sides, and these attacks are now converging. We have found that the mechanics of the atom is different in many ways from that of large bodies, and we—or they—have found what the mechanics of the atom is, or at any rate how its results can be calculated. Physics has already told us the "empirical formulae" of the atoms, the number of electrons which they contain and their dispositions. It has given us a mechanism of atomic linkage. It has provided us with methods of measuring many of the characteristic properties of the links between atoms, the distance between the atoms, the relative positions in space, the way in which the electrons are shared between the atoms, the work required for their separation. The problems before us are far too complicated to be solved by physicist alone—by deductive reasoning founded on experiments with a few selected compounds. But much of the information we need he has shown us how to obtain; if we cooperate heartily he will provide us with more; and in this way our theories can be tested and amended by physical measurements and physical reasoning at every step. All that is needed is a proper mutual understanding and good-will.

EDWARD W. MORLEY, CHEMIST, INVESTIGATOR, TEACHER

(Some Personal Notes)

By CHARLES FRANKLIN THWING

PRESIDENT EMERITUS OF WESTERN RESERVE UNIVERSITY

OF the many scholars, scientific, classical, linguistic, historical, philosophic, sociological, who were my college associates for more than thirty years, none was more learned, more illustrious, more devoted, than Morley.

Edward Williams Morley was a child of the manse. He was also a graduate of Andover Theological Seminary. The principles underlying his religious parentage and training were the fundamental and permanent elements of his character. But early in his service as a minister (in Twinsburg, Ohio), he was offered a professorship in Western Reserve College in the neighboring town of Hudson. For in this service he had proved that his interest was rather scientific than theological or clerical. The foundation bore the traditional title of "Natural History and Chemistry." The professorship under this and other titles he held until his retirement in the year 1906. His teaching covered forty years.

Morley united, as not many college professors do unite, great power as a teacher with equally great power as an investigator. His power as a teacher was primarily found in his knowledge, and quite as fundamentally in his devotion to the individual student. His power as an investigator is, of course, illustrated in his devotion to his many and diverse researches. His power as a teacher lives, and lives as long as do the lives of the hundreds of students whom he taught, and to whom he gave intellectual quickening. His work as an investigator relates to at least two fields of nature. In one of these fields his work is completed and is done apparently unto conclusiveness. This work has given him place among the greatest of scientists. In the other field his work still progresses. The first field relates, as says his successor Professor O. F. Tower, to "The densities of oxygen and hydrogen and the ratio in which they combine."[1] The field in which the work is still going on is the field associated with the name of Einstein. In the second field he collaborated with Professor A. A. Michelson "In developing the interferometer, an instrument for measuring lengths in terms of the wave-length of light. They used this instrument to determine the relative motion of the earth and the luminiferous ether."[2] With Professor W. A. Rogers he worked in measuring the expansion of metallic bars; and also with Professor Dayton C. Miller, of the Case School of Applied Science, he experimented upon the "velocity of light in a magnetic field." In all these and other experiments he became associated with his friend, Charles F. Brush, and with Elias Loomis, of Yale, who, long before Morley, was a professor in Western Reserve College. The Michelson-Morley cooperation and the earlier Loomis-Morley cooperation are among the outstanding partnerships in scientific research. Great in his discoveries and inventions, Morley was also great in his associates, and they also were made great through and in him.

These facts both prove and illustrate the breadth of Morley's mind. His interests and devotions were many, his chief interest however lay in the field of the physical sciences. His intellect was at once comprehensive and concentrated. He recognized the differences between a vocation and an avocation. His avocations, however, were several. He knew and loved music. Playing the organ at the chapel service was one of his minor services given to the college at Hud-

[1] O. F. Tower, "Edward Williams Morley," *Western Reserve University Bulletin*, August, 1923, p. 59.

[2] *Ibid.*, p. 61.

son. He learned Russian in order to read the Russian chemical and other journals. But his vocation was commanding, persistent, unrelenting.

The great and lasting results Morley achieved arose from several causes and conditions. Among them were his intellectual alertness, his comprehensiveness, his patience, his laboriousness, and, be it added, his skill in manipulation. His reasoning seemed to be a series of intuitions. Conclusions followed swiftly on insight. Yet, though being the master of immediate intellectual processes, he was also patient. He revised and re-revised his methods, measures and movements; tested and retested his conclusions. Like Pasteur, he examined all hypotheses contrary or similar. All possibilities of error, either personal or of conditions, he sought to remove. More strongly than many scientists he was able to say, "This is the truth: I can no other." It was also well that Morley's power was not simply of intellect and of will: he had great skill with his hands. In the poverty of the college he was largely his own assistant, and the maker of his own apparatus. He was, for instance, a skilled glass-blower, a skill of the utmost value in his long experimenting process in determining atomic weights. Gifted with all these powers he used them to the utmost. He was among the hardest of all workers ever known to me. He gave full service as a teacher till the trustees of the college offered him complete liberty respecting his interpretation of his duties, a liberty of which he did not fully avail himself. Fourteen hours a day was a minimum of the time spent at his tasks. He toiled to the limits of strength. His wife has said to me that it was not unusual for her at the close of the day to watch for him coming home, questioning whether he might not have fainted on the way. A speedometer which he sometimes used proved that in his walking to and fro, up and down, in the building wherein were his rooms, he frequently walked in a single day no less than twenty miles. Scientists are indeed hard workers, some would say the hardest; and no one of them was a harder worker than Morley.

As a scientist Morley's place is secure. It is by common consent among the highest. In the unique worth of this service I of all men should not pass over his worth as a teacher. For hundreds if not thousands of students rise up to bless him. Formally he taught chemistry, but he also taught every other subject. He especially taught English, and the oral use of our English speech. Precise himself in language, he demanded correctness and precision of all students. Oral slovenliness he abominated. Many a student have I heard say, "Morley taught me English as no English teacher." Devoted to the students in ways both specific and general, he required of them an equal devotion to the subject of study. No tolerance had he for the shirker. Faithlessness easily stirred his indignation. He was profane without words. He could not suffer fools, either intellectual or moral. They quickened his abhorrence. But to the student highest, earnest, alert, laborious, he was devoted. His devotion to truth, as I have intimated, was no less intense. From these two foci of devotion to truth and of laboriousness are swiftly and easily drawn the ellipse of his achieving life and rich character.

I can not compare Morley to Pasteur in respect to the directness and beneficences of his service to humanity; but I can compare him to Pasteur in respect to the fundamental elements of scientific research. I can not compare him to Darwin, for Darwin was not a teacher; but I can compare him to Darwin in respect to the intuitive vision, the comprehensiveness of understanding, the persistent patience, the humility of spirit, the prolonged and sober enthusiasm in which he pursued his researches.

OBITUARY

RECENT DEATHS

DR. GEORGE P. DREYER, professor and head of the department of physiology in the College of Medicine of the University of Illinois, Chicago, since 1900, died on February 27, at the age of sixty-five years. Professor Dreyer is known for the discovery of the secretory nerves of the suprarenal glands, and for his work on blood proteids and differential respiration.

CHARLES GLASER, well known for his researches in analytical and technological chemistry, died on February 17, in Baltimore, at the age of seventy-six years.

DR. EARL DOUGLASS, geologist and paleontologist, in charge of the dinosaur collections of the University of Utah, died on January 14, at the age of sixty-nine years.

SIR RICHARD CARNAC TEMPLE, Orientalist, died in Switzerland on March 6, at the age of eighty years. He was a former president of the anthropological section of the British Association for the Advancement of Science and had written many works on the East. Sir Richard was a member of numerous British and American scientific groups, including the Smithsonian Institution in Washington, the American Geographical Society, the American Philosophical Society and the Numismatic Society of Philadelphia.

Nature reports the death of Professor J. S. Dun-