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.

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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.

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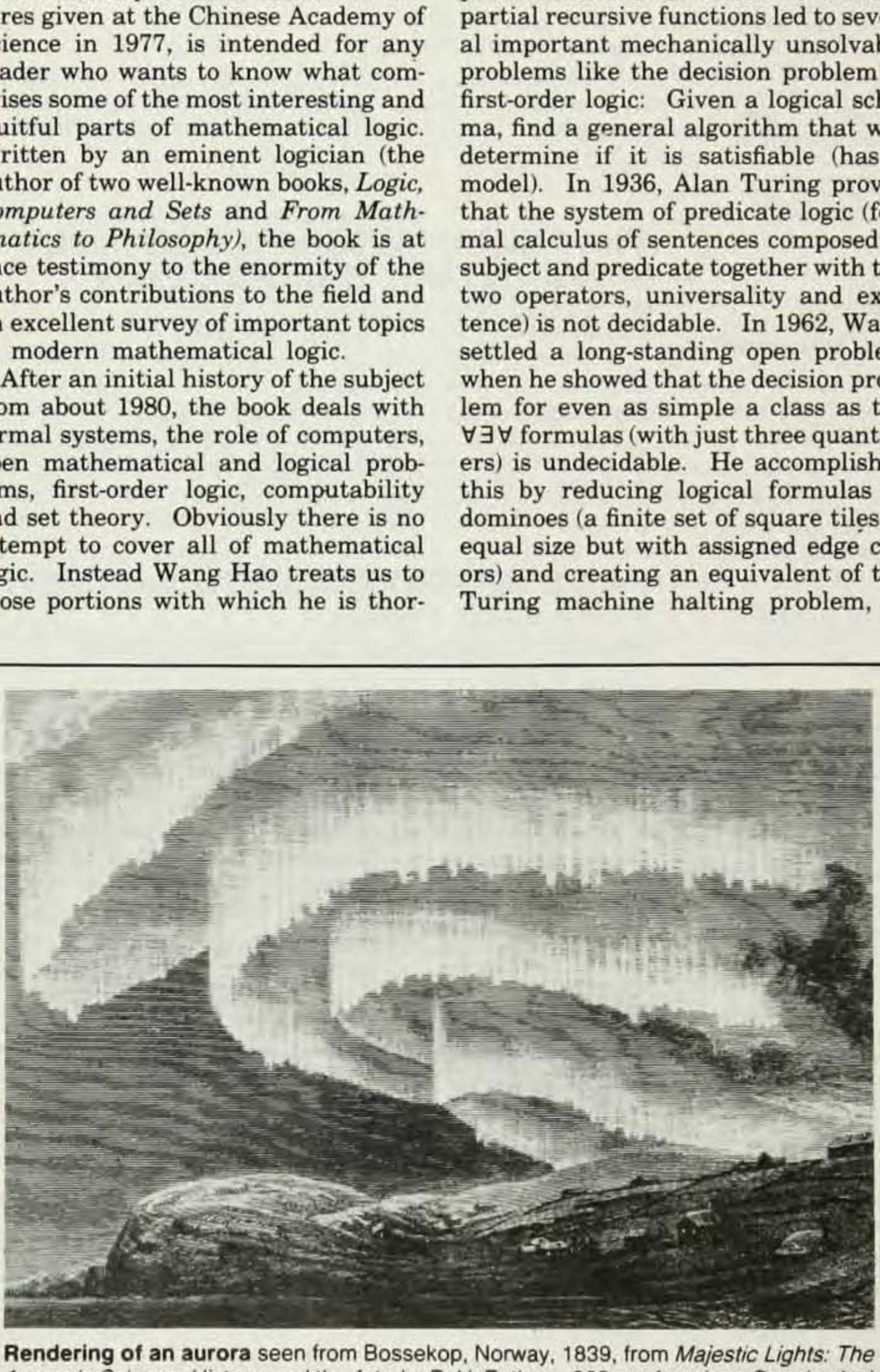
Cosmic X-Ray Astronomy

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



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.