands of patents and patent applications in a quest to understand what makes a patent successful. In short, the TRIZ method searches for pairs of "contradicting" parameters, in which improving one requires a process that makes the other worse. Once one identifies a set of such parameters, the method looks inside and outside the field of interest to arrive at the best solution for improving the first parameter. Seryi argues for making a wider adoption of that approach for scientific innovation.

Many books provide cut-and-dried problems that have definite quantitative solutions. However, with his end-of-chapter exercises Seryi takes an unusual approach. He offers thoughtful exercises with open-ended solutions that should provoke engaging discussions followed by in-depth analyses. Thus, wrestling with the exercises mimics the work of ac-

tual researchers. An excellent example is the problem that asks students to define approximate parameters of a second-generation synchrotron radiation source that produces 10-keV photons.

Among the book's few shortcomings is that Seryi only makes passing references to "ultimate" storage rings and he offers no substantive discussion of multi-bend achromats, the technology that is driving what many are calling the new fourth-generation synchrotron radiation source. Arguably the field's most exciting innovation in recent years, multi-bend achromats are designed to achieve significant reductions in the product of electron beam size and angular divergence; the improved beam leads to much brighter emitted radiation.

Those omissions aside, *Unifying Physics of Accelerators, Lasers and Plasma* is a must-have for every student and practitioner of accelerator science. It is a quick reference guide and provides solid, intuitive discussions of what are often quite erudite concepts. I enthusiastically applaud this outstanding book.

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Crystal Clear

The Autobiographies of Sir Lawrence & Lady Bragg

Edited by A. M. Glazer and Patience Thomson

Oxford U. Press, 2015. \$59.95 (427 pp.).
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As promised on the book's back cover, *Crystal Clear: The Autobiographies of Sir Lawrence & Lady Bragg* "takes you behind . . . the life of one of the most prominent scientists of the twentieth century," William Lawrence Bragg (commonly referred to as Lawrence), and features unpublished autobiographies by him and his wife Alice, "a public figure in her own right." Intended only for the family, the autobiographies contain numerous insights into Lawrence's science, Alice's public service, and their family. The volume was edited by crystallographer A. M. Glazer and by the Braggs' daughter Patience Thomson, who provides stories that illuminate and enchant. Here I concentrate on Lawrence's account.

The story of the collaboration of Lawrence and his father, physicist William Henry Bragg (commonly referred to as William), has been outside the mainstream; their work as pioneers of x-ray crystallography has been important to all the sciences but central to none. To survive as a discipline, crystallography had to establish its own international union, conferences, and journals—the field only became prominent with the establishment of molecular biology. Most recently—in biographies, in centenary celebrations, and during the 2014 International Year of Crystallography—the Braggs' scientific story became known, but the family background is still hazy. Most important, therefore, is the light this book sheds on the events that Lawrence experienced during a life that appeared unendingly triumphant.

In 1885, 23-year-old William, a new graduate from the University of Cambridge, was appointed a professor of mathematics and physics at the University of Adelaide in distant Australia. There he married a daughter of the local chief scientist, whose family would provide Lawrence with his favorite child-

hood experiences. When Lawrence's elbow was broken in an accident, he became one of the first in Australia to be x-rayed, a technology that would come to dominate his life.

Lawrence attended the prestigious secondary school St Peter's College, where he was promoted to higher and higher grades, which isolated him from his peers. He enrolled at Adelaide, where most of the classes he attended were taught by his father. In 1908 he graduated with first-class honors in mathematics. When William took his family to England the next year, Lawrence went to Cambridge to study mathematics but was persuaded by his father to transfer to physics, and he again graduated with a first. Things of great importance happened to him at Cambridge; for example, he became a member of a small group of adventurous friends, the closest of whom was Cecil Hopkinson. Later, Cecil would be killed in World War I and Lawrence would marry Cecil's cousin, Alice Hopkinson.

In 1912 Lawrence became a research

student in the Cavendish Laboratory: "It was a sad place at that time. There were too many young researchers . . . too few ideas for them to work on, too little money and too little apparatus." Then Max von Laue's paper on the diffraction of x rays by zincblende (ZnS) appeared, and William discussed it with his son.

Lawrence conceived of the idea that the spots observed by von Laue were due to the reflection of x rays by sheets of atoms in the crystal; Bragg's law and the structures of ZnS and other crystals followed.

William used his son's insight to study x rays but he soon joined Lawrence in spectroscopic studies of crystals. Confusion then emerged: Credit and speaking invitations were given to William, and thereafter their separate and combined achievements were universally misunderstood. It was not an easy time for Lawrence; Bragg's law is singular, after all, not plural!

Then came World War I, which halted their research. Lawrence was offered a secret assignment to develop "sound



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ranging,” a French idea of listening to the sound of gun firings to determine the location of the hidden German weapons that were devastating Allied forces on the western front. Against all odds he succeeded, and sound ranging played a crucial role in the subsequent Allied victory. Lawrence was awarded a Military Cross and elected as an officer of the Order of the British Empire, but the story has been unappreciated until recently.

Good news arrived in the midst of the war: Lawrence and his father were awarded the 1915 Nobel Prize in Physics. However, the war would also claim the lives of Lawrence’s younger brother, Bob, and best friend, Cecil. Furthermore, it is now recognized that pretty much anyone close to the front line for an extended period, as Lawrence was, experienced war trauma that had ongoing consequences. Later he had several nervous breakdowns, and he was diffident and insecure in personal relations. I have found no indication that Lawrence was accorded any understanding for his condition.

For those times he underwent a nervous breakdown, he relied greatly on his wife. They met at Cambridge; Alice completed her studies before she accepted Lawrence’s proposal. She recalled that he was shy and serious minded but had a subtle sense of humor. Lawrence’s mother warned Alice that “life would not always be easy. You must make the running, my dear . . . as I have always had to do with Dad [William].”

An inexperienced professor, Lawrence succeeded Ernest Rutherford at the University of Manchester in 1919. The demobilized students were difficult, and a vile series of anonymous letters drove Lawrence to a nervous breakdown. However, time healed those wounds. He was elected a fellow of the Royal Society, his Manchester School was born, and his staff was supportive. There were also lighter moments, as when Alice put a goldfish in each finger bowl at dinner. Lawrence also provides extensive accounts of family holidays, research on the silicates, another nervous breakdown, and much more.

When Rutherford died unexpectedly at Cambridge in 1937, Lawrence again succeeded him, this time as Cavendish Professor. But again he was unwelcome, for crystallography was seen as an unacceptable replacement for nuclear physics.

And again Lawrence would ultimately triumph. After World War II, subjects hitherto attention-starved began to prosper: among them, radio astronomy, electron microscopy, and metal physics. “But probably the work which in future years will be regarded as the outstanding contribution of the Cavendish Laboratory in these after-war years was the start of the investigation of biological molecules by X-rays” by Max Perutz, John Kendrew, Francis Crick, James Watson, and others. Family matters and delightful sketches about Lawrence fill the subsequent pages, until Lawrence’s final appointment as director of the Royal Institution.

But this account “remained unfinished,” the editors write, “probably because when he subsequently moved to the Royal Institution in 1954 he walked into a maelstrom left by the departure of [Edward] Andrade.” Lawrence had to work hard to sort out the problems, which he did to great effect, although he sometimes found himself snubbed by members of the Royal Society, which greatly upset him. Lawrence retired in 1966 and died in 1971.

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Introduction to the AdS/CFT Correspondence

Horațiu Năstase

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The anti-de Sitter/conformal field theory (AdS/CFT) correspondence, also known as holographic duality, is a conjectured relation between quantum field theory and a higher-dimensional gravity theory. It was proposed in 1997 by Juan Maldacena in the context of string theory.

Since then, the correspondence has been extensively checked and generalized. It serves as a strong-weak coupling relation that maps a strongly coupled problem in quantum field theory to a weakly coupled problem in classical gravity. Some calculations that are hard on the field-

theory side of the duality are easy on the gravity side. The AdS/CFT duality establishes an unexpected relation between high-energy particle physics and condensed-matter physics on the one hand, and general relativity on the other, and it is a new manifestation of the fundamental unity underlying the different subfields of physics. A pedagogical book on this sophisticated and rapidly developing subject is clearly welcome.

Horațiu Năstase’s very readable *Introduction to the AdS/CFT Correspondence* is such a book. Written by a well-known expert on the AdS/CFT correspondence and its applications, the book is intended for graduate students and researchers who want to be acquainted with the new holographic techniques. Readers are assumed to understand basic notions of quantum field theory and have some familiarity with general relativity.

The book is organized into three parts. In the first, Năstase introduces the necessary concepts to formulate the correspondence. In the second, he gives the formulation and applies the duality to maximally supersymmetric gauge theories in four spacetime dimensions. The last part of the book deals with advanced topics and applications. That natural organization is, not surprisingly, similar to the one adopted by Martin Ammon and Johanna Erdmenger in their text *Gauge/Gravity Duality: Foundations and Applications* (Cambridge University Press, 2015).

One of the most difficult aspects of writing a book on the AdS/CFT correspondence is deciding how much string-theory background to include. Clearly, minimizing the string-theory content would help to reach a wider audience. Too much string theory and you may lose readers. Less string theory will keep the readers but may cause them to miss the depth of the subject and see the holographic rules as arbitrary and unjustified.

Part 1 of *Introduction to the AdS/CFT Correspondence* achieves that balance, which makes it suitable for teaching the subject starting from well-defined string theory solutions. The opposite, phenomenological approach has been followed by Jan Zaanen, Yan Liu, Ya-Wen Sun, and Koenraad Schalm in *Holographic Duality in Condensed Matter Physics* (Cambridge University Press, 2016); that text

