

LAWRENCE'S LABORATORY: BIRTHPLACE OF BIG SCIENCE

Lawrence and His Laboratory: A History of the Lawrence Berkeley Laboratory, Volume 1

J. L. Heilbron and

Robert W. Seidel

U. of California P., Berkeley,

1989. 586 pp. \$29.95 hc

ISBN 0-520-06426-7

Reviewed by W. Peter Trower

Ernest Orlando Lawrence was among the most important actors to have played on the American scientific stage. His focus on instrumentation rather than physics, specifically particle accelerators, was a departure from that of the great European laboratories. With little theoretical guidance, but with the benign certitude that new physics would result, Lawrence invented, financed and produced these engines of nuclear physics—ever bigger to attain ever higher energies and thus ever more expensive. Here in the first volume of an intended trilogy, Robert Seidel and John Heilbron trace the development of this remarkable American and the ramifications of the institution he created from its genesis to the beginning of World War II.

Thus far Lawrence's focus on instrumentation has been proven fruitful. Important discoveries were made at Lawrence's laboratory—the neutron's magnetic moment, nuclear electron capture and the photosynthesis process. The production of the myriad new isotopes and elements that fleshed out and extended the periodic tables of Mendeleev and Segrè was for many years virtually an exclusive Berkeley cottage industry. At the last

of Lawrence's machines, the Bevatron, a comparable plethora of not-so-elementary particles, the most well known of which were the antineutrons, was seen and elucidated.

Important discoveries were also missed. It was Chadwick at the Cavendish Laboratory who found the neutron, although Berkeley cyclotroners unknowingly had been producing great clouds of these particles for several years in almost every bombardment. These neutrons, readily absorbed throughout the wooden laboratory, induced sufficient radioactivity to jam its Geiger counters. The cause of their inoperative detectors was only realized after the announced Joliot-Curies discovery of artificial radioactivity. Ernest's "boys" confirmed the existence of nuclear fission a few hours after the word of the Hahn-Strassman result reached Berkeley.

Lawrence attracted the best and the brightest to build, improve, repair and run his machines. In their spare time, they produced some quite remarkable science. Luis Alvarez, Melvin Calvin, Ed McMillan and Glenn Seaborg grew into giants on this fertile turf, while others, like Pief Panofsky, Bob Wilson and C. S. Wu, did so elsewhere. But all who worked at Lawrence's laboratory were forever altered by the experience.

From its modest beginnings in a small wooden building behind Le Conte Hall on the Berkeley campus, the "Rad Lab" grew into its current crowded incarnation up on "the Hill" with some 6000 workers. Lawrence's laboratory provided the venue for the invention of the cyclotron, the proton linear accelerator and phase stability and for the development of the bubble chamber into a powerful particle detector. The Rad Lab also gave birth to the disciplines of nuclear chemistry, nuclear medicine, particle physics, heavy-ion physics and carbon-14 and cyclotron dating.

Lawrence's discoveries were essential to making the University of California the world's preeminent public educational institution that it is today. These same activities also created what is now known as "big science" with its focus on instrumentation rather than ideas. This industrial approach to scientific problem solving was put to good use in developing radar at MIT and nuclear weapons at Los Alamos for the war effort. Thus science and government attained the intimacy that they uneasily enjoy today.

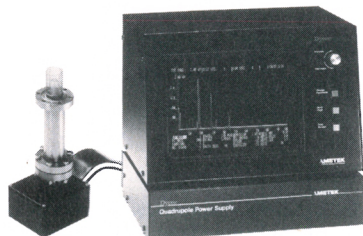
To know the history of Lawrence's laboratory is to begin to understand much of today's cultural scientific landscape. For example, prefigured in Berkeley of the 1930s is the current plight of the solitary investigator: As fewer ever more expensive projects are funded, his or her intellectual freedom exponentially drains away. For the particle physicist, the Lawrencean culprit is increasingly the Superconducting Super Collider, the multi-billion dollar behemoth whose main theoretical justification rests on the possible detection of a putative candidate for the source of mass.

That the practice of history is little understood by most physicists should be evident to anyone attending those often redundant symposia that masquerade as history of science. Here the creators of a field propose to tell us what really happened in those bygone days. Like gizzard stones, their usually pleasant and entertaining reminiscences are well worn from retelling and coated with the patinae of personalities. For historians these recollections serve mainly to illuminate the values and norms of the tribe. Contrary to the belief of most raconteurs, their contributions bear little resemblance to the actual events and are sweetly innocent of the forces that shaped them.

Fortunately, this book has been constructed by historians. Heilbron

W. Peter Trower, an experimental physicist at Virginia Polytechnic Institute, has produced three books with or about the late Luis Alvarez, who was proudly one of Ernest's "boys."

High Performance Dycor™ Quadrupole Mass Spectrometers



The Dycor Quadrupole Mass Spectrometer offers a dynamic range of 7 orders of magnitude along with a high resolution CRT, analog bar, and tabular display modes, with an RS-232 port for computer interface as standard features.

The Dycor product line is manufactured at our facility in the U.S.A. This permits us to offer it at a price which is the most cost-effective in the industry.

Whether your need is residual gas analysis, process monitoring, or leak detection, the microprocessor-based models provide you with the ultimate in performance.

Applications include:

- Residual Gas Analysis
- Process Monitoring
- Leak Detection
- Chemical Vapor Deposition
- Fermentation
- Sputtering
- Plasma Etching
- Molecular Beam Epitaxy
- Cryogenics
- High Energy Physics
- Vacuum Furnaces
- Evaporation
- Ion Beam Milling

Features:

- 1-100 or 1-200 AMU Range
- Faraday Cup and Electron Multiplier
- 9" or 12" High Resolution CRT
- Analog Bar or Tabular Display
- Pressure vs. Time Display
- Linear to 4 Decade Log Scale
- RS-232 Computer Interface
- 10^{-14} Torr Minimum Detectable Partial Pressure
- Background Subtraction
- Spectral Library
- Sample Systems for higher Pressures

For literature, contact AMETEK, Thermox Instruments Division, 150 Freeport Road, Pittsburgh, PA 15238, TEL: 412-828-9040, FAX: 412-826-0399.

AMETEK
THERMOX INSTRUMENTS DIVISION

and Seidel have made full use of the available inventory of materials to present a lucid, plausible and realistic understanding of a remarkable man, the institution that indelibly bore his imprint and his interactions with his cultural milieu. No hagiography this, for as Swift treated his Gulliver, so the authors give a full account of the human Lawrence: his prodigious entrepreneurial skill, his unbridled mid-western boosterism and his almost religious belief in the endless fruits of "progress." They show that these traits did more to propel Lawrence's vision than did his considerable talents as a practicing physicist. The authors present the laboratory's technological process and product in painstaking, but never dull, detail. Their copious collection of well-selected diagrams and photographs provides further leavening for an already zesty text. That they relate all this arcanum to the larger, evolving social and institutional context is a masterful achievement.

Lawrence and His Laboratory is a wonderful read. The authors' seamless, sprightly and irreverent prose offers many delights. The descriptions of the laboratory and its habits are so human in scale that a nonscientist can peruse them with pleasure and profit. Further, there are many new insights and much valuable information here for those interested in our roots as physicists. Seidel and Heilbron have even gotten the physics right!

By indifferent promotion and inept production, the publisher has failed this important and interesting book. Few, if any, reviews of this work have appeared in the general print media, so its existence will be mainly known to students of science and scientists. The index does not include many entries and citations, a flaw that reduces its usefulness as a reference.

Nonetheless, if the two remaining volumes of this trilogy live up to the high standard of the first, then the authors will have erected an imposing edifice of 20th-century history. In progress is a second book, which deals with the essential contributions of Ernest and his "boys" to far-flung war efforts, their reunion on the Hill, the laboratory reaching its apogee and finally Lawrence's death. The planned third volume will trace the meander of Lawrence's institution to its current state of aimless mediocrity as his strong, single-minded leadership has been increasingly replaced by the organizational chart and bureaucratic bloat. With the tall timber being harvested but not replaced, squaw carpet abounds.

Physics of High- T_c Superconductors

J. C. Phillips

Academic, San Diego, Calif.,
1989. 393 pp. \$49.95 hc ISBN
0-12-553990-8

There exist now some half-dozen larger reviews or books related to the physics of high- T_c cuprates. It is with the sentiment "another one" that the undersigned took the book by J. C. Phillips in hand and... read it cover to cover, sentence by sentence. Why? Being in a sense a newcomer to the field of superconductivity, the start was obvious: He was attracted by the first two chapters on the old materials and their theory. In reading them, he learned some aspects that had escaped him previously and sensed that the author of the book had a deep understanding, which he conveyed easily, both with respect to the materials as well as the theoretical results concerning them. Especially the anharmonicity of the "old" high- T_c materials was substantial, including the related lattice softening and instabilities, their pressure dependence and T_c enhancement. This is specifically so for the elements nitrogen and oxygen on one side, and the d-transition elements on the other. The chemical physics aspects related to the above properties guide the reader through the whole book. In this context the word "fictive phonons" enters. The undersigned, coming from the ferroelectricity field, is more used to models of "order-disorder dynamics," whose meaning is nearly the same: the "rattling" Slater ions.

The new materials are exposed in Chapter 3. First the remarkable properties of the Chevrel phases are described which form a link to the more recent discoveries. This link is not only historical but also conceptual, in that a link Pb atom is found between Mo_6S_8 clusters in PbMo_6S_8 ($T_c = 15.3$ K). Then the description passes on to the BaPbBiO_3 perovskites, which are the true predecessors of the cuprates and reach T_c of about 30 K for $\text{K}_{0.3}\text{Ba}_{0.7}\text{BiO}_3$. Phillips then describes the structural, electronic and superconducting properties of the La_2CuO_4 and $\text{YBa}_2\text{Cu}_3\text{O}_7$ cuprates. He does this with considerable insight into the materials. Of course, as the chapter was obviously written quite early, the results from ceramic samples occupy quite some space. Nevertheless, essential structural and transport properties are well brought out, such as the near linear in-plane temperature dependence of the resistivity above T_c .