the point of departure for any serious effort to appraise the meaning of genius in the era of apocalyptic science. Highly recommended.

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A former editor at the Hastings Center (Institute for Society, Ethics, and the Life Sciences), Robert Andersen is currently at work on a book on the atomic scientists.

Computers and Instrumentation: A Practical Handbook of Measurement, Interfacing and Control Circuits

A. Carrick
256 pp. Heyden, Philadelphia, 1979. $19.50

Minicomputers with performance rivaling that of batch-mode "mainframe" computers of a decade ago can be had for thirty thousand dollars; a modest microcomputer, complete with plenty of memory, floppy disks, graphic printer, terminal, and analog/digital interfaces costs one fifth as much. The ready availability of computational power in the laboratory is merely convenient; connecting a computer "online" to an experiment is revolutionary, seen from the framework of scientific experimentation of merely two decades ago.

This ability to gather data from an experiment while controlling the various parameters (perhaps in response to the data just gathered) can now be considered a pleasant fact of scientific life. The essential skills—assembling the computing system, interfacing to the experimental apparatus, writing and debugging the software—are, unfortunately, far harder to come by than that elegant hardware harvest from Silicon Valley.

In this volume, subtitled *A Practical Handbook of Measurement, Interfacing and Control Circuits*, Alan Carrick, an experienced British industrial designer of electronic instrumentation, has attempted to set down "a basis for questioning about computers in scientific surroundings." In fact, he grapples with the specifics of computer architecture, analog and digital hardware fundamentals and, of most importance, the interfacing of small computers to laboratory instrumentation.

Computing hardware, the most rapidly changing area of electronics, is therefore the most difficult to write about and get into print without it appearing hopelessly dated by the time the ink has dried. Carrick's solution is to take a historical and generic approach, avoiding the specifics that would make the book a true "practical handbook." In my opinion, the volume is greatly weakened by the intentional omission of the specifications and names of parts. We are shown an example of microprocessor architecture, but *which* microprocessor? The feeling of loss is most poignant in the otherwise admirable collection of analog and digital instrumentation examples: schematic diagrams with unnamed and unknowable resistors, capacitors, amplifiers. Carrick avoids the specifics in software as in hardware: Barely a dozen lines of programming accompany as many interface examples.

By contrast, the most successful and enjoyable sections are those in which the author allows himself the luxury of naming names: the fine summary of the standardized interfaces (RS232C, IEEE488, CAMAC and the British BS4421). Carrick is in fine form, too, when general advice is what is needed: what to look for when choosing a computer; software languages, standards, benchmarks; good advice on the use (*non*use!) of monostables; the hardware/software choice in design; when to avoid computers.

While this volume makes interesting reading, particularly for those already acquainted with small computers, it does not succeed as a handbook. Those looking for detailed help should consider J. W. Cooper's *The Minicomputer in the Laboratory* (Wiley, 1977) and M. Sargent and R. Shoemaker's *Interfacing Microcomputers to the Real World* (Addison-Wesley, 1981). The former is a fine introduction to assembly-language programming (PDP-11) with laboratory applications; the latter covers all aspects of microcomputer hardware and software, including interfacing, control and signal processing, based around the specific example of the Z80. Both feature very detailed and complete examples.

PAUL HOROWITZ
Harvard University

Nuclear Nightmares: An Investigation into Possible Wars

N. Calder
175 pp. Viking, New York, 1979. $10.95

I can think of few, if any, books of recent years that I would recommend as strongly—but with as little pleasure—as Nigel Calder's *Nuclear Nightmares*. Out of his sense of responsibility as a journalist he has taken on the most worrisome and intractable problem of our times, the threat of nuclear war, and found the situation worse than he had expected: not just risky but insane, a peril from which there is little hope of escape.

My strong recommendation for this disquieting book has its basis in the belief that whatever small hope there is might be increased if enough people, particularly those professionals concerned with nuclear arms and policy, read it.

The subject divides naturally into four components: technology; the consequences of the use of nuclear arms; the ways in which nuclear war might begin and develop, including all the esoteric doctrinal questions; and what, if anything, might be done to make nuclear war less likely or to mitigate its consequences.

It is difficult for someone like myself, who has lived with these matters for decades, to judge whether Calder has treated them at a level that is meaningful and understandable to the intelligent nonexpert, but I believe he has. I feel more comfortable in giving him accolades for accuracy—I don't recall any technical errors—and for giving balanced and reasonable judgments on matters of some dispute, such as how "conventional" war is changing as a result of the introduction of precision-guided munitions and what are the likely near-term prospects (very poor) for charged-particle-beam weapons.

He is at his best in dealing with doctrine and concepts for use of nuclear weapons, including differences between the East and the West, and in highlighting the uncertainties that must attach to their use. Although advocates of "flexible response," "extended deterrence" and "limited nuclear war" will resist his arguments, I find them persuasive in demonstrating that nuclear weapons cannot be used for these purposes without risks that are unreasonable.

Nearly all of this material is woven into the four central chapters, each of which deals with a type of possible origin of nuclear war: the East-West conflict in Europe; the spread of nuclear weapons to additional countries; failures of command and control; and disarming attacks by one of the superpowers against the nuclear forces of the other. I find the first of these chapters flawed in that Calder has accepted too much of the conventional wisdom about the superiority of the Warsaw Pact forces relative to NATO's. After all, the personnel balance in the European theater is about even; by any reasonable measure, NATO has been spending more each year on its military establishment than the Pact; and the Soviets have a Chinese problem for which some allowance ought to be made. I am also troubled about his giving the first and fourth scenarios as much weight as he does. Perhaps he is right, as a reporter, in doing so. They have certainly been the scenarios stressed in the development of policy and the rationalization of weapons-acquisition decisions. However, overemphasis on them underlies, in my

view, much that is wrong in policy and posture, and more emphasis on them is not likely to be helpful.

But these are small quibbles about a book that is filled with trenchant criticism of our dependence on nuclear arms and contains in its postscript a biting assessment of arms control efforts as well.

GEORGE RATHJENS
Massachusetts Institute of Technology

Popular Lectures on Mathematical Logic

W. Hao
273 pp. Van Nostrand, New York, 1981. $24.95

This book, a published version of lectures given at the Chinese Academy of Science in 1977, is intended for any reader who wants to know what comprises some of the most interesting and fruitful parts of mathematical logic. Written by an eminent logician (the author of two well-known books, *Logic, Computers and Sets* and *From Mathematics to Philosophy)*, the book is at once testimony to the enormity of the author's contributions to the field and an excellent survey of important topics in modern mathematical logic.

After an initial history of the subject from about 1980, the book deals with formal systems, the role of computers, open mathematical and logical problems, first-order logic, computability and set theory. Obviously there is no attempt to cover all of mathematical logic. Instead Wang Hao treats us to those portions with which he is thoroughly familiar: $\forall\exists\forall$ formulas of predicate logic, formalization of predicative set theory, finite axiomatizability, automatic theorem proving, search for new axioms in set theory, formulation of Turing machine theory in terms of computerlike models, decidability and tiling problems.

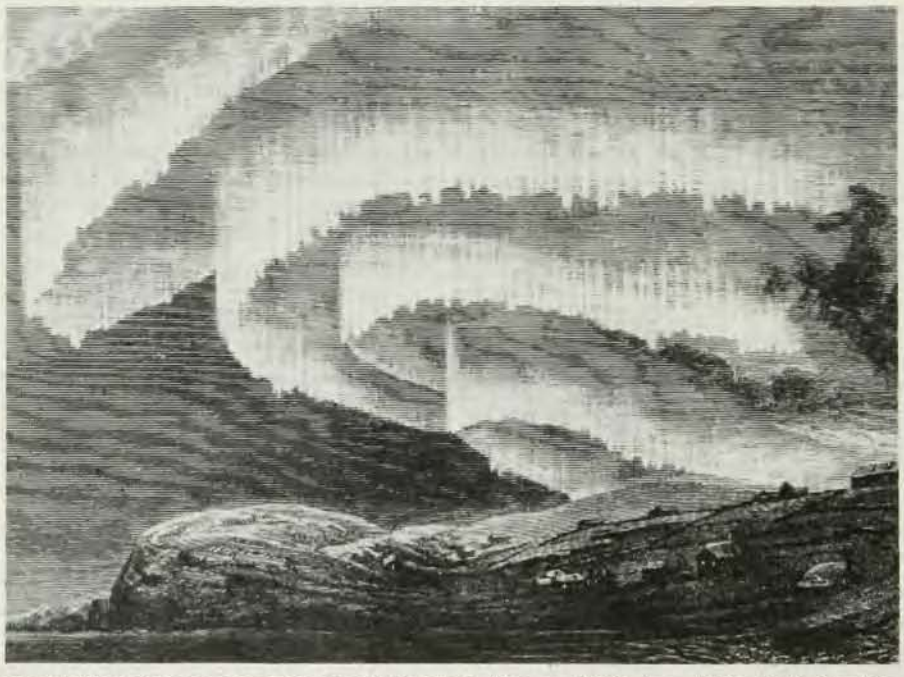
Most of the chapters begin with early results and end with open problems. Only proofs of very important theorems are presented. One finds excellent coverage of Cantor's and Godel's work, lucid accounts of constructability and forcing, and extensive material on computers and computability.

Wang discusses one of the great achievements of mathematical logic in this century, the development of methods to prove that certain classes of problems are not solvable. The idea of partial recursive functions led to several important mechanically unsolvable problems like the decision problem of first-order logic: Given a logical schema, find a general algorithm that will determine if it is satisfiable (has a model). In 1936, Alan Turing proved that the system of predicate logic (formal calculus of sentences composed of subject and predicate together with the two operators, universality and existence) is not decidable. In 1962, Wang settled a long-standing open problem when he showed that the decision problem for even as simple a class as the $\forall\exists\forall$ formulas (with just three quantifiers) is undecidable. He accomplished this by reducing logical formulas to dominoes (a finite set of square tiles of equal size but with assigned edge colors) and creating an equivalent of the Turing machine halting problem, to decide for any Turing machine (abstract computing device) whether it will eventually halt when the initial tape is blank. The solution to this problem produces the solution to decision problems for all quantifier classes. This is important because the complexity of a logical formula is directly related to the number and order of its quantifiers, and a measure of the complexity of a mathematical problem is given by the structure of its equivalent logical formulas.

The three appendices "Dominoes and the Infinity Lemma," "Algorithms and Machines" and "Abstract Machines" represent areas where the author has made singular contributions. Each provides an excellent introduction to the subject. One of the most interesting features is the set of footnotes, rich in historical and anecdotal detail. In part this compensates for the lack of a comprehensive bibliography. As for the index, it is painfully poor.

What Wang has accomplished in this book is a clear account of the interrelationships between widely different topics and their relative importance, all of this with an historical perspective in mind. In eschewing comprehensiveness, he has given instead a humanist's approach to mathematical logic.

FRANCINE ABELES
Kean College



Rendering of an aurora seen from Bossekop, Norway, 1839, from *Majestic Lights: The Aurora in Science, History, and the Arts*, by R. H. Eather. 323 pp. American Geophysical Union, Washington, D. C., 1980. Courtesy Widener Library, Harvard University.

Cosmic X-Ray Astronomy

D. J. Adams
145 pp. Hilger, Bristol, 1980 (US dist: Heyden, Philadelphia). $29.50

From the first detection of an extrasolar source in 1962 to the launch of the Einstein Observatory in 1978, the purview of x-ray astronomy has expanded from a few bright binary stars harboring accreting collapsed companions to virtually every type of astrophysical system known, from nearby normal stars to the most distant galaxy clusters and quasars. As of this writing, however, the field is at a critical point. With the demise of the Einstein satellite in April of this year, there is no operating x-ray observatory in orbit. The next opportunity for x-ray observations of any sort are from a small European satellite scheduled for launch in eighteen months; the next US x-ray facility is more than five years away.

Such a forced hiatus is rare in any field of inquiry, but it provides an ideal opportunity for compiling histories and summarizing progress to date. Unfortunately, D. J. Adams has done neither in this monograph. Working at the University of Leicester in the early 1970s, Adams developed payloads for sounding rockets and the British x-ray satellite Ariel V, but for the last five