

A symbiotic relationship

THE GOVERNMENT OF SCIENCE. By Harvey Brooks. 343 pp. MIT Press, Cambridge, Mass., 1968. \$6.95.

SCIENCE POLICY AND THE UNIVERSITY. Harold Orlans, ed. 352 pp. The Brookings Institution, Washington, D. C., 1968. Paper \$2.95, cloth \$7.50.

by Paul Craig

As science budgets become increasingly competitive with other claimants upon the national budget, it becomes incumbent upon the scientific community to concern itself with the politics and government of science and with the establishment of internal priorities within science. There exists within the scientific community considerable expertise in these matters, and scientists will do well to take advantage of this knowledge. The individual who wishes to learn something of the "state of the art" in government-science interaction can hardly do better than study the two volumes under review here.

Harvey Brooks of Harvard University has been an advisor to government for a number of years. In this role he has concentrated his attention on the examination of broad issues of policy formulation relating to the manner in which governmental and societal needs in research and development may be identified and satisfied. It is a tribute to his insight that the essays (spanning a seven-year period) collected in *The Government of Science* identify and anticipate issues and problems that the general scientific community is only now confronting. The breadth of Brooks's concern may be indicated by citing a few chapter titles: "The Government of Science," "The Science Advisor," "Future Needs for the Support of Basic Research," and "Can Science be Planned?"

The Brookings Institution is an independent organization that devotes itself to those aspects of economics, government, foreign policy and the social sciences that it feels are deserving of public attention. Studies by the Institution are highly variable in approach and usually rewarding. *Sci-*

ence Policy and the University results from a continuing concern within the Institution about the nature of the symbiotic relationship between government and the universities, and how this relationship affects the growth of science. The Brookings approach was to sponsor a series of relevant seminars. In each session a position or interpretive paper was prepared by an expert in a particular area of concern. Representatives included Don K. Price and Hendrik W. Bode of Harvard, Alvin Weinberg, director of Oak Ridge National Laboratory, Wolfgang K. H. Panofsky of the Stanford Linear Accelerator and Howard E. Page of the National Science Foundation. The papers were circulated to the seminar members before each meeting. The meetings consisted of brief summaries of the papers, followed by intensive discussion. The editor, Harold Orlans, has condensed the discussions and inserted connective comments and references. The participants in the discussions are identified only by generic terms (congressman, physicist, NASA official and so on). As the book includes an appendix listing all seminar members, speakers and guests, an en-

tertaining sport is to attempt to associate viewpoints with these names. The discussions are wide ranging, sometimes rambling, but generally incisive. A reader might feel he is a participant in a roundtable of experts. The give and take brings out a variety of points likely to be omitted in a more formal presentation.

Harvey Brooks presented one of the Brookings Institution seminars and one of his essays ("The Future Growth of Academic Research: Criteria and Needs") appears in both volumes. This duplication suggests, as turns out to be the case, that the subject matter of the two volumes overlaps substantially. Indeed, the Brookings study might have been titled simply *Science Policy* as the book ranges further than its title implies. Brooks's concern tends toward broad issues of science development and support, whereas the Brookings seminars tend more toward consideration of specific mechanisms.

Some of Brooks's essays are background material for decisions. An example is the study prepared in 1961 for the President's science advisor, Jerome B. Wiesner, on the pros and cons of a Department of Science. Us-



ing the specific question of a Department of Science as a takeoff point, general issues of science support are explored. The justification for the multifaceted and often confused support of a particular branch of science by many divisions of government is discussed. Several essays are detailed analyses of specific questions, as is Chapter 9 on the curriculum needs of a modern engineering program, and Chapter 11, a study for the Academy of Sciences on the definition, status and use of applied research, and how one might undertake a program of "research on research."

Questions are raised regarding government support of research. In supporting science, the government must ask what this science is to be used for. No single answer can be given. In applied areas planning is clear. But to what extent can (or should) directions in basic research be controlled? What is the role of the universities, and how is knowledge that develops in one area of society transferred to other areas where it may be put to use?

Because science must today be largely supported by the government the needs of government itself must be considered. The military has for a number of years taken over a major portion of the support of both basic

and applied research. The justification for military support of basic research goes back to Alamogordo, and is succinctly phrased by Brooks: "In military development there is nothing more costly than the basic scientific results that were not available when the time was ripe for their use." But military support of science is only one type among many, and the military today is tending to shy away from research that is not highly product oriented.

There are many types of science that contribute to or are required by non-military facets of the society. Many such areas are related to specific agencies of government. Education is in a separate category because it is essential to all science.

The Brookings study is more concerned with specifics. Don K. Price presented at the seminar his well-known paper, "Federal Money and University Research," on the historical development of Federal support of science. There is a discussion of how government allocates money to research, details of how the Federal science budget is made up in the Budget Bureau and presented to Congress, and the question of how the scientific community ought to decide its priorities and the needs of academic research.

A particularly relevant paper by Herbert Roback tells what kind of information is of interest to Congressmen and how to present it to them. On most issues the spectrum of informed opinion was expressed. On high-energy physics, for example, one person stated that the physics panel of the National Academy of Sciences took a poll among its members on the most fundamental field of physics and discovered that every member said high-energy physics. Later in the discussion it was asserted that "the findings of physics would ultimately prove of great social value" to which the response was: "Never in the history of science have so many bright people worked so long and spent so much money and given rise to so little in the way of practical accomplishment." In another session, Panofsky offers an eloquent (if not entirely convincing) defense of high energy as a training ground for students.

Alvin Weinberg did not contribute a new paper but discussed his much commented-upon study "Criteria for Scientific Choice," which originally appeared in "Minerva" and has recently been reprinted (*Criteria for Scientific Development: Public Policy and National Goals*, Edward Shils, ed., MIT Press, 1968). His object is to define criteria by which a society may decide amongst rival claims for support from various scientific research directions. His emphasis upon "embeddedness" and social utility have been much debated. It is a controversial paper and the discussion with government officials and social scientists as well as natural scientists makes for superb dialog.

Both volumes reviewed here suffer certain weaknesses of structure. Perhaps this is inevitable in any collection representing thoughts of a variety of individuals, or the uncorrelated collection of one individual's writings. In *The Government of Science* it is particularly unfortunate that in collecting Brooks's work no attempt beyond a brief paragraph at the beginning of each chapter was made to interrelate or to coordinate the essays. Not only is there no index, but footnotes within each section are the original ones; even references to other articles appearing in the collection refer to the original publications. But these are minor objections. The volumes are prime references for the scientist who hopes to function efficiently in the changing scientific climate of the late sixties. The

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scientist or administrator who fails to become aware of the new issues raised here does so at his peril.

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Theory of natural diffraction

ELEMENTS OF X-RAY CRYSTALLOGRAPHY. By Leonid V. Azároff. 610 pp. McGraw-Hill, New York, 1968. \$15.75

by Richard B. Zipin

My own introduction to crystal geometry came seven years ago as a beginning graduate student in a course in which we depended on lecture notes. As the instructor was not completely satisfied with any of the textbooks available at that time, he was therefore writing his own. As far as I know, my former instructor's book has not yet been published, but here at last is a book that will fill the sorely-felt gap in my personal library. Many sections of the book were familiar to me even before I read them, as Leonid Azároff, the author of this book, and

the man who taught me both got their crystallographic educations at MIT.

In his preface, the author warns that many readers may be reminded of lectures that they have had. He and my own professor presumably listened to the same lectures, and I have only had such lectures secondhand. Nevertheless, on opening this book I became reunited with an old friend—a clear and fairly complete introductory exposition of x-ray crystallography that should be welcomed by students and teachers alike. The author is already well-known to students of the solid state, not only for his research, but also for his previously published textbooks.

This text is based on the concept that diffraction spectra of single crystals constitute a reciprocal-lattice array. The author has separated his material into four distinct areas: crystal geometry, x-ray physics, diffraction theory and experimental methods. His personal interests are readily apparent in that the latter two subjects comprise more than two thirds of the book. The appendixes include material aimed at helping the students who will use the book as a text; there is some mathematical development, a set of tables, a short bibliography, and answers to some of the problems that appear at the end of each chapter. There is adequate material included so that in-

structors will find the book suitable for an introductory course at either the undergraduate or beginning graduate level.

My own preferences would have been better satisfied with a book that deals more extensively with the group-theoretic concepts in crystal geometry and the physics of x rays, rather than a book that concentrates so much on experimental techniques; but each author must write a book that satisfies himself. I can only recommend this book to those who require a good introduction to x-ray crystallography written with students in mind.

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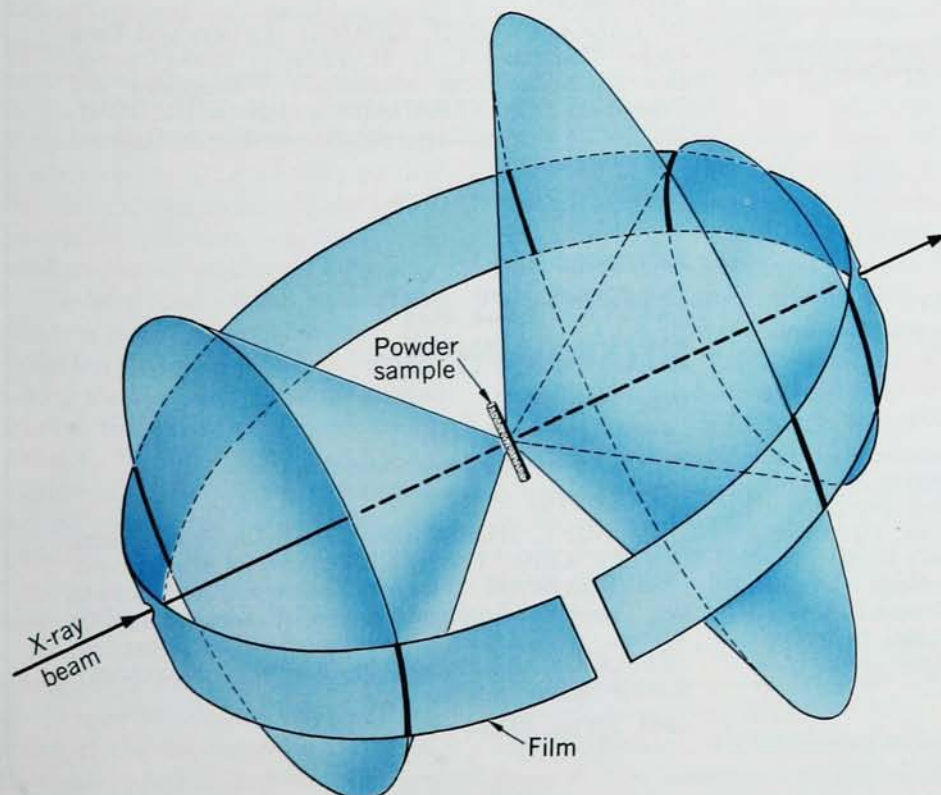
Mössbauer spectroscopy

MOSSBAUER EFFECT METHODOLOGY, Vol. 3. Conf. proc. (New York, Jan. 1967) Irwin J. Gruverman, ed. 250 pp. Plenum Press, New York, 1967. \$12.50

by H. H. Wickman

For the past four years (1965–68) the New England Nuclear Corp (a supplier of Mössbauer sources) has sponsored a Mössbauer-Effect Methodology Symposium held prior to the annual meeting of the American Physical Society. The present volume, edited by Irwin Gruverman of New England Nuclear, contains proceedings of the third symposium held in New York, in January, 1967. The volume is composed of two sections, the larger being a collection of applications of Mössbauer spectroscopy in the area of material sciences; the second section is devoted to the methodology of several relatively recently developed Mössbauer nuclides. The level of the articles is generally introductory and for the most part the discussions are accessible to nonspecialists.

Not all of the articles contained in the material sciences section could be considered to be in the mainstream of current research in which gamma-ray nuclear resonance is involved. Among the articles that should be of fairly general interest is a concise description of chemical and magnetic order in alloy phases written by Clyde W. Kimball, who considers in some detail the



POWDER METHOD. The diffraction cones emanating from a cylindrical sample are shown intersecting a film strip; the strip is also placed cylindrically to intercept all the cones produced. (From *Elements of X-Ray Crystallography*).