Book Reviews

The Sleepwalkers. A history of man's changing vision of the universe. Arthur Koestler. Macmillan, New York, 1959. 624 pp. Illus. $6.50.

In the preface to this book, Koestler notes with some justifiable astonishment that there is no modern history of cosmology, "no comprehensive survey of man's changing vision of the universe which encloses him." His own book, to judge from its subtitle, while intended to fill this gap, is nevertheless, as it turns out, no such complete history. For while it opens with the Babylonians and ends with Newton, the bulk of it is actually devoted to an account of the three titans of modern planetary astronomy—Copernicus, Kepler, and Galileo. In recounting the story of their lives, the pattern of their discoveries, and their impact upon the course of modern intellectual development, Koestler would serve a double purpose. He would not only retrace the history of one of the most fascinating and momentous periods in science; he would also draw the moral that is to be found in reflecting upon that history. For him that moral is that the allegedly common notion of the history of science as a steady, cumulative affair must be reassessed and discarded, and that emphasis must be placed on the mutually supplementary roles of science and mystical religion in any complete intellectual approach to the universe. What emerges is a lively, provocative, yet markedly uneven book. One suspects that the book began as a biography of Kepler, of whom no satisfactory account had yet been given in English, and was gradually built up to include an account of pre-Keplerian cosmological speculations and of Kepler's immediate predecessors and contemporaries. Indeed, since the presentation of the cosmology of the ancient and medieval world is quite inadequate, and the treatment given Copernicus and Galileo shows much hostility and bias, the book would have had a greater evenness and unity if it had remained precisely such a study of Kepler. For it is in studying Kepler, his hero, that Koestler finds occasion for close study of the theme that interests him most. Kepler is an outstanding example of the type of individual (of which Pythagoras was the prototype) in whom are inextricably combined the mystic and the savant. Moreover, in his major works Kepler has left us a carefully documented account of the processes of his own creative thinking, with all its attendant blundering, dogged persistence, and heartbreak. In the life of this one man, Koestler finds summed up the whole history of cosmic theories, for that history "may without exaggeration be called a history of collective obsessions and controlled schizophrenias; and the manner in which some of the most important individual discoveries were arrived at reminds one more of a sleepwalker's performance than an electronic brain's."

That the subject matter of cosmology should engage the attention of Arthur Koestler might, at first glance, occasion some surprise. One tends to think of him as the author of novels with political themes—in particular, of *Darkness at Noon*. Yet, when we remember his other books, such as *Insight and Outlook* and *The Yogi and the Commissar*, we realize that the interest there shown in the various levels of psychological awareness and in the reconciliation of empirical and mystical attitudes is what here, in *The Sleepwalkers*, continues to manifest itself, though in a fresh context.

The cosmology that dominated men's minds throughout the ancient and medieval world was rooted in a number of dogmas whose unshakable hold over men's minds proved the most serious obstacle to any fruitful advance in physics and astronomy. Chief among these was the belief (inherited from Aristotle) in two sets of physical principles, one for terrestrial phenomena, the other for celestial. A second was the belief in the uniquely centered and privileged position of the earth in a spatially finite, spherical universe—the dogma of geocentrism. A third was the demand that all explanations in geometric terms of the motions of the heavenly bodies be construed in terms of circular motions. This bit of apriorism, established by the Pythagoreans and confirmed by Plato, was to saddle mathematical astronomy from the days of Eudoxus to those of Copernicus. What we call the scientific revolution, on its cosmological side largely initiated by Copernicus and brought to a relatively final synthesis by Newton, consisted in a gradual loosening and abandoning of each of these dogmas and their replacement by views that had greater empirical justification and theoretical usefulness.

Copernicus, to whom Koestler refers as "the timid Canon," was, in his own person and mentality, far from being a scientific revolutionary. The author of *The Book of the Revolutions of the Heavenly Spheres,* according to Koestler "was denied the essential qualities of the prophet; awareness of a mission, originality of vision, the courage of conviction." The long delay in publication of *The Book of Revolutions* was caused not by fear of condemnation by ecclesiastical authorities but by fear of ridicule. Copernicus was indeed a conservative in the major lines of his thinking. Of the principal doctrines defining orthodox cosmology summarized above, Copernicus left untouched the adherence to Aristotelian physics and the method of circular description for celestial motions. At a time when men like Roger Bacon, Nicholas of Cusa, William of Occam, and Jean Buridan had already seriously weakened the hegemony of the older physics, Copernicus cleaved to the older scheme. In his continuance of the use of epicycles and deferents, the mainstay of Ptolemaic astronomy, Copernicus in no way departed from the ancient tradition. As a matter of fact, as Koestler points out, the oft-repeated claim that Copernicus reduced the number of epicycles required in planetary astronomy of the Ptolemaic type is actually false. Although Copernicus had claimed in the *Commentariolus* that "thirty-four circles suffice to explain the entire structure of the universe and the entire ballet of the planets," this was but an optimistic preliminary announcement that was not matched by the actual performance set forth in the *Revolutions*. The Ptolemaic scheme, as brought up to date by Peuerbach in the 15th century, required but 40 circles, yet Copernicus in his own sys-

tem requires 48; thus, far from reducing the number of circles, he actually increased them. Where then was the great significance of his work? It was, of course, in the shift he accomplished for astronomy and cosmology from a geocentric to a heliocentric orientation. He demolished that pillar of the older cosmology by offering a tremendously simplified explanation of the *retrograde* motions of the planets. "So long as the earth was the hub of the universe, this phenomenon could be 'saved' by adding more epicycles to the clockwork, but there was no natural reason why the planets should behave as they did. But if the hub was near the sun, and the earth turned round it together with the other planets, it was obvious that each time the earth 'overtakes' one of the outer planets (which circle at a slower rate) that planet will appear to recede for a while; and each time the earth itself is overtaken by the faster moving inner planets, an apparent reversal of direction will again result." It was this idea that provided the impetus for the new way of thinking that flowered into the Copernican revolution and that brought with it the eventual shattering of the older cosmology.

It was Kepler's role in this revolution that engages the full and admiring attention of Koestler as he relates the incidents and guiding motifs of the life of that tortured genius. The section of Koestler's book dealing with Kepler is the richest and most rewarding part. Koestler's pen traces in fascinating detail, with the aid of Kepler's painstaking autobiographical remarks about his work and personal affairs, the pattern of a fiercely dedicated life. "Johannes Kepler, Keppler, Kheppler, or Keplerus was conceived on 16 May, A.D. 1571, at 4.37 a.m. and was born on 27 December at 2.30 p.m., after a pregnancy lasting 224 days, 9 hours and 53 minutes. The five different ways of spelling his name are all his own, and so are the figures relating to conception, pregnancy and birth, recorded in a horoscope which he cast for himself. The contrast between his carelessness about his name and his extreme precision about dates reflects, from the very outset, a mind to whom all ultimate reality, the essence of religion, of truth and beauty, was contained in the language of numbers." At the age of 24 Kepler received an overpowering inspiration that was to dominate and guide him in all his work for the rest of his life. Kepler carefully recorded the date of this inspiration—9 July, 1595, while he was drawing a figure on the blackboard for his class. It was then that the idea struck him—which he regarded as the key to the secret of creation—that the universe (or, more precisely, the distances between the six planets known in his day) was built around the five perfect or Platonic solids. The idea was, of course, a completely false one. Yet, as the main inspiration for his first book, the *Mysterium Cosmographicum,* published when he was 25, it was nevertheless, like so many other erroneous thoughts, the breeding place of many fruitful ones. As Koestler remarks, "it led eventually to Kepler's laws, the demolition of the antique universe on wheels, and the birth of modern cosmology."

Underlying this inspiration and the prolonged search for the exact mathematical patterns that bind together the planetary world—patterns that Kepler, as a true empirical scientist, insisted must square with the observational materials at hand—was a basically religious outlook. He believed that the sun is at the center of the world because it is the symbol of God the Father, the source of light and heat and of all moving energy. The sphere of the fixed stars he took to be the symbol of the Son, while the invisible forces which, emanating from the Father, act throughout interstellar space represent the Holy Ghost. And binding all these together is the unifying scheme of Geometry, which God used in creation and which the mind of man can hope to discover. The prolonged search for the laws of planetary astronomy that marked Kepler's life as a scientific quest is of the greatest value for the student of scientific methodology. To the probing eye of the psychologically oriented biographer, the growth of the man is of equally great fascination. Koestler suggests that "the sufferings of a mange-eaten, chaotic childhood had left a sober thirst for universal law and harmony; memories of a brutal father may have influenced his vision of an abstract God, without human features, bound by mathematical rules which admitted of no arbitrary acts."

Koestler's estimate of Galileo, the third of the great figures treated in this book, is in sharp contrast to his estimate of Kepler. He finds the personality of Galileo unattractive. He would counteract the wide acceptance of Galileo's importance in the history of astronomy, while giving him full credit as the founder of modern dynamics. The trial of Galileo, according to Koestler, should not be taken as an example of the inevitable conflict in the philosophies of blind faith and enlightened reason, of Church and science. Rather, it was "a clash of individual temperaments aggravated by unlucky coincidences."

The historical portion of the book is brought to a close with a brief chapter on the Newtonian synthesis. Koestler feels it quite appropriate to end his survey at this point. Dismissing all the most recent and highly significant researches of modern physics and cosmology as still largely too controversial, he would have us believe that "the blueprint of the universe remains essentially the one Newton drew for us, in spite of all disturbing rumours about the curvature of space, the relativity of time, and the runaway nebulae." The judgment just quoted is so contrary to the most obvious truth and, in its own way, so perverse, that it almost seems as if Koestler uses it as a rationalization for choosing the stopping place he did choose for his own historical review.

Koestler's dim view of the intellectual worth of contemporay science is based on its allegedly paradoxical character and unintelligibility. The fundamental reason for his disparagement is that, in his opinion, modern science has become isolated from the inspiration which a religious outlook on the world has to offer, and did offer earlier thinkers. It has become a mere technical and abstract manipulation of symbols. Such symbols are solely useful as devices for "saving the phenomena" but are useless for giving us insight into the real structure of the universe. The divorcement of science from a faith in the rationality of the universe, in its underlying purposiveness and orderliness, has resulted in a form of scientific *hubris* which may prove to be man's undoing. The spiritual ebb tide of the modern age coexists with a unique increase in physical power and therefore poses the greatest dangers, from the potential misuse of that power. Unfortunately, Koestler's indictment of modern science lacks convincingness, since what he offers as a corrective is itself so mistily and narrowly conceived as to be philosophically of little value. That the religious dimension of experience or the mystic's perspective on the world are in themselves important to any fully developed mentality need not be challenged. What needs to be challenged is Koestler's belief that only with some faith in the purposive orderliness of the world can science achieve the drive to sustain its inquiries. Religion or

mysticism need not be so conceived that some ontological teleology is essential to their viewpoints. It is sufficient if a deeply cultivated sense of the mystery of existence provides a corrective to any dogma of the total intelligibility of the universe, an intelligibility to be finally revealed by science or any other means.

MILTON K. MUNITZ
Department of Philosophy,
New York University

Federal Budget and Fiscal Policy, 1789–1958. Lewis H. Kimmel. Brookings Institution, Washington, D.C., 1959. x + 387 pp. $5.

This highly readable volume has a somewhat misleading title. Kimmel has not written a comprehensive history of federal budgeting and fiscal policy but has concentrated on the evolution of attitudes toward the balanced budget and public debt. The volume starts with Washington and Hamilton and ends with Eisenhower and Anderson. Economic events, the viewpoints of government officials, and the contemporary prescriptions and theories of economists are interrelated in each phase of fiscal history. The author has a light touch throughout and does not attempt a technical treatment. The book is apparently addressed to the general reader and to the practitioner. Although there is reference to such matters of fiscal economics as the balanced budget multiplier, the author does not attempt to break new theoretical ground.

The great change that has occurred in this 170-year period lies in the role and responsibility of the national government for the aggregate level of income and employment. This change has necessitated an abandonment of rigid notions of budget-balancing and at least some diminution in fears about the horrors of the national debt. Kimmel's history of the emergence of what is commonly called "a positive fiscal policy" or "fiscal policy for growth and stability" points out that attitudes toward balanced budgets and the national debt had become stereotyped by the end of the 1920's. Adherence to fiscal orthodoxy was a traditional article of faith, and the march of events had not forced a rethinking of the issues. The attack on the conservative creed first came in the writings of economists, in the immediate pre-Keynesian period, from 1930 to 1936. The transformation in popular attitudes toward the national debt and deficits did not emerge until World War II, when it became completely evident that very large deficits and a rapid rise in the national debt were accompanied, not by bankruptcy and ruin, but by unprecedented increases in national output and an unprecedented rise in levels of material well-being.

Kimmel finds that, in the postwar period, the obsessive belief in the efficacy of a balanced budget has all but vanished, and that there are no important differences between the major political parties on this point. The philosophy of the Employment Act prevails, and budget policy will be adapted to the requirements of economic stabilization.

It is not possible to dissent from this conclusion. Certainly there is a predominant view that, in the event of a serious recession, federal taxes will be reduced and expenditures will be increased, let the deficits fall where they may. But there remains a curious lag in thinking in some quarters. Kimmel quotes a 1957 statement by Senator Goldwater, which appeared in the *Congressional Record*: "Where is the finely drawn line between freedom and slavery when, under the present deficit, every baby born in this country has a $1,675 first mortgage tag hanging around its neck?" Perhaps it is the senator who should read this book.

JESSE BURKHEAD
Department of Economics,
Syracuse University

Index Kewensis Plantarum Phanerogamarum. Supplement 12. George Taylor, Ed. Oxford University Press, New York, 1959. 162 pp. $12.

The appearance of a new supplement to the *Kew Index* has been eagerly anticipated by taxonomists who work with the flowering plants, for this continuing publication, perhaps more than any other single work, makes possible the orderly progress of plant taxonomy. The 12th supplement of the work (first published in 1895) covers the years 1951 to 1955 inclusive. An estimate indicates that between 17,000 and 18,000 binomials are included in this supplement; most of these are names of new species or new combinations published during the 5-year period, but some are names published earlier and overlooked in prior supplements. Like the other recent supplements, the 12th carries a separate listing of newly described (or previously overlooked) genera. There are 472 names in this list.

This is the first supplement that has appeared under the nominal editorship of George Taylor, the new director of the Royal Botanic Gardens at Kew. In his foreword Taylor gives credit to M. I. Skan for the preparation of the supplement. Botanists in all fields owe a debt of gratitude to both Skan and Taylor, and to the Royal Botanic Gardens, for the preparation and sponsorship of this indispensable work. In its format and in the excellence of its printing, the 12th supplement is a worthy addition to a distinguished series of botanical reference works.

A. C. SMITH
Museum of Natural History,
Smithsonian Institution

The Gifted Group at Mid-Life. Thirty-five years' follow-up of the superior child. vol. 5 of *Genetic Studies of Genius.* Lewis M. Terman and Melita H. Oden. Stanford University Press, Stanford, Calif., 1959. xiii + 187 pp. $4.50.

If we were to identify a large group of 11-year-olds with IQ's that place them within the highest 1 percent of the school population and follow their careers for 35 years, what would we find? Few biographers have the pertinacity to wait for an answer. It is our good fortune that Terman has undertaken such a study—and of no less than 1500 individuals. Unfortunately Terman's death occurred before he could witness the ground swell of interest in exceptional talent which followed the scientific events of 1957.

The book is concerned primarily with the status of the gifted subjects in 1955, when their average age was 44. Careful comparisons have been made of the incidence of death, suicide, mental illness, sexual maladjustment, schooling, occupational rank, income, and fecundity in the gifted group and in the general population. The authors have been remarkably successful in bringing together statistics that are scattered over many fields. The analysis shows that the gifted subjects continue to be superior in nearly every respect. We learn that the present birth rate of 2.4 children per mother among the gifted women and the wives of gifted men is insufficient to "maintain the