NATIONAL ACADEMY OF SCIENCES

GEORGE W. STEWART

1876—1956

A Biographical Memoir by
HARVEY FLETCHER

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Biographical Memoir

G. W. Stewart

GEORGE W. STEWART

February 22, 1876—August 16, 1956

BY HARVEY FLETCHER

GEORGE W. STEWART was born in St. Louis, Missouri, February 22, 1876, and died in Iowa City, Iowa, August 16, 1956, being in his eighty-first year. He was a member of the National Academy of Sciences for eighteen years and actively participated in its affairs during this period. He was at the State University of Iowa for forty-seven years, until his death.

His early childhood environment and training are very beautifully portrayed in the sketch which he sent to the Academy, from which I quote:

"I had an older brother, Oscar, an older sister, Mary, and a younger brother, Victor. The home life with four children was always an active one, especially since much of it was spent in a parsonage where there were always many callers. The interest of the home was largely centered in the community, in the needs of people generally and in the growth and influence of the local church. The making of money and attainment in life as measured by business success were naturally not often the subject of table or family discussion, chiefly because they were crowded out. There were no revolutionary views of society taught but rather the faith that society must be evolved through the individual's interest and endeavor to bring about a better civilization. The reading of good literature was emphasized, though most of this was upon problems of society.

There was little, if any, very light reading material in the home. Even standard works of fiction took second place.

"There was always emphasized the need for a sharp discrimination between right and wrong in conduct. But all this was suffused with the broadest type of interest in humanity and the greatest sympathy with the other fellow. For example, it was upon this ground that teetotalism was taught and practiced and that form of risk called gambling was avoided. Thus discriminations were based not only upon logic, but also importantly upon their practicability and their helpfulness to others.

"The home was not highly emotional religiously. Father became a minister because of the influence religion had upon people and the happiness in their homes. He was spiritually and not literally minded. His sermons were carefully and logically organized according to the custom of the day. Later in life he read more fiction, threw away all of his old sermons and based his shorter efforts on life as he saw it about him. Evidently he early regarded experimental religion as more to be stressed than theological beliefs or rigid creeds. It was the life he lived and the motives which actuated him that influenced all his children. His breadth of view was shown, as subsequently learned, by his setting aside the rules of the Methodist Discipline and receiving into the church *without baptism* those of the Quaker faith who did not approve of that ritual. This occurred at Carthage, Mo., in 1871–73, at a time when debate concerning forms of baptism were common, and many thought 'salvation' depended upon baptism. Also there subsequently came to light other acts which showed his view that all organization and rituals are but tools for the encouragement and enrichment of what he termed the spiritual life.

"Mother was ever watchful of the many possible errors that can be made by a pastor and had an abundance of good judgment that was exceedingly helpful to father. She was not a great reader, but a home maker and a leader of the women of the parish in the development of their activities. She seemed to know everything about

her children at all times. She had an uncanny insight into the character of everyone she knew, and this was very helpful to father who was more trusting than she. There seemed to be present in the home a confidence in humanity, and yet an awareness of its weaknesses.

"The home was as harmonious as a character-forming one could possibly look to a child. Father and mother seemed to work together especially well because they seemed to have a common objective and did not overemphasize their own personal interests. There was no effort made in the home to determine the careers of any of the children. No particular professions or occupations were held up as ideal. We were led to look forward to higher education, if the finances would permit, and we were encouraged to have self-confidence. For why should not high thinking, earnest people succeed in rendering a service to civilization and thus have a place in the world? Often we were reminded that high thinking and simple living make men and women of real worth.

"My first recollections are of pleasant times, play with other children, entertainments in the church, social gatherings at the parsonage. The unpleasant recollections are only of cuts and bruises and minor accidents for which presumably I alone was responsible.

"I recall an early ambition that was never realized. It seems that I passed rather rapidly through the first room or two in school and that this gave me a confidence that I would soon pass through the rest of them. But the family only smiled indulgently at this ambition which I failed to achieve.

"One incident in the life of my older brother left a very marked impression. It appears that he rebelled at learning the multiplication tables, even inferring that he could not master it. My father summoned my brother to his study, informed him that there were no stupid ones in this family and suggested very definitely that my brother learn his tables forthwith or be punished. My brother learned the multiplication tables at once and was, from that time on, excellent in mathematics. He is O. M. Stewart, well-known textbook author in physics and for many years head of the Department of Physics,

University of Missouri. This incident and its suggestiveness I have never forgotten.

"I was never bookish, preferring to play rather than to study. Not until the seventh or eighth grade did anything occur to stimulate me to serious efforts. Then my teacher in a very personal way appealed to my pride, telling me how much better my sister was than I. From that time on my studies became a more important challenge to my efforts.

"My first year of public school was at Sedalia, Mo. I continued at Carthage, Mo., from about six years to nine years of age; then at Kansas City, Mo., from nine until seventeen, completing three years of high school. The moves from Sedalia to Carthage and to Kansas City were made in March, the time of changes in the Methodist Conference to which father belonged. Undoubtedly these changes had some advantages, but also the disadvantage arising from the dissimilarity in the programs of the schools. I do not recall disliking any subjects in school.

"My home occupations during the school period were those of a city boy living in a semi-modern house. There were a few duties, but my school work was regarded as of first importance. During my second year in high school I studied shorthand in order better to be prepared to earn money during vacations. During the following summer I continued my stenographic training by working in a wholesale lumber office at a small wage. This employment continued for three hours per day through a large part of the last year in high school. Immediately following this I took a position at the Methodist Book Concern in St. Louis, Mo., where I spent a year and a summer laying aside funds to pay my way to college. This break in my education was a financial necessity.

"I entered DePauw University in September, 1893 and received Phi Beta Kappa and A. B. degree in 1898.

"I ran a boarding club a part of the time and earned money during summer vacations. I was able to graduate without interruptions and only a few hundred dollars in debt. I was honored by appointment

to a responsible office by my college fraternity. I took a great interest in the fraternity, and this brought me into intimate contact with fifty or sixty men during the four years. In this way I acquired great faith in men. Also I saw and learned to appreciate almost, if not all, the human traits I have since known. This experience was important in making me at home in the world among those of different views.

"I borrowed the money for graduate study from a Mr. Kauffman of St. Louis and entered Cornell University in 1898. Received the degree of Ph. D. in 1901. Graduate assistant in physics, Cornell, 1899–1901. Elected to Sigma Xi in 1900."

He was an instructor at Cornell from 1901 to 1903, when he accepted a position at the University of North Dakota, where he stayed for six years. In 1909, he went to the State University of Iowa as Professor and Head of the Department of Physics and remained there until his death in 1956. During this period he served as Acting Dean of the Graduate School for several short periods.

He was a member of Phi Beta Kappa and an honorary member of Sigma Pi Sigma and Phi Kappa Phi. He was President of the American Physical Society in 1942 and a member of its Council for several years. In 1930 he became National President of the Society of Sigma Xi. He was awarded three honorary Doctor of Science degrees, by DePauw University (1928), University of Pittsburgh (1931), and Kalamazoo College (1949). The American Association of Physics Teachers awarded him the Oersted Medal for outstanding teaching in 1942. He was also identified with the Acoustical Society of America, The Optical Society of America, and the Society for Promotion of Engineering Education.

The physics building at the State University of Iowa is a monument to his name. Provost Harvey H. Davis of this University paid tribute to him in these words:

"He has given a long record of distinguished and devoted service to the University, both through his own efforts and through those of people he selected for staff appointments. The Physics Building

was planned and its construction almost literally supervised by Dr. Stewart. Its long usefulness with comparatively little remodeling attests the wisdom of his planning."

Again I quote from his autobiography:

"It is difficult to know precisely how my later interests in life developed. They have never been separated from that early interest in people that was in the home as a child. Above has been related my stimulus to better study that occurred in the grade school. Fortunately though not at all bookish, I began to regard the assignments of study as something to conquer. I was made to think of education as a strengthening of the mental sinews rather than as an accumulation of directly useful knowledge. I did fairly well in high school; in college I tried to excel.

"It might be that I was definitely influenced by my brother who had become a physicist at Cornell University. But at the time I thought I was quite independent in my choice. My reasons were these: First, my college work convinced me that I had a mind that was regarded as analytical. I knew physics demanded that qualification. Second, I realized that many aspects of physics were unexplored, and anyone going into it would never be limited by the narrowness of the field or the limitations of his position. Third, I had continued to be deeply interested in people, and I thought I saw the way in which a physicist might help stabilize young minds in the inevitable drift from creeds and tradition. Fourth, and most importantly, the fundamental nature of physics was particularly appealing. Physics appeared to be on a journey of penetration into the depths of nature. It seemed to be one of the most highly intelligent and fundamentally significant ventures of man. My debate as to a career was between the law, the ministry and physics. The law seemed to be very attractive so far as its practice depended on the use of the mind. Further it promised definite opportunities to assist people and society very directly. But it did not seem to have in prospect that deep and alluring fundamental exploration possible in physics.

The ministry seemed laudable, but in it one would not have the freedom of mind and the constructive opportunity physics seemed to promise. I had no reason to believe that I had any extraordinary gifts in physics. Indeed I felt certain that I would not be satisfied with mere technicality anyway. My professor of physics was a trained cabinet maker, whose scholastic training extended to the master's degree. He was not brilliant nor was he a great scholar. But he had a love for physics. Every spare moment he spent in his shop constructing new pieces of apparatus. This deep love for the subject appealed to me strongly. I knew there was something there for me, also, though doubtless in a different way.

"I can recall no relation of adult performance to juvenile promise. My family was not aware of any constructive talent. Indeed my curiosity more than once caused me to take some balky mechanism apart only to find it too complicated or too difficult to restore. Indeed, my family thought also that I was too impatient for a teacher.

"But physics appealed strongly to me, and I knew I could always use my mind for advancement in that field no matter in what position I found myself. Curiously enough, I did not wish to remain at Cornell University where the young men, I observed, felt they were under some external pressure to do research. I remained two years after taking the degree, accomplished some additional investigations but rather longed to be more 'on my own' where there would be broader demands upon ability. When the chance to go to the University of North Dakota arose, I accepted it, thinking that there where research was not demanded, I would learn whether or not I would carry on investigation as a natural part of any mental life. I reasoned also that education in the Middle West was growing apace and that if I succeeded at North Dakota, I would be called elsewhere in that region. In looking over these steps it seems that my ambition never reached far beyond what seemed a quite possible realization. Thus, with the exception of not being able to get from room one to room twelve in a short time in that public school in Sedalia, Mo., I have never been disappointed by the non-realization

of a clearly thought-out ambition. Yet I was not appointed to two positions for which I applied. One was for a teaching position in a high school in Indiana which I sought in my senior year. The other was for a professorship in a New England college which I sought in about 1902. But it appears that in each case failure was probably my good fortune."

Although he always had heavy administrative duties and made many contributions to the science of teaching, he managed to take time enough to make several important research contributions. His earliest work was in radiation, but in 1910 he turned to the field of acoustics. He was one of the very few in the American Physical Society who gave papers on acoustics. Professor Webster of Johns Hopkins University, Professor Miller of Case School of Applied Science, Professor Sabin of Harvard, and Professor Stewart were pioneers in America in this field.

As will be seen from the lists of his paper given at the end of these memoirs he published twenty-seven of them on acoustics from 1903 to 1926. Probably his most significant contribution in this field was the invention of the acoustic filter. He patented some of these filters and sold the rights to use to the Bell Telephone Laboratories. Some of these ideas were used in the construction of telephone microphones and receivers. He did not arrive at these inventions by the experimental method, but by solving the fundamental wave equations for fluids under special boundary conditions. He considered cases where the cross sectional area of tubes suddenly changed, and also the case of tubes with one or more branches. He was able to show that with a proper combination of these he could produce high pass, low pass, or band pass types of filters.

He then turned his attention to X-ray studies of liquids, and between 1926 and 1941 he published thirty papers in this field. His main contribution was to show that liquids in general have a "liquid structure" simulating crystalline structure but not identical to it.

However, he considered research was more an essential and natu-

ral activity of the mind than a goal in itself. He was attracted to creativeness, holding technical research as but one of the opportunities of creative activity for the physicist and teacher.

Before Stewart's arrival at the State University of Iowa, only two M. S. and no Ph. D. degrees had been granted there. He stressed graduate work. One year after he arrived, the first Ph. D. in physics was granted. By 1946, about 70 Ph. D. degrees and 150 M. S. degrees had been granted.

Later, his urge to do research work lessened, and he founded the Iowa Colloquium of College Physicists. After retirement this became his main interest. I quote from a biography published in the *Proceedings* of the Iowa Academy of Sciences:

"Into it he put all his energy and drive, striving to make every meeting surpass the preceding ones. Many of the more than one hundred physicists who converged on our campus every June for this meeting were former students of Professor Stewart but all were made to feel his warm welcome and his personal interest in their problems and achievements. He encouraged active participation in the Colloquium by including 'Round Tables' and discussions each year to supplement the formal lectures, and by means of an exhibit consisting of numerous experimental and other devices. An evening was devoted to viewing this exhibit and prizes were awarded as determined by vote of the members of the Colloquium. Although he was hospitalized for six weeks prior to the June 1956 meeting it was held as scheduled and Professor Stewart was present to greet everyone and to 'attend' the meetings by means of a public address system set up in his office. He had moreover nearly completed the program for the 1957 Colloquium at the time of his death."

While a graduate student at Cornell University, Professor Stewart met and became engaged to Zella Mildred White, a medical student in the University. He and "Dr. Zella" were married in 1904. Their forty years of marriage are related with great insight and tenderness in a biography which he prepared after her death in 1943. They had

one son, Rodney Cromwell Stewart, who is now a resident of Iowa City.

While Professor Stewart was a tireless worker and got great satisfaction out of keeping occupied, he nevertheless found time to become an enthusiastic golfer and took time off for several extensive tours. The first and longest was a five-month cruise in 1932 with "Dr. Zella," which took them to many countries of the world and from which they returned with a host of pleasant memories and many souvenirs. In the summer of 1935 they visited South America, and in 1938 they took a European tour, visiting France, England, Holland, and the Scandinavian countries. Many visitors in Professor Stewart's home have enjoyed his descriptions of their travels and impressions of other lands.

Professor Stewart took an active part in the organization of the University's interreligious School of Religion and served on its board for twenty-five years. He was President of the board at the time of his death.

At his funeral service, on August 20, 1956, Dr. M. Willard Lampe of this school made the following significant remarks about him which are included in these memoirs:

"In this presence one feels more deeply than he can speak. This is so not merely because of our sorrow as relatives and friends, not merely because of the mystery of death and its sensed relationship to the greater mystery of life, but because, now that our loved one and friend is gone, we are more aware than ever of the richness and fullness of the life he has lived, and also because we are keenly aware of an unpayable indebtedness to him. In my case I realize that I am here and came to this community nearly thirty years ago because, in no small degree, of his influence upon me, and I am also vividly reminded that through the years he has been a source of inspiration and strength—sometimes as an honest critic, sometimes going far out of his way to say a kindly word, always an encourager and friend.

"Of my many associations with him, let me relate only one which

I select as illustrative of the man he was, and of what was central in his life. It was an incident of at least fifteen years ago. One morning shortly after the beginning of a new school year, he telephoned to ask if I would give him two hours at my convenience so that he could tell me of a great discovery he had made during the summer. He said he could summarize this discovery in a short sentence, but he knew it would sound trite to me unless he could give me considerable background. We quickly set a time and he came to my office. This was his story.

"Mrs. Stewart and he had spent the summer on a leisurely ocean voyage around South America, stopping at several ports en route. He had taken no books with him. He had assigned himself no papers to write. No persons or places were the specific object of his visit. There were no problems he wanted to solve—except one, the central problem of any serious mind, viz., what is the most satisfactory philosophy of life? He reviewed this problem in the light of his total experience. He was the son of a Methodist minister. He had done his undergraduate work at DePauw University, a strong Christian institution. He had pursued his special study at Cornell University and then had gone on into his life work as a physicist, all the while retaining his interest in the broad fields of culture, and participating actively in many of the opportunities presented by these fields for personal growth and human service. All of this panorama he had reviewed and contemplated as, day after day, he mused in his steamer chair, or talked with his fellow passengers, or saw the sights of the various ports. He tried to weave it all into the most meaningful pattern, and to make it contribute to some touchstone which he might wholeheartedly accept and follow as a working philosophy of life. Several times during his talk with me that day he stressed the thought that when he stated his conclusion he wanted me to interpret the words far more profoundly than they might appear to me to mean because of any familiarity I might have with them, and I assure you that when he was through, I was prepared so to do. The formula at which he arrived, and for which he became

a zealous protagonist and missionary both in spirit and in many active endeavors (although I never could believe that it was anything really new in his life), was this: The most satisfactory philosophy of life is for one to be loyal to the highest and best that one knows. Just that simple and profound!

"After that conference I used to quiz Professor Stewart occasionally on what the phrase 'highest and best' precisely meant to him, what its content was. He did not want to be too specific about it, in fact, its nonspecific character was an essential in his thought, but we who knew him know perfectly well what some of its elements were. One element was his belief in the creative powers which every human being possesses in larger or smaller measure, and the obligation upon each one to use these powers. I have heard him give many a talk, in and out of the university which might well have had as a text the Biblical counsel, 'Stir up the gift of God within you.' Another element in the constituency of his formula was a warm, sparkling friendship that transcended honest differences of opinion, even on important subjects like religion. To this 'highest and best' he was utterly loyal. That is why he was such a bulwark of strength in the interreligious School of Religion from its earliest beginnings. I have just received from Dr. O. D. Foster, a warm friend and admirer of Professor Stewart, and the originator of the idea and essential plan of the School, a letter in which he wrote that at the first conference about the School on this campus, one of the most heartening factors was a talk by Professor Stewart in which he, a noted scientist, enthusiastically approved the project. I have often said—and for this I could cite many a chapter and verse—that Professor Stewart could and did defend the philosophy of the School of Religion better than I, its long-time director, and by defense I mean both intellectually and in practical relationships. There was between him and certain Catholics and Jews in this School a spontaneous, free-wheeling camaraderie, that I have never seen excelled. It was indeed fitting that during the last several months of his life he served as president of the board of trustees of the School.

"Well, our friend, as we say 'is gone.' But I am sure that spiritually he went with a cheery wave of the hand. On returning to Iowa City from a year's absence, I called on him a few weeks ago, and found him his old interested and interesting self, fully prepared as he expressly told me, to meet and take whatever might come. To me he was and is one of God's princely sons who, though gone, lives on forever!"

This is a very fine tribute to this man who had so many interests in life.

One can trace his scientific activity and thought by looking through the list of published papers which is given below.

KEY TO ABBREVIATIONS

Amer. J. Phys.=American Journal of Physics
Chem. Rev.=Chemical Reviews
Ind. J. Phys.=The Indiana Journal of Physics
Iowa Acad. Sci.=Iowa Academy of Sciences
J. Acous. Soc. Amer.=Journal of the Acoustical Society of America
J. Chem. Phys.=Journal of Chemical Physics
J. Gen. Ed.=Journal of General Education
J. Higher Ed.=Journal of Higher Education
J. Opt. Soc. Amer.=Journal of the Optical Society of America
Phys. Rev.=Physical Review
Proc. Nat. Acad. Sci.=Proceedings of the National Academy of Sciences
Rev. Mod. Phys.=Review of Modern Physics
Rev. Sci. Instr.=Review of Scientific Instruments
School Sci. Math.=School Science and Mathematics
Sci. Mo.=Scientific Monthly
Trans. Faraday Soc.=Transactions of the Faraday Society

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