

theory, including a proof of the existence of periodic waves of finite amplitude. The principal structure of the treatment is mathematical and much emphasis indeed is laid on the mathematical techniques employed, which include among others complex function theory, the method of characteristics in the solution of partial differential equations, and the Fourier transform. The author does not hesitate to devote space to the proof of uniqueness theorems and is obviously very much interested in the mathematics. However, it would be quite wrong to give the impression that the book is solely mathematics. A great deal of attention is paid to physical examples and there are many excellent photographic illustrations of various types of water waves, bringing out clearly the results of the analytical treatment. The average physicist using the book would indeed have been aided by more numerous references to mathematical sources.

Among topics of special interest to physicists may be mentioned the tides, wave diffraction, waves produced by a ship as well as the effect of sea waves on the ship's motion, shock waves in water, gravity waves in the atmosphere, and flood waves in rivers. The reviewer would have wished a more thorough examination of the rather difficult but from the physical standpoint extremely important topic of group velocity in a dispersive medium. The author dismisses this as having primarily kinematic significance, deprecating the common association with energy flow. This is a controversial point about which more might well have been said.

The presentation is very clear and the typography excellent. There is also an adequate bibliography of both classical and recent literature.

Edward Williams Morley: His Influence on Science in America. By Howard R. Williams. 282 pp. Chemical Education Publishing Co., Easton, Pa., 1957. \$6.50 in US; \$7.00 elsewhere. *Reviewed by R. S. Shankland, Case Institute of Technology.*

This fine biography is the result of nearly twenty years of searching out letters and personal papers of Professor Edward Williams Morley (1838-1923), in studying this material, and in the preparation of an inspiring account of an outstanding personality and pioneer American scientist. Morley received all his formal education in New England at a time when nearly all students of science looked to Europe. However, both at Williams College and at the Andover Theological Seminary, Morley's great natural gifts enabled him to surge far beyond his formal educational opportunities. When he first undertook the development of courses in chemistry at Western Reserve University, in Hudson, Ohio, he had had practically no formal training in the subject. However, his exceptional intellectual abilities and habits of self-discipline and intense work enabled him to provide chemistry courses which were unique for his time, not only in the middle west, but throughout the country.

In addition to his teaching, Professor Morley also be-

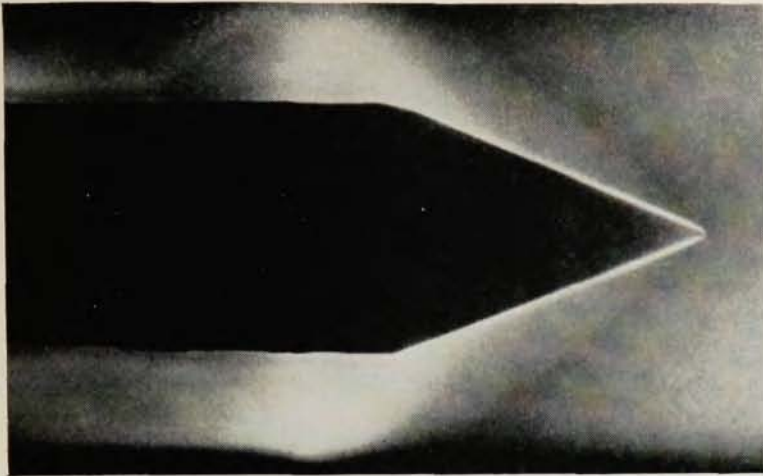
came a world-wide leader in the development of analytical chemistry, especially gas analyses, and his reputation soon led to his appointment as Professor of Medical Chemistry in the Cleveland Medical College.

The research activities which gradually developed during the Hudson years became his major concern when Western Reserve University moved to Cleveland in 1882. The most notable of Professor Morley's researches in chemistry was the measurement of the relative atomic weights of oxygen and hydrogen, a research for which he was awarded the Davy Medal of the Royal Society of London and other rewards for highest scientific distinction. A measure of the stature of Edward W. Morley in chemical research may be indicated by the fact that he was second in the balloting for the Nobel Prize in Chemistry in 1902, when the award went to Emil Fischer.

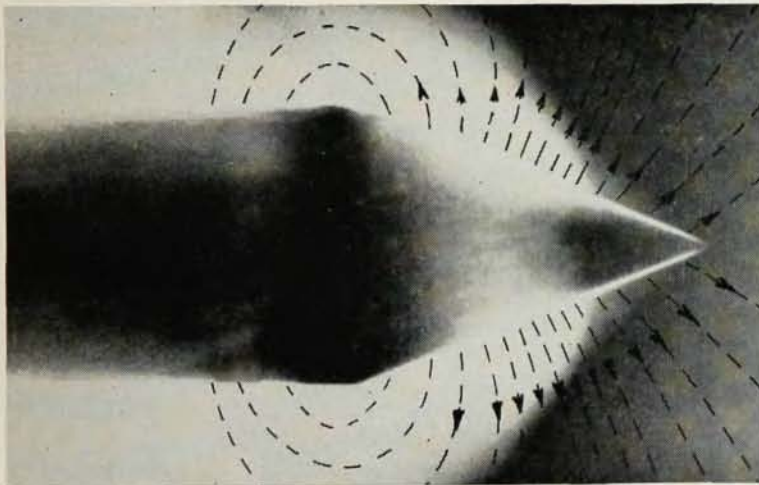
In addition to his distinguished position in chemistry, Professor Morley also held a very high place in both physics and mathematics, and it was most natural that he should collaborate with Professor Albert A. Michelson of Case School of Applied Science when in 1882 the two colleges moved to adjoining campuses in Cleveland. Michelson's first research work at Case had been a repetition of his measurements of the speed of light, which he conducted independently of Morley. However, during the year 1884 Michelson and Morley were thrown close together on two occasions, the first being at the meeting of the British Association for the Advancement of Science at Montreal in August, and they also both attended the "Baltimore Lectures" of Lord Kelvin delivered at the Johns Hopkins University in October of 1884. The late Professor Henry Crew once told the reviewer that Morley was the "shark" at the Baltimore Lectures, working all of Kelvin's problems and explaining them in detail to the others. Lord Rayleigh also was at Montreal and at Baltimore and both he and Kelvin urged Michelson to repeat the aether-drift experiment which had been given a preliminary and inconclusive trial at Potsdam in 1881. The prevalent theories relating to this subject as developed principally by Lorenz could have been salvaged if either the Potsdam experiment were wrong (as widely believed), or if an earlier experiment by Fizeau on the speed of light in moving water was in error. This accounts for the fact that the first research collaboration of Michelson and Morley was to repeat the Fizeau experiment in a form that gave definitive results confirming the earlier findings.

With this result established, Michelson and Morley then began their collaboration on the great experiment which is very properly known as the *Michelson-Morley Experiment*. Professor Morley's contributions to this work were of major importance. In addition to encouraging Michelson he provided the ample facilities of his research laboratory, and also made the key suggestion that the optical parts of the interferometer be mounted on a large slab of sandstone ($5' \times 5' \times 1'$) to reduce vibration and the effects of mechanical strain which had nullified the observations at Potsdam. Further-

PROGRESS REPORT FROM AVCO RESEARCH LABORATORY

NEW LIGHT ON **MHD***

NO MAGNETIC FIELD. This shock tube photograph, taken by emitted light only, shows the typical shock wave configuration formed by high-velocity gas flowing around a pointed cone.



WITH MAGNETIC FIELD. Here is shown the magnetohydrodynamic displacement of the shock wave. The magnetic field is caused by electric current flowing through a coil of wire within the cone. This experiment qualitatively demonstrates the interaction of a high-temperature gas with a magnetic field. This effect would be expected to produce drag and reduce heat transfer to the body.



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The Avco Research Laboratory was founded a little more than three years ago for the purpose of examining high-temperature gas problems associated with ICBM re-entry. The success of this research led to the birth of a new corporate enterprise, Avco's Research and Advanced Development Division.

The Research Laboratory, now established as a separate Avco division, has expanded to embrace all aspects of physical gas dynamics. We are currently gravid with several embryonic projects which we anticipate will likewise grow into new corporate enterprises. Our work in the physics, aerodynamics and chemistry of high-temperature gases is growing in the following areas:

A. Magneto hydrodynamics—

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B. Space flight—

Manned satellites
Electromagnetic propulsion

These developments have created a number of openings for physicists, aerodynamicists and physical chemists. If your background qualifies you to work in any of these areas, we would be pleased to hear from you.

Arthur Kantrowitz

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Everett, Massachusetts*

P.S. A listing of laboratory research reports indicative of the scope and depth of our activities is available. Address your request: ATTENTION LIBRARIAN, AVCO RESEARCH LABORATORY, EVERETT, MASS.

***Magneto hydrodynamics**, the study of the dynamics of electrically conducting fluids interacting with magnetic fields.

more, it was Morley who suggested that the entire apparatus be floated on mercury with an annular trough and float system which he devised. These great improvements enabled Michelson and Morley to employ a multiple-path optical system for their interferometer which lengthened the paths of the light beams by a factor of ten. As a result the anticipated fringe shifts predicted by the aether theory from the motion of the earth in its orbit would be 0.4 of a fringe, an amount which could not possibly have failed to be detected. The stone and mercury support also had the great advantage that the interferometer could be rotated continuously and observations made at all azimuths. As is well known, this famous Michelson-Morley experiment was completed in July, 1887, and gave a conclusive null result, which made it imperative that the far-reaching revisions in electrodynamics made by Lorentz, Poincaré, and above all by Einstein in the Special Theory of Relativity, should follow.

Following their work on the Michelson-Morley experiment, Michelson and Morley continued their collaboration on work (1887-1889) which established the feasibility of using light waves as the ultimate standard of length. Professor Michelson completed this work at Paris several years later, but an exceedingly important byproduct of their search in Cleveland while looking for a very narrow spectrum line suitable for the wavelength standard was the discovery of both the fine structure and the hyperfine structure in many lines of atomic spectra.

Toward the end of his career at Western Reserve University, Professor Morley collaborated with Professor Dayton C. Miller of Case. After the rather general acceptance of the Fitzgerald-Lorentz contraction hypothesis to explain the null result of the Michelson-Morley experiment, Morley and Miller devised a larger and more versatile interferometer which they used in 1904 to show that the same null result was found when the optical parts are supported by either sandstone, wood, or steel.

Three Dimensional Dynamics: A Vectorial Treatment. By C. E. Easthope. 227 pp. (Butterworths, England) Academic Press Inc., New York, 1958. \$7.80. *Reviewed by T. Teichmann, Lockheed Aircraft Corp.*

While the vectorial treatment of analytical mechanics has become preeminent in American and many European texts, it has tended to have rough going in the British Empire largely perhaps because of the influence of the many important Victorian and Edwardian expositions on this subject which studiously eschew the techniques of Gibbs and Heaviside. The publication of this book seems to indicate that this opposition to vectors is at last dying out and that it is now becoming respectable in England to write each equation once only instead of three times.

The treatment here is essentially an undergraduate treatment of standard Newtonian mechanics specifically excluding the more advanced concepts of Lagrange and

Hamilton-Jacobi theory. Within these limitations, however, the author has presented an extremely clear and usable picture of the methods of analytical mechanics. The text contains examples to illustrate all phases of the various general theorems and methods described. The chapters are generally followed by problems which illuminate the methods and challenge the reader without plumbing the depth of old-fashioned Tripos problems. A useful and significant portion of the book is devoted to the behavior of rotating bodies (more than half the book concerns such problems). In view of the present increasing interest in guidance and celestial mechanics, it seems probable that a thorough knowledge of this type of material will become the sine qua non of engineers as well as physicists, and this book can be recommended particularly to those who wish to refresh their knowledge of the subject with special reference to its practical application in missiles and satellites.

Roots of Scientific Thought: A Cultural Perspective. Edited by Philip P. Wiener and Aaron Noland. 677 pp. Basic Books, Inc., New York, 1957. \$8.00. *Reviewed by L. Marton, National Bureau of Standards.*

The title of this splendid anthology is more informative than it appears at first sight. It heads what may appear first as just another book on the history of science. Actually the book is considerably more. As the editors pointed out in one of their prefatory chapters, "The historian of ideas . . . is interested not only in the logical, cumulative development of scientific thought but also in the extralogical components and their historical affiliations with other cultural developments in the history of the arts, of social institutions, of religion, and of philosophy." It is in the light of this illuminating sentence that one has to look at and analyze this volume.

The anthology consists of 33 papers which appeared earlier in the *Journal of the History of Ideas*. They cover the development of scientific ideas from the earliest classical times until the most recent evolution in cosmology. However, the emphasis is more or less on the sixteenth and seventeenth centuries. The articles are divided into four groups: the first is called The Classical Heritage, the second From Rationalism to Experimentalism, followed by The Scientific Revolution and From the World-Machine to Cosmic Evolution. Each group is preceded by a summary review of the whole era. Three of these summaries are written by the editors themselves and one is written by Crombie. The authors of the papers are representatives of the best history-of-science tradition: Moody, Koyre, Crombie, Randall, and many others. Some of these papers are considered classics of their kind and constitute a very interesting discussion of the subjects which they are treating. It is hard to pick out the best ones in such a galaxy of splendid papers, but I like best John Herman Randall, Jr.'s "The Place of Leonardo da Vinci in the Emergence of Modern Science", Edgar Zilsel's "The Origins of Gilbert's Scientific Method", Francis R. Johnson's "Gresham College: Precursor of the Royal