

BOOKS

Physics, Physicists and the Cold War Chill

American Science in an Age of Anxiety: Scientists, Anti-Communism, and the Cold War

Jessica Wang
U. North Carolina P., Chapel Hill, N.C., 1999. 375 pp.
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Reviewed by Robert H. March

The cold war created a relationship between science and the US government that is still to be reckoned with. In *American Science in an Age of Anxiety*, Jessica Wang, a historian at UCLA, explores the origins of this relationship, and especially its loyalty and security provisions, in the decade following World War II. Though the title specifies "science," the monograph is almost exclusively concerned with physics and physicists.

The story begins in the heady days of 1946 when a group of atomic scientists, flush with prestige from their wartime triumphs and under the aegis of the newly formed Federation of American Scientists (FAS), waged a successful public campaign for the McMahon Act, which created the Atomic Energy Commission (AEC) as a civilian rather than a military agency.

The honeymoon proved short-lived. As relations between the US and USSR deteriorated, conservatives launched a hunt for the "traitors in our midst." The politics of scientists became a particularly sensitive issue. Support for open scientific communication or international control of atomic energy became grounds for denial of security clearance.

At the core of the struggle sat the House Un-American Activities Committee, which sought the return of nuclear research to military control. But HUAC faced a classic legislative turf battle with the Joint Committee on

Atomic Energy. The AEC itself, chaired by the New Deal liberal David Lilienthal, hoped to create a security system that would protect the civil rights of its scientific staff. In this three-way tug of war, FAS opted to play insider politics and did manage to achieve some minimal concessions toward due process in AEC security.

In the hands of anonymous panels, military security arrangements remained arbitrary and capricious. Wang cites one example of an individual apparently denied clearance based on membership in the American Association for the Advancement of Science!

The situation worsened in the fateful year between the summers of 1949 and 1950, which saw in rapid succession the creation of the People's Republic of China, the testing of the first Soviet A-bomb, the confession of atomic spy Klaus Fuchs and subsequent arrest of Ethel and Julius Rosenberg, and the start of the Korean War. The National Science Foundation was born in this period, with a provision that required fellowship applicants to file a loyalty oath and noncommunist affidavit.

In the 1950s, it became difficult to hold international scientific meetings in the US—as many as half of the foreign invitees were denied visas by the State Department, which also arbitrarily withheld passports from Americans whose travel was deemed "not in the national interest." Thus chemist Linus Pauling had to win the Nobel Prize in order to be issued an unrestricted passport to travel to Sweden to claim it. In 1958, a Supreme Court decision in the case of physicist Bruce Dayton finally established a constitutionally protected right to free travel.

The removal of the security clearance of J. Robert Oppenheimer in 1954 proved a turning point. It has been widely regarded as excessive and even irrational, and led to revisions of the AEC security code that at last provided genuine due process.

Wang devotes considerable space to five case studies: Harlow Shapley, Edward Condon, Eugene Rabinowitch, John and Hildred Blewett, and Robert Vought. Prominent scientists like Shapley, Condon, and Rabinowitch had some success in defending themselves, while Vought and the Blewetts found themselves in precarious circum-

stances and had to rely on the good offices of their superiors.

The case of Condon provides a particularly poignant example. Starting in 1946, he incurred the personal animosity of Representative J. Parnell Thomas, chairman of HUAC. The committee continued to harass Condon for years thereafter, even after Thomas was driven from office and into prison in 1950 for payroll fraud. Though a past president of the American Physical Society and a member of the National Academy of Sciences, Condon was hounded from public service as director of the National Bureau of Standards. He then went into industrial research, until his clearance was finally cancelled in 1954 at the behest of then-Vice President Richard Nixon.

Wang concludes that "the search for potential spies motivated by ideology was by its very nature a low-probability enterprise, one that would identify hundreds of false positives for every true positive," while missing altogether those motivated by simple greed.

This is a scholarly monograph, and, as such, it is a bit too challenging for casual, bedtime reading. But it is largely free of jargon and would make profitable reading both for scientists who lived through the events it recounts and for younger colleagues who may find some of its revelations astonishing.

Rayleigh-Bénard Convection: Structures and Dynamics

A. V. Getling
World Scientific, River Edge, N.J., 1998. 245 pp. \$48.00 hc
ISBN 981-02-2657-8

It was 45 years ago that George E. Uhlenbeck advised a class of physics students that "the books on fluid dynamics have been written by engineers and mathematicians, so they are either too thick or too thin." Though this remark lost some of its pungency when the English translation of *Fluid Mechanics* by Lev D. Landau and Evgenii M. Lifshitz (Pergamon, 1959) appeared, there were still not many books on the subject that physicists might enjoy. But things have been looking up,

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especially in those branches of fluid dynamics whose rapid progress has led to the incorporation of their techniques into modern physics.

A notable example is the solitary wave in shallow water, whose stable exemplar, the KdV soliton, has mathematical properties that leave one speechless on first hearing of them. Still, wonderful as they are, the solitons arise in a system that is free from real-world problems, such as the instability and dissipation that enrich the lives of fluid dynamicists with difficult but fascinating challenges. Adding these features to the study of the dynamics of thin fluid layers brings us into the kaleidoscopic world of fluid dynamical pattern formation.

At the turn of the century, Henri Bénard produced his famous picture of the hexagonal flow pattern observed in a thin layer of spermaceti heated from below. More than 50 years later it was realized that the nature of this particular pattern owed more to the temperature dependence of the surface tension than to the influence of the gravitational acceleration, which was the key ingredient in the theoretical analysis by Lord Rayleigh. (Rayleigh's theory and some subsequent elaborations are detailed in Subrahmanyan Chandrasekhar's *Hydrodynamic and Hydromagnetic Instability*, Oxford, 1961.) The surface tension operates on only the top surface, and so it breaks the symmetry underlying Rayleigh's theory. This is enough to modify the expected form of the convective cells.

Bénard and his students soon appreciated that his first experimental results were atypical of ordinary fluids. They went on to attempt "to define and to measure in a horizontal liquid layer heated from below, the convection currents that prevail, considered as near as possible to their state of greatest stability." The problem so formulated is at the center of modern convective pattern research, and the work of Bénard's students anticipated some important modern discoveries and methods. Surprisingly, their early grasp of the basic issues is generally overlooked in the current literature.

Though *Rayleigh-Bénard Convection: Structures and Dynamics* by Alexander V. Getling does not dispel this general misimpression, it does give a careful account of work on the patterns of convective motions performed in the second half of this century. Getling, of the Institute of Nuclear Physics at Moscow State University, describes the recent addition of such cell shapes as bull's-eyes, spirals, and labyrinths to the more traditional structures of convective motions, rolls, and hexagons. His account of this growth in the ex-

perimental and theoretical understanding of convective pattern dynamics during the past 30 or 40 years follows the presentation of the original research papers closely.

In his admirably slim volume, Getling attempts no grand synthesis and is driven by no current fads. We do not find the words "complexity" or "chaos" in the index of his book, though they are normally to be heard in many discussions of this subject—even the second edition of Landau and Lifshitz's *Fluid Mechanics* describes the transition to chaos by period doubling. Getling confines himself to the results of convective pattern theory, and one need not look for more.

Yet similar pattern studies have occurred in other subjects, such as oscillating chemical reactions and biological structure formation. The subject has gained a universality that is attractive to physicists because pattern formation exemplifies concepts from such other branches of physics as condensed matter. These connections have developed in the 30 years since the Ginzburg-Landau equation first appeared in theoretical discussions of convection. This discovery set off a wave of cultural diffusion that brought the Navier-Stokes equations of fluid dynamics back into physics, even as fluid dynamicists and applied mathematicians have learned to speak of disclinations, order parameters, and Goldstone modes.

Physicists who want a global vision of where the study of patterns has gone in the past decade or two will need to decide whether they want to follow Getling's straight and narrow path through convection or seek a wider view, like that provided in the prodigious review article by Michael C. Cross and Pierre C. Hohenberg (*Rev. Mod. Phys.*, **65**, 581-621, 1993). Or perhaps they would prefer the more mathematical outlook afforded by Paul Manneville's *Dissipative Structures and Weak Turbulence* (Academic, 1990). Those who favor the applied mathematical outlook may find it interesting to see how the technique once known as slowly varying wave theory has made a successful reappearance in this seemingly waveless terrain, as described in the review by Alan N. Newell, Thierry Passot, and Jocelyn Lega (*Ann. Rev. Fluid Mech.*, **25**, 399-453, 1993). Still, there is no denying that the convective regime of moderate amplitude, where pattern theory works well, is well worth a book of its own, and Getling's is of about the right thickness.

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Nonlinear Optics: Basic Concepts

Douglas L. Mills
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ISBN 3-540-64182-3

Douglas L. Mills's *Nonlinear Optics* is the second edition of a well-known text first published in 1991. In the preface to the first edition, the author states clearly what his intended audience is: students who have completed a year of graduate-level electricity and magnetism (and quantum mechanics) and who wish to learn something about nonlinear optics. He attempts specifically to introduce the competent graduate student in physics or electrical engineering to nonlinear optics, but does not try to cover the field in the kind of detail of, say, Amnon Yariv's *Quantum Optics* (Wiley, 1975, 2nd edition). In short, Mills has produced a high-level "overview" text.

The strength and the weakness of this book in both of its editions flow from the author's aim. The text covers virtually all of the main research areas in modern nonlinear science, and the style and presentation are inviting to the general reader. In this sense, it serves a valuable purpose, for it offers a broad, easily accessible introduction to one of the most important research topics using lasers. The second edition includes an emphasis on nonlinear optics at the surfaces of materials, a subject of great activity over the last 10 years and, combined with the sections on nonlinear optics in fibers, it offers the reader a real sense of the excitement and opportunities in nonlinear optics.

The downside is that while Mills takes pains to express many of the equations in their correct form and even derive in detail some of the results, he is not consistent in the depth with which he goes into individual topics. For example, he spends multiple pages deriving phase-matching conditions yet leaves much to the reader in developing fundamental equations in optical fibers. Accepting that this disparity is a necessary risk in any overview text, *Nonlinear Optics* comes close, but not close enough, to being useful as a main text for the course Mills wishes to offer. Anyone planning to use this book as a guide for a second-year graduate course in nonlinear optics would have to include a great deal of outside reading, or supplement it with one of the more established texts in the field (for example, Yariv's).

As a note on structure, I would have appreciated a much more detailed index, and especially an author index