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EDWARD CHARLES PICKERING

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BY

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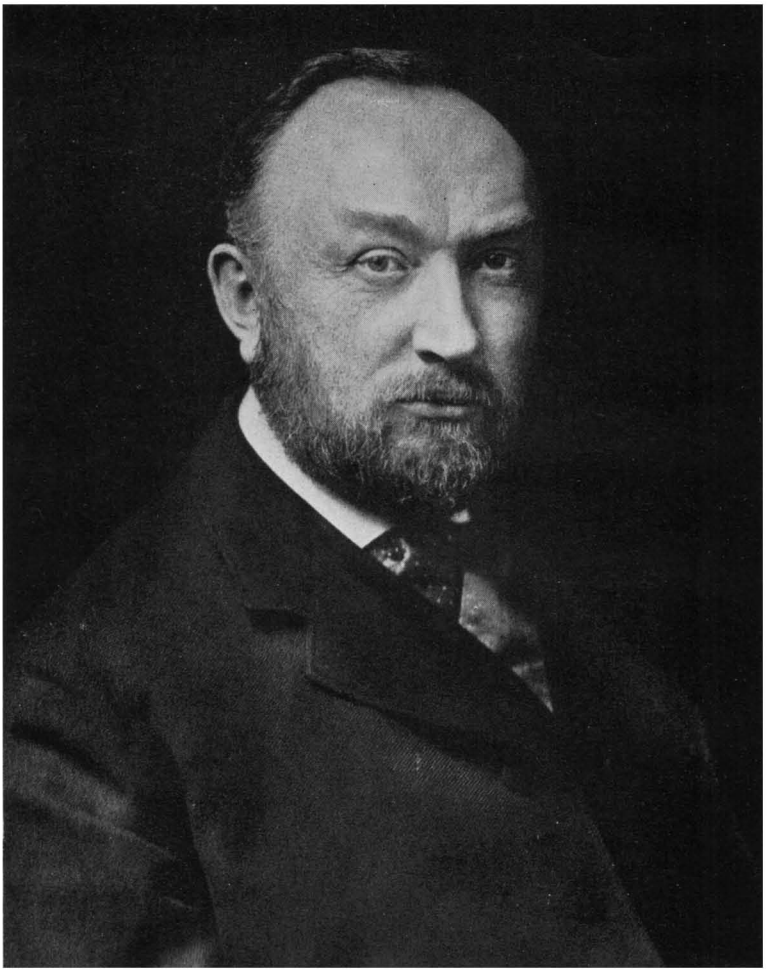

EDWARD CHARLES PICKERING

BY SOLON I. BAILEY[1]

Edward Charles Pickering was born on Beacon Hill, Boston, July 19, 1846. He died at Cambridge on February 3, 1919. At the time of his death the Observatory was less than eighty years old, and he had been Director forty-two years, a period considerably longer than the combined terms of his three predecessors.

Mr. Pickering was fortunate in his heritage. Of a family always prominent in New England history, he was heir neither to riches nor to poverty, but to splendid opportunity, which he eagerly grasped. From early youth to old age, his zeal in the pursuit of scientific problems was unbounded. His education was begun in private schools, but later carried forward at the Boston Latin School. He had small love of the classics and gave them scant attention. In the Lawrence Scientific School, however, he entered upon his work with that enthusiasm which marked all the activities of his mature life. He was graduated from this school *summa cum laude* at the age of nineteen, and was immediately appointed Instructor of Mathematics in that institution. A year later he became Assistant in Physics at the Massachusetts Institute of Technology, and in the following year Thayer Professor of Physics, a position which he held until he became Director of the Observatory. During his ten years at the Institute, the history of his work is the history of the Department of Physics. His appointment as Thayer Professor came at the urgent request of President William B. Rogers, the former occupant of the chair, who wrote to Pickering regarding it:

"Let me say that, with all the urgency of other Institute duties, I should be quite unwilling to relinquish it to any other successor, so much do I love its exercises, and so sure am I that under

[1] This biography has been taken from Professor Bailey's "History and Work of the Harvard Observatory," with only slight alterations. The bibliography has been prepared by Jenka Mohr.—Harlow Shapley.

your direction they will preserve the breadth and character which it has been my aim to give them."

At this time Pickering was only twenty-two years of age. During the busy years of his professorship at the Institute, forty-one scientific papers were published by him, or by students under his direction, as well as two volumes of his pioneer textbook entitled "Physical Manipulations." He established in connection with these volumes the first physical laboratory in America for students. The idea of such a laboratory had been suggested by President Rogers, but its successful installation and management were due to Pickering. The importance of this development was widely recognized; it has been regarded as marking an epoch in the teaching of physics. Pickering measured the value of the course in physical manipulation by its success in teaching the student to think for himself, and in fitting him to solve problems experimentally. Research was Pickering's chief interest, although teaching consumed the greater part of his time. His own investigations, on the subject of light, formed a fitting foundation for his future life work.

In 1869 and 1870, Mr. Pickering took part in the expeditions sent out by the United States Government to observe the total solar eclipses. He introduced at the Institute a course of lectures for older students on geodesy and topography, and one on practical astronomy, especially for engineers. He also designed a spectrometer, which was constructed by Alvan Clark and Sons, and was the most powerful instrument of its kind at that time.

A notable contribution of a different character was made by his early experiments with the telephone. In 1870 he constructed a receiver consisting of a flexible iron diaphragm supported at the edges and replacing the armature of an electromagnet. The apparatus appears to differ in no way in principle from the receiver later in use. He would not consider protecting the device by patent, since such a course would have been contrary to his code of ethics.

In 1876 Pickering founded and became first president of the Appalachian Mountain Club. The great value of this club for popular purposes is well known, but his primary aim was the

furthering of health and science. He perfected a portable 12-pound micrometer level for the rapid determination of approximate positions and altitudes. With this instrument he made thousands of observations of various points of interest in the White Mountains. The intensity of his interest and the enthusiasm and success with which he carried out his plans made a deep impression on his associates.

Professor Pickering was chosen Director of the Harvard Observatory in 1876, and entered upon his duties on February 1, 1877. The appointment of a physicist to direct an astronomical observatory caused some criticism from astronomers of the old school. There was no lack of candidates for the position among astronomers of experience and reputation. President Eliot, however, who called him to the directorship of the Observatory, was thoroughly familiar with the unusual scientific and administrative ability which Pickering had shown at the Massachusetts Institute of Technology.

Pickering found the times propitious for the introduction of new methods. The old astronomy of position and motion which had occupied the chief place in the programs of the great observatories in the past was destined soon to be pushed into the background by the urgency of astrophysical problems. Even the determination of magnitudes of stars had not been placed on a sound scientific basis and comparatively little was known as to their nature. Everywhere there was a great dearth of facts. In such a condition of the science, Pickering decided that the accumulation of great masses of data would constitute the greatest contribution he could make to the advancement of astronomy. Theories in regard to the structure of the stellar universe could wisely be deferred until better foundations were provided.

Pickering's first care at the beginning of his administration was to secure additional funds for carrying on observations, and for publishing those already made, and also for the extension of his investigations into new fields. His first Annual Report contained an appeal for financial aid, and every succeeding report included some such direct or indirect appeal. The great schemes he was planning could be carried out only through the assistance

of many minds and many hands, and these could be obtained only by a great increase of endowment. Little by little this was secured. His own part in this increase was considerable. In all, he gave to the Observatory more than a hundred thousand dollars.

The first and one of the greatest of Pickering's achievements was in stellar photometry, which for many years was his leading interest. He found the Observatory equipped with two instruments of the highest class for that time: the large 15-inch equatorial refractor, and the new 8-inch meridian circle obtained by Winlock. For a while he carried on investigations with photometers attached to the large refractor, but later his observations became more and more photographic. These early labors held particular interest because of the measurement, in 1877, of the newly discovered satellites of Mars. While he was engaged in carrying on these investigations, a meridian photometer was constructed for the convenient measurement of the magnitudes of all the brighter stars.

Considerable work bearing on the structure of the Milky Way was done by Pickering during his long directorship. In connection with his photometric catalogues, he discussed the distribution of stars of different magnitudes. Dividing the stars into groups half a magnitude apart, he studied the distribution of the 4193 stars of the early Harvard Photometry, together with that of the 324,000 stars of the Northern Durchmusterung, and the 7363 stars of the Uranometria Argentina. Pickering found the actual number of stars observed was less than that indicated by theoretical discussions, on the improbable but convenient assumption that the stars are of equal brightness and uniformly distributed in space.

The improvement of the photographic dry plate came at the beginning of Pickering's administration, and its possibilities were promptly grasped by him. Something of romance was perhaps lost by the introduction of photographic methods, but the gain in efficiency was tremendous. Charting a field of stars, formerly a labor of weeks or months, could be accomplished in an hour, the resulting photograph often showing more stars

than could be seen by the eye with a telescope of equal size. The creation of the library of celestial photographs, mainly of stars, containing more than 200,000 original negatives, was an unique achievement, involving the foundation of the most valuable and irreplaceable astronomical collection in the world, and destined in time to give a history of the sky.

Pickering early saw the possibility of photographic photometry and made many experiments and observations. For many years the difficulties were too great for its successful use, but before the close of his life these had been overcome in large part. He conceived the idea that a large collection of celestial photographs, covering the whole sky and repeated at short intervals over a long series of years, would have immense value, and he attempted to make this record of the stars as complete as possible. An auxiliary station was founded in the southern hemisphere in order to cover the southern sky. Photographs of various kinds were taken; the spectra of the stars were obtained with the objective prism. Records were made with instruments of widely different powers: at one extreme the 24-inch Bruce doublet, which, with an exposure of one hour, showed stars to about the seventeenth magnitude; and at the other extreme a wide-angled one-half-inch Ross-Zeiss lens covered a field about 60 degrees square, so that the entire sky available could be covered in a single night with exposures of one hour, stars to about the ninth magnitude being photographed.

These half-examined plates, made, in many cases, only for the purpose of securing as complete a record as possible, appeared to many as unnecessary and extravagant, and even excited ridicule. This attitude seems absurd now that their value has been so fully demonstrated. Hardly a new star or variable has been discovered in recent years whose history could not be traced in a large degree upon these photographs. The extensive discoveries of novae, asteroids, variable stars, and other interesting celestial objects from this collection of photographs are ample proof of its value. A series of plates having exposures of four hours with the 24-inch Bruce was proposed, and a considerable number of excellent photographs were made at

Arequipa from the South Pole northward. Such a series, if it could be completed for the whole sky, would contain a hundred million or more stars, and from it might be derived definite lists of clusters and nebulae for the determination of their distribution, motions, and distances. The scheme, however, would require a long time for its completion with a single telescope, and meanwhile the Selected Areas of Kapteyn, Pickering's own Standard Regions, and other cooperative plans made this complete plan less necessary.

With the development of photographic methods, Pickering included some work on the solar spectrum in the general study of spectral classification, paying special attention to the varying intensity of the atmospheric lines in the solar spectrum as affected by variations in temperature, moisture, and other meteorological conditions. He also did pioneer work on line intensity for the spectral regions around the Fraunhofer line E, and thus helped to pave the way for the future investigations of solar and stellar atmospheres.

The study of stellar spectra, carried on by several observers under Pickering's direction, constitutes one of the greatest achievements of the Observatory. Toward the close of his life, the completion of the Henry Draper Catalogue of stellar spectra, for which the classification of more than two hundred thousand stars was done by Miss Cannon, absorbed Pickering's attention. This catalogue, consisting of nine volumes of the Annals, was nearly finished at the time of his death. To estimate its importance, one needs only to remember how small was our knowledge of the nature of the stars in 1885, when he began to photograph them with the objective prism, and to consider how intimately the Harvard classification has entered into nearly all lines of astronomical research.

Aside from the classification of spectra, the objective prism plates yielded enough in the way of by-products to justify Pickering's enthusiasm: several novae, hundreds of new variable stars, and long lists of peculiar stars of special interest. Nothing pleased him more than to know that the results obtained at the Observatory were those most needed by astronomers in

their investigations. Certainly no better example could be found of a recognized and fulfilled astronomical need than the classification of stellar spectra in the nine volumes of the Henry Draper Catalogue, as carried out by Miss Cannon.

It is possible that Pickering's best work was in photometry and spectroscopy, but he was active in many other fields. The study of variable stars was a marked feature of the Observatory work during his administration. When he began his observations, about 200 variables were known; at the time of his death 3435 variables had been found at the Harvard Observatory. He published, in 1880, a classification of variable stars which is the accepted notation at the present time. He soon began to encourage their observation on a scale hitherto unknown. This was possible not only through the increasing resources of the Observatory, but also through the assistance of amateurs. When the American Association of Variable Star Observers was formed, he gave the members the assistance which they needed. The spirit in which this was given and received is well shown by the regard and affection in which he was held by the members of the Association. At their meeting in 1918 they presented him with a beautiful gift, after their president had made the following reference to him: "He has assisted us in everything that we have undertaken, and has carefully watched our progress along every step of the way, and the manner of his so doing has been that of the Big Brother."

The astronomy of position was not neglected during Pickering's directorship, although his chief interests lay in astrophysical lines. Two zones of the Astronomische Gesellschaft, those from $+ 49^\circ 55'$ to $+ 55^\circ 10'$, and from $- 9^\circ 50'$ to $- 14^\circ 10'$ declination, were observed and published during that time, although the observations for the former zone were begun under Professor Winlock. Altogether, the work of the meridian circle occupied the time of one professor and several assistants during half a century, the results filling a dozen volumes of the Annals.

When Pickering came to the Observatory, only a dozen volumes of the Annals had been published or were ready for

printing. At the time of his death, about eighty of these quarto volumes had been issued or were practically ready for the printer. Many of these, indeed, were chiefly the work of others, supervised or edited by him. On the other hand, an enormous amount was his own. He was a natural leader, but he was an indefatigable worker as well. He worked for the real love of it, carrying on observations for several hours each clear night, in addition to his arduous duties as director. Of the two million observations concerned in the visual Harvard Photometry, more than half were made by him.

Pickering's interest in the work of others seemed as intense as that in his own. His desire was to secure the largest possible results. If he was fond of quantity, the care with which he examined and reexamined all that he did is evidence that quantity was not sought at the expense of quality. Loyalty to his predecessors in office was one of his marked characteristics. He devoted much time and badly needed financial resources, during the early years of his directorship, toward completing and publishing their unfinished work.

As unusual as were Pickering's scientific accomplishments, his personal qualifications were equally rare. For men and women he had an equal charm. His grace of manner and conversation captivated all those who knew him intimately. To all who seemed to have any claim upon him, he gave a courteous regard. He seemed always able to draw out a person's best qualities, and to leave him with the rare and happy sense of having found at last real appreciation. To astronomers especially he was ready with unlimited service, and he is remembered by many as an ideal host.

Pickering thoroughly believed in the advantage of broad associations for the good of science and mankind. One of the most cherished objects of his life was to secure an international fund for the benefit of astronomers of all nations. Of a similar nature was his plan for an international southern telescope which would be devoted to the needs of astronomers anywhere.

Believing that the best service he could render to astronomy was the accumulation of facts, to this end he massed all the

forces he could command, instituting great pieces of research, sometimes employing many routine workers, that in the end a sufficient basis should be provided for a solution of stellar problems. His practical nature led him to adopt graphical instead of analytical methods, whenever they appeared equally accurate.

Pickering loved to discuss but refused to dispute. He loved appreciation, but was not swerved from an approved course by its absence. His persistence in what he believed right was balanced by a readiness to accept new ideas. Until the very end of his life he kept an alert, unprejudiced mind, and was always glad to modify or abandon his plans if something better presented itself. He was prompt to give advice, whenever it was requested, and possibly in some cases where it was not desired. Always glad for friendly suggestions himself, he did not hesitate to offer them to others. He was held in high esteem by his fellow astronomers. The following tribute (1919) is from one of them:

"His wonderful energy and enthusiasm, his alertness, his unvarying courtesy, his wide vision and generous heart, make his passing a keen personal loss even to those of us who knew him slightly. For a number of years I have thought of him as the Dean of American Science."

Mr. Pickering was married in 1874 to Lizzie Wadsworth Sparks, daughter of Jared Sparks, a former president of Harvard University and a well-known historian. Mrs. Pickering, who is still remembered as an especially charming hostess, died in 1906. No children were born to them.

Pickering received nearly all the honors which the world had to bestow on a scientific man. These he valued highly as the expression of the appreciation in which his work was held. He received the honorary degree of Doctor from six American and two foreign universities. He took special pride in being a Knight of the Ordre Pour la Merite. His collection of medals was a large one; he was twice awarded the gold medal of the Royal Astronomical Society. In addition to membership in American societies, he was a member or associate of the national

societies of England, Germany, Ireland, Italy, Russia, Sweden, and Mexico. He was made a member of the American Academy of Arts and Sciences at the age of twenty-one, and a member of the National Academy of Sciences at the age of twenty-seven. He was President of the American Astronomical Society from 1905 until his death in 1919.

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Note to Professor Pickering's Bibliography

The present list of published work does not include anything published in either the Harvard Observatory Bulletins or the Harvard Observatory Circulars. The Bulletins comprise a series of brief notes, generally on small problems or work in progress. The Circulars are a series of larger papers. In both series Professor Pickering published a great many researches; but since all Bulletins and Circulars during his directorship were printed as of the Observatory, rather than of individual members, it is impossible to tell specifically which articles were his own. Professor Pickering published also a series of Annual Reports of the Director of the Harvard Observatory to the President of the University, giving an account of the work for each year. These reports also have been omitted from the bibliography.