Book Reviews

The Urey Tradition: A Teacher and His Students

Isotopic and Cosmic Chemistry. Dedicated to Harold C. Urey on his seventieth birthday, 29 April 1963. H. Craig, S. L. Miller, and G. J. Wasserburg, Eds. North-Holland, Amsterdam, 1964. 553 pp. Illus. $15.

Harold Urey thinks in a manner that is direct and fast, and he speaks his mind freely. "Urey deals the cards from the top of the deck and calls them as he sees them. . . . This characteristic has not particularly endeared him to administrators and politicians, but many graduate students, accustomed to the normal amount of larceny which lurks in the souls of college professors, have been profoundly gratified by his blunt and uncompromising honesty . . . both personal and scientific" (p. xii). Perhaps that is why his following is so large. Perhaps that is why so many remember how much he has done for their field of science. Perhaps that is why I have been an ardent Ureyphile so long. "Harold Urey . . . has exemplified to a degree seldom equaled, the excitement in science" (Hildebrand, p. ix).

Few men have had as wide and profound an effect on American science as Harold Urey, and this book is a good measure of his influence. Every piece in this collection of 32 historical, theoretical, and empirical papers entertains a phase of his interest, stems from his thought, confirms or challenges his conclusions. It would be gross presumption for me to comment on all the papers, but let those that are beyond me at least be mentioned.

A witty and affectionate foreword by R. M. Hutchins, a reminiscence by J. H. Hildebrand, and a crisp biographic preface by the editors are followed by a historical note, "The discovery of deuterium," by G. M. Murphy, Urey's coauthor in that experiment. Next are two theoretical papers, "The death of an ogre" (a disposal of the Loschmidt paradox of thermodynamics) by J. E. Mayer and "Separation factor in isotopic phase equilibria" by G. Boato and G. Casanova, and then three papers on isotope biochemistry by G. Hevesy, M. Cohn, and D. Rittenberg. J. M. McCrea's paper is entitled "The mass spectrometer as an effusiometer," and S. Silverman presents the report of a decisive attack by carbon isotope studies on the problem of the origin of petroleum.

S. L. Miller shows how difficult it is to imagine any form of life without liquid water and how restricted life must be in the universe. H. A. Lowenstam finds that the strontium-calcium ratio in shells increases with age and suggests that the effect may be due to biochemical evolution. Some will disagree with his view. C. Emiliani and his co-workers present a detailed paleotemperature analysis of shell deposits from two Mediterranean caves, reaching back 100,000 years, and J. R. O'Neil and R. N. Clayton discuss isotope geothermometry of calcite, quartz, and magnetite systems. S. Epstein, D. L. Graf, and E. T. Degens conclude, on the basis of oxygen isotope studies, that dolomite is a secondary product of calcium carbonate deposition, and H. P. Taylor, Jr., and S. Epstein, having studied the ratio of oxygen-18 to oxygen-16 in soils and more tektites, find themselves now squarely on the fence in the debate over the terrestrial versus the extraterrestrial origin of tektites.

A brief note by I. Friedman and his co-workers shows that the water in water-rich minerals in rhyolitic lavas is lighter than the water in minerals with a lower water content, and L. Wood and W. F. Libby write on radiocarbon date accuracy. E. Goldberg and his co-workers present a mass of ionium-thorium ages and mineral analyses of North Atlantic sediment cores, together with some strange discrepancies with carbon-14 results, and F. G. Houtermans, A. Eberhardt, and G. Ferrara report the isotopic composition of fumarolic lead from Vesuvius, Vulcano, and the Valley of Ten Thousand Smokes. C. C. Patterson presents a comprehensive and lucid analysis of large-scale lead isotope evolution in the earth, and M. A. Lanphere and his teachers provide an equally important discussion of the redistribution of rubidium and strontium isotopes in rock metamorphism. S. K. Runcorn then writes on convection in the earth's mantle and growth of its core. His logic is insistent, but I found it difficult to fight off the recurring impression that I had heard it all somewhere before. What is presented as an extension of the ideas of Vening Meinesz, Urey, and Chandrasekhar comes out as more nearly a review. A brief paper by W. H. Munk and D. Davies, "The relationship between core accretion and the rotation rate of the earth," closes the geophysical part of the book.

There are seven papers on the constitution and postulated origin of meteorites by J. R. Arnold, H. Brown, and I. Goddard, H. E. Suess, H. Craig, P. Eberhardt, and J. Geiss, W. B. Clarke and H. G. Thode, and V. R. Murthy. One wonders what prompted Craig, one of the editors, to write on a topic already selected by Suess, a distinguished invited contributor. F. Hoyle and W. A. Fowler then review the theoretically derived abundances of uranium and thorium in the solar system, and J. A. Glasel outlines the state of our ignorance with respect to comets. The book ends with "A note on classical fields" by A. E. Ruark, who was Urey's senior coauthor in 1927.

Scattered through the text one finds strange phrases, odd references, and loose initials. Many of them are errors of grammar and orthography, some are mere *lapsus calami*, but the rest must be lapses of some other kind. The reader may want to know how they got in. If responsibility is the price of seniority, we blame the senior editor.

One could cite examples and debate forever the question of how much a teacher influences his students. The plain fact is that Urey's students have gone out and been heard. Some became teachers in turn, and their names now appear in this book, mostly as junior coauthors after the name of a student of their own. Thus the fulminating impetus of Harold Urey now spans two generations.

The subject matter of this book has a wide range, but "despite the seeming diversity of topics . . . the complete assemblage follows Urey's maxim of

'Treating the whole subject.' Indeed, the topics are in large part derived from chapters in the life of Harold Clayton Urey . . ." (p. xvii). Even among the very great men in science, few can expect such a birthday present.

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Technology for the Layman

Masers and Lasers. How they work, what they do. M. Brotherton. McGraw-Hill, New York, 1964. xvi + 207 pp. Illus. $8.50.

The Story of the Laser. John M. Carroll. Dutton, New York, 1964. 181 pp. Illus. $3.95.

Masers and Lasers. H. Arthur Klein. Lippincott, Philadelphia, 1963. 184 pp. Illus. $3.95.

These three volumes were written to provide accounts that would give the layman some understanding of the new field of laser technology and of its great potential. The three books have much in common. Each consists of roughly 200 pages of lucid, nonmathematical discussion of lasers, stimulated emission, waves, electromagnetic theory, atoms, and certain aspects of solid-state physics.

Brotherton's book is distinguished by unusually careful and clear discussion of the physical principles and details of maser and laser operation. The great communications potential associated with the unusually large bandwidths available in the optical region and the problem of attenuation in long distance transmission are treated very nicely. It is evident that Brotherton writes about all these things with a deep understanding. Carroll's book is distinguished by the discussion of many possible applications and by his description of the construction of lasers. Klein places more emphasis on the basic physics, and his book appears to be intended for readers at the level of the high school.

There are inaccurate features. The speed of signaling by use of wires is determined by the group velocity of electromagnetic waves guided by the wires. Carroll suggests that the electron drift velocity determines the signaling speed. Also he appears to be unaware of the principle of complementarity.

The reader whose knowledge is limited to facts gleaned from Klein's book will be surprised to learn that the present time standard is a cesium beam clock and that there can be coherence in spontaneous emission processes of an assemblage.

Brotherton and Klein imply that all noise is due to heat motion. The spontaneous emission noise that really limits all voltage amplifiers is not discussed.

The free electron vacuum tube amplifier operates by stimulated emission of photons from the electrons in the interaction region. Masers and lasers differ only in the use of different kinds of quantum states. All three authors appear to be unaware of this as well as of other issues relating to the comparison of maser devices with free electron devices. Thus, the statements that masers provide a great improvement in noise performance over free electron devices are indeed true for microwave free electron devices, but at low frequencies, above the flicker noise range, free electron amplifiers can have noise performance comparable to, or better than, the performance of a microwave maser. Brotherton tells us that a black body must be at a temperature of 10^{15}K to match the laser brightness. However, a black body must be at 10^{27}K to match microwave klystron brightness.

The early history of masers and lasers is complex. Objective judgments with respect to the importance of principles, and of what constitutes reduction to practice, are somewhat difficult to make. None of these authors does a sufficiently careful job in this respect. The history presented is incomplete and inaccurate and appears to be based on newspaper accounts. There is a traditional respect for published work, arising from the fact that a scientist who publishes assumes responsibility, runs the risk of criticism, and makes his results available to large numbers of other workers. All three authors have only partially accepted this view. Among the important published work not discussed is a paper by R. H. Dicke and his 1958 patent proposing the Fabry Perot cavity.

To be consistent a historian who includes unpublished work should include all such work about which information can be obtained at the expense of reasonable effort. The well-documented unpublished work of G. Gould (1957 and early 1958) contained proposals for a Fabry Perot cavity, an optically pumped alkali vapor laser, the enhancement of inverted populations by collisions of the second kind, the achievement of laser action in electrical discharges, and the ruby as a possible working substance. But this aspect of the history is not considered in any of these volumes.

Each book is good for an evening of enjoyable reading. Brotherton's book will appeal especially to one whose interests are mainly in the physics of these devices, Carroll's book will appeal most to the engineer, and Klein's book will appeal most to the young reader.

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Protozoology

Progress in Protozoology. Proceedings of the First International Congress, Prague, 22–31 August 1961. J. Ludvík, J. Lom, and J. Vávra, Eds. Czechoslovak Academy of Sciences, Prague; Academic Press, New York, 1963. 730 pp. Illus. Plates. $24.

As the chronicle of an important international conference [see *Science* **135**, 110 (1962) for a meeting report], this volume presents a valuable cross-section of protozoological studies recently completed or now in progress. All major aspects of protozoology are represented—taxonomy, cytology, genetics, ecology, biochemistry, biophysics, and electron microscopy. There is also a section devoted to toxoplasmosis, and an assortment of papers dealing with a variety of parasitic protozoa.

Only a few of the contributions are extensive articles. The majority of the entries are less than five pages in length, and many are short abstracts. If we include the synopses of speeches offered at the opening and closing sessions of the congress, there are about 200 contributions. Recent studies by protozoologists in the United States, Czechoslovakia, Poland, the U.S.S.R., and England are particularly well represented.

Most of the papers and abstracts are in English, and the few that are in French or German have been given English titles in the table of contents. Line drawings are incorporated directly