for the *Enciclopedia Italiana*. The statistical theory of the atom could have been listed as well in his next major field of interest, quantum mechanics. From the abundance of topics here let me choose the following ones: theory of collisions treated by the method later called after Weizsäcker and Williams [23b], hyperfine structure [55, 73], orbital magnetic momentum of an electron in a central field of force [39], his great paper on beta decay and neutrinos [76, 80b], the explanation of the strange Raman spectrum of CO_2 [68], Raman effect in crystals [69, 71], and the use of pseudo-potentials in scattering [119b]. Fermi's penetrating simplicity is perfectly exhibited in a series of papers on quantum electrodynamics [50, 52, 64, 65, 66, 67, 70]. Of these, everybody knows [67] his famous paper in the *Reviews of Modern Physics*. Less known is his short early paper [65], an attempt to discuss the electromagnetic mass of the electron using quantum electrodynamics. Nearly half of the volume is taken up by papers in neutron physics; [128] is Fermi's Nobel lecture. This paper, coupled with Segrè's introductions in [84a] and Amaldi's in [112], gives a fine historical picture on the development of neutron physics. Fermi's work in this field is familiar enough that one need not point out the different important papers. It is valuable that the English translation of many Italian articles in this field are included in the present volume.

In the beginning I mentioned the three major reasons to study collected works; among these there was the quest for the personality of the investigator. Lord Rutherford's obituary in *Nature*, written by Fermi [123], shows that at the age of 36 he considered most important those points of personality which he also fully possessed. "Lord Rutherford certainly belonged to that highest class of experimenters—very few in the history of human thought—who appear to their admirers to be led by some sort of instinct always towards the successful attack of fundamental problems . . . Lord Rutherford will be remembered in the history of science not only on account of his personal contributions but also as a teacher, in the highest meaning of the word. One of the largest and most successful groups of investigators developed around him and learned from him not only the principles and the methods of research, but also the necessity of endurance and steadiness as essential requirements of the man of science."

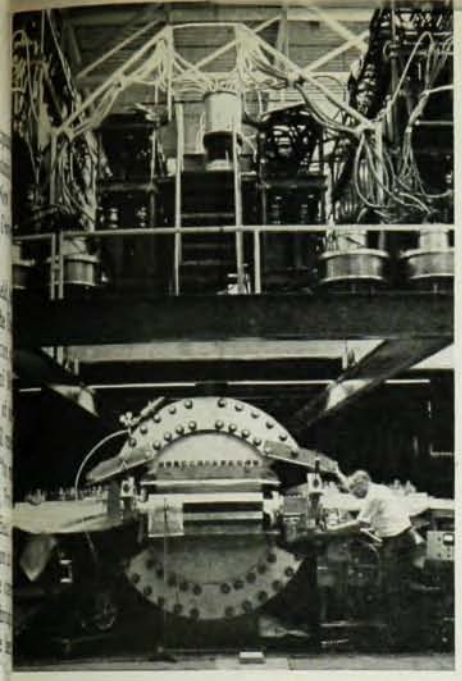
The Fabric of the Heavens. The Development of Astronomy and Dynamics. By Stephen Toulmin and June Goodfield. 285 pp. Harper and Bros., New York, 1961. $5.00. *Reviewed by Norman Feather, University of Edinburgh.*

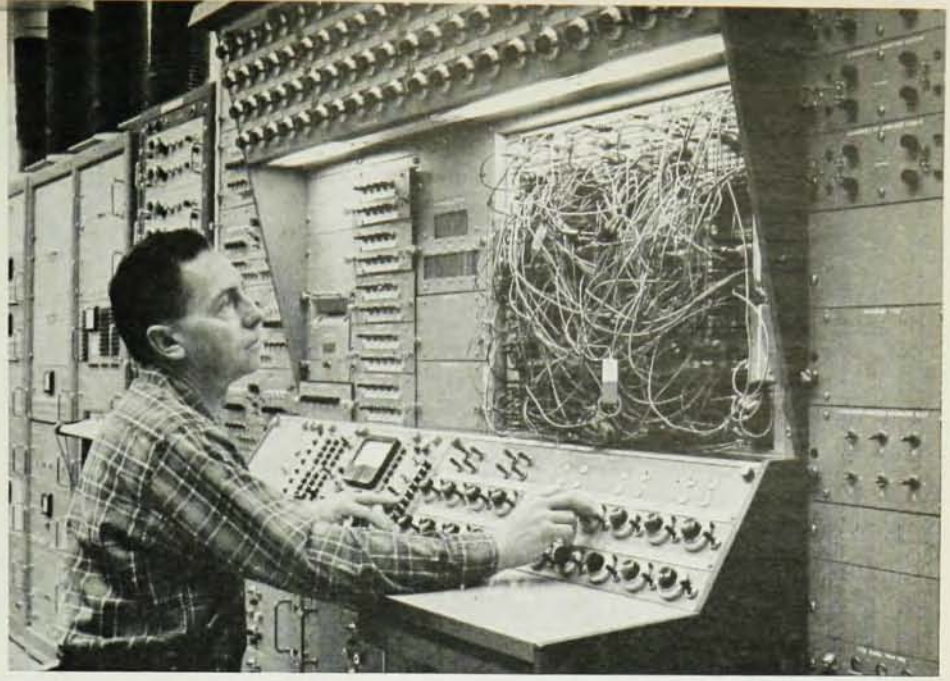
IN 1957, Professor Toulmin and Dr. Goodfield, teaching in the Department of Philosophy at the University of Leeds, England, announced a new lecture course which they entitled, quite simply, Origins of Modern Science. The lectures were open to students of science and the humanities, alike, and they were well received. Encouraged by the success of this attempt "to restore the conversations between the two cultures", Professor and Mrs. Toulmin (now working at the Nuffield Foundation for the History of Ideas in London) are at present engaged in widening the circle of these conversations, drawing in the intelligent layman through the medium of the printed page. The volume here belatedly reviewed is the first of a series of four projected volumes, covered by the general title *The Ancestry of Science* and taking in turn, and then surveying, "particular groups of topics which have played important parts in the evolution of our ideas". It may be said, at once, that if the other three volumes maintain the high standard of the first, then the work as a whole will be a notable achievement.

In *The Fabric of the Heavens,* the reader, carefully forewarned to cast aside his twentieth-century habits of thought, suddenly finds himself in the Babylon of 1000 B.C. Thereafter (for this is Chapter 1), there is no escaping from his mentors. Not until the last chapter of the book is he allowed to think again wholly as a modern man has become accustomed, by common sense, to think. The discipline is admirably suited to the authors' task, and cunningly devised for the reader's edification—and, indeed, for his delight. Before he has fully awakened to the stratagem, he is seeking to put himself in harmony with Nature as a member of the Pythagorean brotherhood, then he is in Plato's Academy, where he meets Eudoxos, and in the Lyceum with Aristotle. Throughout his later wanderings, through Alexandria in the days of its glory and of its intellectual decline, escaping to Jundishapur and thence to Baghdad, he remains a convinced Aristotelian (is not June Goodfield also a zoologist?).

But the reader is, after all, a Westerner at heart: Mecca is not his spiritual home. Again he is wandering

A pre-Halley look at Halley's comet. An engraving of the 11th century Bayeux tapestry (*courtesy New York Public Library*)





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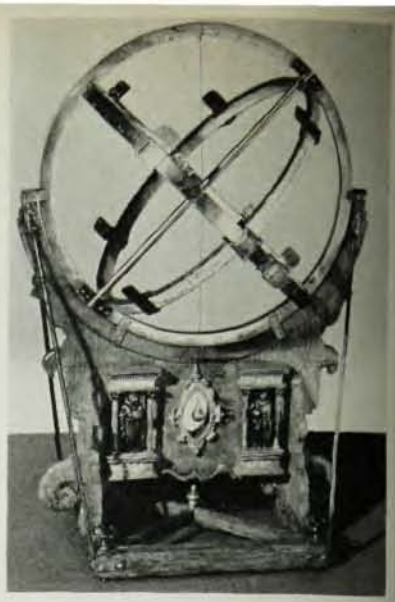
in Europe, in and out of the cathedral schools of Chartres, Rheims and Cologne; sadly he realizes that he has lost his memory; he pities the doctors for their ignorance of what men once knew. In Paris, in the early fourteenth century, Buridan revives his curiosity, then Nicolas of Oresme, then Nicolas of Cusa: within a century the whole climate changes. He hears vaguely of William Heytesbury and his circle in Oxford, later he visits Copernicus at Frauenburg and thinks him somewhat of a reactionary, somewhat of a failure. He is with Tycho Brahe at Uraniborg, and Kepler, and he catches up with Galileo at Venice (perhaps he admires Kepler most of the three). Finally, that surpassing genius, that inscrutable person, Isaac Newton: he finds him at Woolsthorpe in the plague year (but surely there were two years of plague?) and follows him back to his room in the Great Court of Trinity College at Cambridge. There, at last, his journey is finished. He re-assumes his twentieth century habits of thought, and briefly muses on his odyssey.

Anyone who reads this book will, I think, surrender himself to its intrinsic charm in the way that the anonymous reader of my sketch surrendered—and he will not feel that he has been duped in the end. The writing is easy and gives confidence (the only real error that I have detected is the ascription to Ramsay, rather than to Lockyer, of the "helium" spectrum in sunlight): concerning the authors' vocabulary, only (the repeatedly used) "paradigm" is likely to bring furrows to the brow.

A History of Astronomy. By A. Pannekoek. Transl. from 1951 Dutch ed. of *De Groei van ons Wereldbeeld*. 521 pp. Interscience Publishers, Inc., New York, 1961. $9.75. *Reviewed by Otto Struve, National Radio Astronomy Observatory.*

THE last time I met Professor Pannekoek, who died in April 1961, was ten years earlier at a small gathering of Dutch astronomers at Zonnenburg Observatory of the University of Utrecht, Holland, upon which occasion I delivered to the director of the Observatory, Professor M. Minnaert, the Gold Medal of the Astronomical Society of the Pacific. Professor Minnaert presented to me on this occasion a copy of the then recently published *History of Astronomy* by A. Pannekoek, entitled *De Groei van ons Wereldbeeld*. I asked all the astronomers present to autograph their names on the flyleaf, some of whom have in the meantime achieved international fame, such as J. H. Oort, H. C. van de Hulst, and others. Pannekoek's history, now translated into the English language, covers the development of astronomy from Babylonian, Assyrian, Egyptian, Chinese, and Arabian times, through the work of Copernicus, Tycho Brahe, Kepler, and Newton, to the most recent advances on the structure and dynamics of the stellar system. The translation is excellent. The material has been somewhat rearranged, and several items have been included as appendices—such as the derivation of the distance of the sun by Aristarchus,



Model of armillary sphere used by Tycho Brahe (*courtesy American Museum of Natural History*)

the derivation of the locations of the planets by Apollonius, and Newton's demonstration of the law of areas and his derivation of the force of universal attraction. The new English edition also contains a greater number of illustrations, and in many cases better ones than did the original Dutch book.

Professor Pannekoek was one of the great astronomers of the present century; he was born in 1873 and studied astronomy at the University of Leiden. However, from 1906 to 1914 he was mainly active in the socialist movement of Germany, and it was only after his return to Holland in 1931, as director of the newly founded Astronomical Institute of the University of Amsterdam, that he devoted his full time to astronomical research. Pannekoek was a modest person and an exceedingly thorough worker. His early interests were devoted to the photometry of stars. However, after the work of M. N. Saha on the processes of ionization in stellar atmospheres, he devoted most of his time to the study of stellar spectra. Since he had no telescope at his disposal in Amsterdam, he made several trips to the United States and investigated stellar spectra obtained at Mount Wilson, Lick, and Yerkes. His chapter entitled "Ionization in the Atmospheres of Celestial Bodies", in Vol. 3, of the first German *Handbuch der Astrophysik*, 1930, has served as a textbook for those interested in all problems of astrophysics.

Throughout his life, Pannekoek had a great interest in the history of science, and the concluding paragraph of his introduction is a suitable indication of his attitude: "Whoever penetrates into the past participates in the development of the human race as his own experience. It is the aim of this work to unfold in this past the development of our astronomical world concept as a manifestation of humanity's growth."

Together with the history of astronomy by G. Abetti, it constitutes the most thorough survey of the history of astronomy throughout recorded history. It is doubtful that there will ever again be a book of this kind since advances in the field are so rapid that no single volume will be able to cover more than a short interval or a selected list of topics.