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CHARLES AUGUSTUS YOUNG

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EDWIN B. FROST

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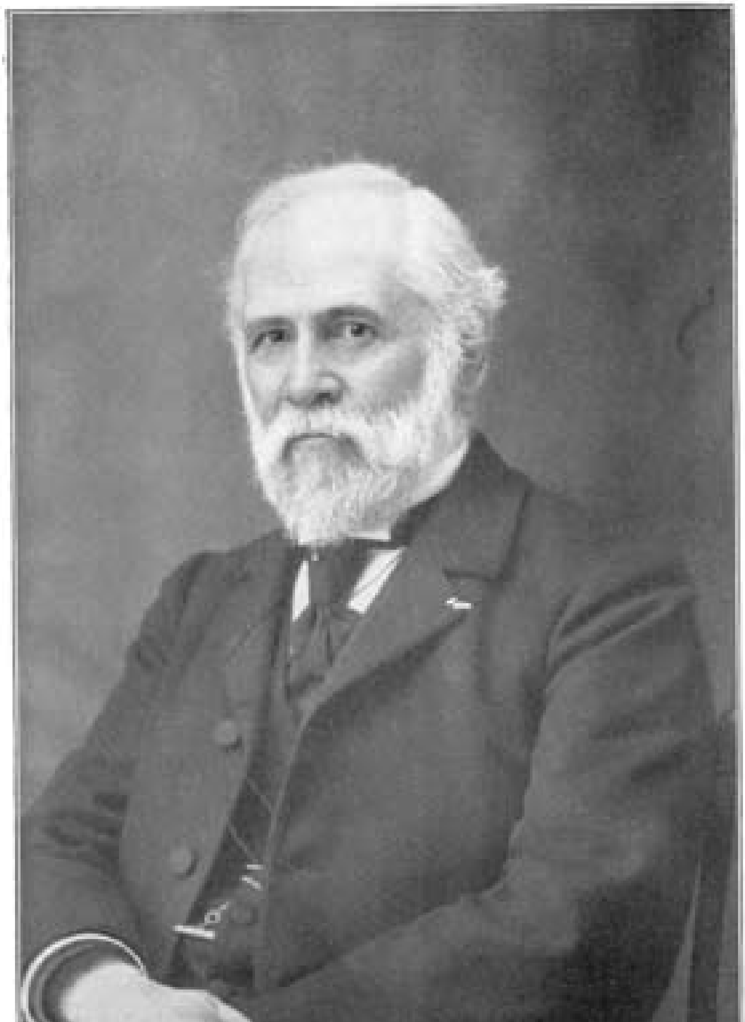

Yours Sincerely
C. A. Young

CHARLES AUGUSTUS YOUNG.

Charles Augustus Young was born in Hanover, New Hampshire, the seat of Dartmouth College, on December 15, 1834, and he died seventy-three years later, on January 3, 1908, in the same village, which had thrice been his home—in youth, in early manhood, and after his retirement from active work. An academic career was his by inheritance, for his maternal grandfather, Ebenezer Adams, of New Hampshire origin, was professor of mathematics and natural philosophy at Dartmouth from 1810 to 1833, and was succeeded in that chair by his son-in-law, Ira Young, father of Charles Augustus. Ira Young was also from New Hampshire, having been born at Lebanon, five miles from the college, in 1801. He was prevented by circumstances from entering college until after he was of age, but he took high rank and graduated in 1828, returning to the college two years later as tutor, and then assuming the duties of professor in 1833. Five years later his chair was changed to that of natural philosophy and astronomy, and it was filled by him with distinguished success until he died, in 1858. He was survived for thirty years by his widow, Eliza Adams, a woman of strong character and intellect.

Charles Augustus thus grew up in the atmosphere of natural philosophy, and, gifted with an active mind, he was ready for college before he had reached his fourteenth birthday; but it was thought best by his father that he should delay his entrance for a year. He graduated in the summer of 1853, at eighteen and a half years, the leader of a class of about fifty men. From his early youth he assisted his father in some of his scientific duties, and made with him a trip to Europe in the summer of 1853, when the elder Young went abroad to examine foreign observatories and to secure instruments for the Shattuck Observatory, then in process of establishment, largely through his own efforts. For two years after graduation Charles taught the classics in the well-known preparatory school, Phillips Academy, at Andover, Massachusetts. During the next year he studied in the theological seminary at Andover, in accordance with an early plan to become a missionary; for a part of the year he continued his instruction in the classics at the academy. His later writings show that this training in the classics stood him in good stead.

An invitation to become professor of mathematics, natural philosophy, and astronomy at the Western Reserve College, at Hudson, Ohio, now changed his career, fortunately for science. He entered upon the numerous duties of his new position at the beginning of 1857, and for nine years devoted himself to this work of teaching, with little opportunity and presumably with little apparatus for research. He established a time-service for the neighboring city of Cleveland, but it does not appear that he made astronomical observations to any considerable extent. During several summer vacations at this time he acted as astronomical assistant on the Government's lake survey, being chiefly engaged in telegraphic determinations of longitude.

In the summer of 1857, shortly after he began his work at Hudson, he was married at Concord, New Hampshire, to Miss Augusta S. Mixer. She was a woman of unusually gentle disposition and character, understanding well how to enliven her husband when he was depressed with his many cares and responsibilities. This singularly happy union continued for nearly forty-four years, until broken by her death in 1901. Their children, a daughter and two sons, were born while they lived at Hudson.

In 1862 he left his college duties, in prompt response to the call of the Governor of Ohio for volunteers, and was for four months captain in the 85th regiment of Ohio, his company, B, being chiefly constituted from the students of the college. The company did not see actual service in battle, but was detailed to duty in guarding prisoners, and later escorted a large number of prisoners to Vicksburg to be exchanged. Professor Young's health was somewhat impaired by these patriotic services.

In February, 1866, he accepted the call to the professorship of natural philosophy and astronomy at Dartmouth, thus succeeding his father after a lapse of eight years. This particular chair had been sufficiently endowed so that quite a large collection of apparatus, particularly in optics, had been acquired for lecture use. Fortunately for the teacher, the method of laboratory instruction had not at that time been introduced in America; otherwise he could hardly have found time for the researches which marked the next few years, and established his position as a leader in the rapidly developing branch of solar physics.

His published writings on this topic began, so far as known, with a series entitled "Spectroscopic Notes," published in the Journal of the Franklin Institute, the first of which was dated July 19, 1869. He was provided with a spectroscope having five prisms of 45° attached to a four-inch telescope equatorially mounted. With this he carefully studied the spectrum of the chromosphere, and watched with a natural interest the strange forms of the prominences, the method for observing which had been simultaneously announced by Lockyer and by Janssen only in the year preceding. These spectroscopic notes were eight in number, the last dated November, 1870. They are brief and to the point. The second recorded drawings of the prominences, and the third was accompanied by a quite satisfactory lithographic reproduction of ten sketches, which have since been widely copied. He refers in the second to his first observation of the bright lines of the chromosphere extending in upon the disk. In the fourth he describes his first study of the spectrum of a sun-spot, finding the *C* and *F* lines reversed and many lines widened, as had been recorded by Lockyer. Young expresses his surprise at the prominence of the lines of titanium in the spot spectrum, which was also true of certain calcium lines. On September 22, 1870, he saw the sodium lines D_1 and D_2 reversed in the umbral spectrum. He adds,

> "At the same time the *C* and *F* lines were also reversed, but with the great dispersive power of my new spectroscope I see this so often in the solar spots that it has ceased to be remarkable."

Two days after he sent this communication to the editor of the Journal of the Franklin Institute, he wrote again announcing his success in obtaining a photograph of protuberances on the sun's limb, using "the hydrogen line near *G*" ($H\gamma$). A woodcut was made from the photograph, but, with the modesty which was always characteristic of him, he says:

> "As a picture the little thing amounts to nothing because the unsteadiness of the air and the maladjustment of the polar axis of the equatorial caused the image to shift its place slightly during the long exposure of three and a half minutes which was required, thus destroying all the details. Still, the double-headed form of the prominence is evident, and the possibility of taking such photographs is established."

This was the first photograph of a prominence obtained anywhere, and it prepared the way for the developments which have made the photography of the prominences a daily routine at observatories concerned with the sun.

He describes in his fifth note the new form of spectroscope he designed for solar work, having the dispersive power of thirteen prisms, the light passing first through the lower portion, and then back through the upper portion of a train of six prisms. The apparatus was made by Alvan Clark and Sons, and Professor Young expresses his admiration "for the exquisite workmanship of the 43 different surfaces by which the light is either refracted or reflected on its way from the slit of the collimator to the eye." The writer can add his testimony to the delight in the use of the same instrument, practically unchanged, nearly twenty years later, and it is still of excellent service despite the improvements of spectroscopes with the general application of the diffraction grating.

His final spectroscopic note gives in a dozen pages an admirable statement "on the construction, arrangement and best proportions of the instrument with reference to its efficiency." The advantages of using a half-prism at the beginning of a train is pointed out, and a simple form of chemical spectroscope is proposed in which flint half-prisms are cemented directly to the single crown lenses of collimator and observing telescopes, the back surface of the prism being made concave to fit the lens. The plan is a very good one and has recently been applied in celestial spectroscopes.

With keen interest in the study of the chromosphere and prominences, stimulated and made possible by the far-reaching results of the spectroscopic observations of the solar eclipse of 1868, it was natural that Young should wish to observe the eclipse of August 7, 1869. He became a member of the party organized by the U. S. Naval Observatory, under the charge of Professor J. H. C. Coffin, of the Nautical Almanac Office. The station was at Burlington, Iowa, and was favored by fine weather, so that excellent results were secured. An interesting popular account of this eclipse was contributed by Professor Young to "The Dartmouth," the students' paper, for September. His scientific discussion was printed in Silliman's Journal for September, 1869, under the title, "On a new method of observing contacts at the sun's limb, and on other spectroscopic observations during the recent eclipse." Half an hour before totality he conceived the idea of observing the contact through the spectroscope set radially upon the sun's disk, and watching the bright *C* line shorten under the approach of the moon; he was gratified at the realization of his plan, and he felt confident that his observed time of contact must be accurate within a second. He suggested the application of the method to the case of the transit of Venus of 1874, for which preparations were already in mind. He later found that this proposal had been made to the French Academy by Faye in January of that year. Young examined during the totality the spectrum of prominences which he had located earlier in the day: *C* was brilliant, the next to it was "the orange line, which for convenience I will call D_3." Then he noted that the line 1474 *K* extended clear across the spectrum, and persisted when the slit was moved away from the protuberance. "Thus it was evident," he states, "that this line belonged, not to the spectrum of the protuberance, but to that of the corona." He also noted a faint continuous spectrum, without dark lines, "evidently due to the corona." The apparent coincidence of three coronal lines with lines located by Winlock in the spectrum of the aurora led Young to entertain the view that the phenomena of corona and aurora were related, with 1474 *K* in particular present in both. He did not assert the relationship with any positiveness, stating, "I do not feel in a position to urge it strongly, but rather await developments." Although he soon saw the error, it was long before it could be suppressed, after once gaining currency. There was much discussion as to the origin of the characteristic corona line 1474 *K*, Lockyer regarding it as due to iron, Secchi as due to hydrogen. The matter was not really cleared up until the Indian eclipse of 1898, when both Lockyer and Campbell found that the wave-length of the corona line is actually a trifle less (λ 5304 on Rowland's scale) than 1474 *K* (λ 5317). The latter is, as Young found, a characteristic chromospheric line, and is probably due to iron.

In view of the interesting discoveries at this eclipse it is not surprising that a strong party of American observers, under Professor Winlock, including Professors Langley, Pickering, and Young, was prepared to study the phenomena of the eclipse of December 22, 1870, at Jerez, in Spain. Better favored than most other parties, they had a chance for observations at totality, through a break in the clouds. Young's discovery of the 1474 line as due to the corona was fully confirmed; it was followed out beyond the limb a distance of more than half the solar radius, and it was seen to be the brightest of the lines. Let us now quote from Young's own words:

"No new lines were observed with which I was not before familiar. But just at the commencement of the totality I made an observation, which was wonderfully beautiful to see, and which, I think, has important theoretical bearings. The slit of my spectroscope was placed tangential to the sun's limb, just at the base of the chromosphere, the 1474 line on the cross-wires. As the crescent of the sun (or decrescent, rather) grew narrower, this line, and the magnesium lines close by, as well as some others in the same neighborhood which I am accustomed to see bright in prominences, gradually increased in brilliancy, when suddenly, as the last ray of the solar photosphere was stopped out by the moon, the whole field of view was filled with countless bright lines—every single dark line of the ordinary spectrum, so far as I could judge in a moment, was reversed, and continued so for perhaps a second and a half, when they faded out, leaving only those I had at first been watching. This points to an atmosphere of heated vapor some five or six hundred miles in thickness above the photosphere, and tends to make Kirchhoff's original theory of the constitution of the solar surface again tenable."

This is from his interesting account of the eclipse written on the next day for the college paper, "The Dartmouth," to which he had previously contributed an exceedingly readable narration of his visits en route at Gibraltar and Tangier. In his letter to Professor Morton for the Journal of the Franklin

Institute, also written on December 23, he states his discovery of the reversing layer very clearly:

> "But the most interesting spectroscopic observation of the eclipse appears to me to be the ascertaining, at the base of the chromosphere, and, of course, in immediate contact with the photosphere, of a thin layer, in whose spectrum *the dark lines of the ordinary solar spectrum are all reversed.*"

The phenomenon was also seen, for an instant only, by Mr. Pye, a young Englishman, who assisted Professor Young, using one of his spectroscopes.

The objective reality of this phenomenon was not fully confirmed until Mr. Shackleton, of Sir Norman Lockyer's party at Nova Zembla, a quarter of a century later, obtained the first successful photograph of the "flash spectrum" at the eclipse of August 9, 1896. Since then it has been photographed by many observers at most of the eclipses favored with clear skies.

The problem of the solar corona occupied Professor Young's mind for some time after the eclipse, and in May, 1871, he published in the American Journal of Science a paper "On the solar corona," supplemented by a note on its spectrum in the July number. After the lapse of nearly forty years there is little to be added to his presentation of the complex nature of the spectrum and the probable sources of its constituents.

In 1870 Professor Young was a member of the Board of Visitors to the U. S. Military Academy at West Point, and, as secretary of the board, wrote its report to the Secretary of War.

A lecture delivered by Professor Young before the Yale Scientific Club, on "The sun and the phenomena of its atmosphere," was published as a booklet in duodecimo form of 55 pages in 1872. It probably was not widely circulated, but it formed the basis of his classic, "The Sun," of the International Scientific Series, which appeared in 1881.

His observational activities were still chiefly directed to the sun, although he printed in The American Journal of Science, in 1870, an account of "a new method of determining the level-error of the axis of a meridian instrument"; and of observations of the spectrum of Encke's comet, which was faintly visible to the naked eye in December, 1871. At this time he had a 9.4-inch Clark equatorial for his work. The observations of the cometary spectrum were consistent and reliable, and could hardly be improved upon today with the same telescope and the visual method.

Four weeks of work in the autumn of 1871, nearly at the time of a solar maximum, sufficed for a preliminary catalogue of the bright lines he saw in the spectrum of the chromosphere, 103 in number. He called attention to the presence of titanium lines, which constituted one-fifth of the whole number reversed. The advantage of a high elevation, with diminished reflection from our atmosphere, was apparent, and in the summer of 1872 Professor Young, under the auspices of the U. S. Coast Survey, made an expedition to Sherman, Wyoming, on a high plateau about 8,300 feet above sea-level, where he set up his telescope and spectroscope and added 170 to his list of chromospheric lines. He states that the elevation gave

> "even greater advantages for my special work than had really been expected, although I was never quite able to realize my *hope* of seeing all the Fraunhofer lines reversed, unless once or twice for a moment, during some unusual disturbances of the solar surface. Everything I saw, however, confirmed my belief that the origin of the dark lines is at the base of the chromosphere, and that the ability to see them all reversed at any moment depends merely upon instrumental power and atmospheric conditions." *

An observation very important in its bearing upon the future development of the study of the surface of the sun is mentioned at the end of this brief paper. Referring to the fact that the calcium lines *H* and *K* were both reversed, as constantly as *h* or *C* when the seeing was good, he adds:

> "They were also found to be regularly reversed upon the body of the sun itself, in the *penumbra and immediate neighborhood of every important spot.*" (Italics his.)

Professor Young made a comparison of the solar outbursts observed at Sherman with the magnetic records at Greenwich and Stonyhurst, and regarded it as probable that every solar

* This has now been practically realized at the Mt. Wilson Solar Observatory. See the paper by Hale and Adams entitled "Photography of the 'flash' spectrum without an eclipse," *Astrophysical Journal,* Vol. XXX, 1909 (October), p. 222.

disturbance receives an immediate response from the earth, and that the magnetic impulse travels, sensibly, with the velocity of light. It is surprising that this question is still under discussion after every case of marked "earth currents" or an extra brilliant aurora: the probabilities are perhaps as much in accord with Young's view as ever.

The coming transit of Venus was now exciting the interest of astronomers. Professor Young was asked to take charge of a party to be stationed at Kerguelen Island, but was unable to leave his teaching for the necessary length of time. He did, however, join the party under Prof. J. C. Watson at Peking, which secured results satisfactory at the time, before the comparative futility of that mode of determining the sun's distance was appreciated.

At about this time Professor Young contributed semi-popular articles on solar phenomena to the Popular Science Monthly and other serious reviews, and wrote for Johnson's Cyclopædia the articles on "Sun" and "Spectroscope." It must be remembered that during all of these years at Dartmouth he was teaching physics as well as astronomy to every third-year student in the college, and was giving annual courses of lectures at two or more schools for young women, besides many popular addresses.

He had promptly appreciated the advantages of the diffraction grating when he saw those ruled by Rutherford, who later placed some at his disposal. He then detected the duplicity of the 1474 line, thus apparently clearing up the outstanding difficulty as to the origin of the corona line, which he never could accept as an iron line. In the summer of 1876, with a good grating, he applied Doppler's principle to the rotation of the sun, and obtained the first good quantitative results by the method.* He hoped to use the atmospheric lines as reference points, but found those he tried "too faint and shadowy;" he therefore set his wires alternately upon the east and west limbs of the sun, and measured the differences, obtaining for the velocity of the sun's rotation 1.42 miles per second, while the value derived from observations of sun-spots was 1.25.

*Vogel had sucessfully made the experiment in 1871 with small dispersion, but his results could not be very accurate quantitatively.

In the summer of 1877 Professor Young accepted a call to the professorship of astronomy at Princeton, with the assurance of a fine modern equipment and less time required for the class-room. His special appreciation of instruments and his well-balanced judgment as a teacher contributed to the establishment within a short time of the best astronomical observatory for the purposes of instruction then existing. By 1882 the excellent 23-inch Clark refractor was set up in the Halsted observatory, and provided with a powerful solar spectroscope for his own researches. But in spite of the energy necessarily required for this new construction, Professor Young was active in research as well as writing. In 1878 he conducted a Princeton party to Denver to observe the eclipse of July 29. It was the plan to investigate the spectrum of the corona and chromosphere, especially in the infra-red and ultra-violet, but the results, at this time of minimum solar activity, were less than had been expected, although the day was fine; the corona line and others were far less conspicuous than at eclipses during a solar maximum.

In the following year he made quite an extensive series of micrometric measures of the polar and equatorial diameters of Mars, using the excellent 9½-inch equatorial; the satellites were frequently seen with that instrument. Cometary spectra were also observed as they presented themselves in sufficient brightness, including Brorsen's (1879), Hartwig's (1880), and the great comets of 1881 and 1882.

The latitude and longitude of the students' observatory were carefully determined at about this time.

Professor Young contributed a number of admirable essays to the Princeton Review, having for their topics "The Recent Solar Eclipse," "Recent Progress in Solar Astronomy," "Practical Uses of Electricity," "Astronomical Facts and Fancies for Philosophical Thinkers," the last a lecture delivered before the Summer School of Christian Philosophy. All of these deserved a wider circulation than they probably received.

An extended program for the transit of Venus on December 6, 1882, was carried out under somewhat unfavorable conditions at Princeton, micrometric, spectroscopic, and photographic observations being included.

Professor Young contributed to the American Journal of Science two further papers, entitled "Spectroscopic Notes," in November, 1880, and November, 1883. Though brief, they are important. The first deals with the *H* line in the chromosphere; with the successful resolution of lines given on maps as common to two different elements ("basic lines"); with the distortion of solar prominences in a diffraction grating spectroscope, and deriving the formula therefor; he adds a note on an immense prominence, over 350,000 miles high. The second paper gives results with a powerful spectroscope of the Littrow type attached to the 23-inch telescope, whereby he resolved "the spot spectrum into a congeries of fine (dark) lines," an observation which has been fully confirmed with yet more powerful apparatus.

In 1892, when the Halsted Observatory received its new spectroscope by Brashear with a fine Rowland grating, Professor Young undertook the work of revising his list of chromospheric lines. Ill health and other causes delayed the work, so that it was never entirely completed, but it was published as "a partial revision" in 1894 in the edition in English of Scheiner's "Astronomical Spectroscopy." This was his last extensive piece of observational work on the sun. His other observations with the 23-inch telescope dealt with the planets, with certain double stars, and with the spectrum of *Nova Aurigæ*. He had at this time some exchange of opinion with a prominent English observer on the subject of large versus small telescopes. Admitting as "sadly true" the greater susceptibility of large instruments to atmospheric disturbances, he finds it also true—

"that I can almost always see with the 23-inch everything I can see with the 9½-inch under the same atmospheric conditions, and see it better—if the seeing is bad, only a little better; if good, immensely better . . . Under higher powers, also, markings which are conspicuous with lower ones often disappear in the same way that the naked-eye markings on the moon vanish in the telescope. Most commonly, however, when I have failed to see with the large instrument anything I supposed I saw with the smaller, it has turned out on examination that the larger instrument was right, and that imagination had constructed a story that was not true, by building up faintly visible details and hazy suggestions furnished by the smaller lens."

A beginning was made in stellar spectrographic work with the new instrument, using both a grating and prisms, but attacks of sciatica had reduced Professor Young's capacity for prolonged night work, and the lack of a regular research assistant at the Halsted Observatory prevented a continuance of investigations in the field.

Solar eclipses very naturally retained his interest and he was enabled by the generosity of friends to take a small party to Russia for the eclipse of August 19, 1887. The station selected by Professor Struve for this party was not very far from Moscow, but, like most other points along the track of totality, it suffered from very bad weather, and no observations were possible. However, the trip gave Professor Young an opportunity to visit the leading observatories of Europe, renewing many friendships and establishing new ones, and he gave a very interesting account of it in Scribner's Magazine for July, 1888, under the caption, "An astronomer's summer trip."

At the eclipse of May 28, 1900, Professor Young organized quite a large party from Princeton and established a station at Wadesboro, North Carolina. The weather was very favorable and excellent results were obtained, but the corona line was too faint for carrying out the program Professor Young had prepared.

During these years Professor Young was delivering many addresses, and he always took such responsibilities very seriously—unnecessarily so, indeed, in later life. A lecture upon a topic somewhat out of his regular line would often lie heavily upon him for weeks until satisfactorily worked out. His address as vice-president of Section A at the Buffalo meeting of the American Association for the Advancement of Science, in 1876, was upon the topic "American Astronomy: its history, present state, needs, and prospects"; as retiring president of the association, at the Philadelphia meeting, in 1884, he discussed "Pending Problems in Astronomy" in a masterly fashion.

He felt no shame in accurately popularizing science, and responded frequently to the requests of the editors of the magazines. To the North American Review he contributed articles upon such topics as "Astronomical collisions," "Theories regarding the sun's corona," "The newest telescope"; to the Forum, "College athletic sports," "Great telescopes," "The latest astronomical news." He summarized the advances from 1876 to 1886 in "Ten years' progress in astronomy," read before the New York Academy of Sciences. He delivered the principal address at the dedication of the Kenwood Observatory, at Chicago, in 1891. He contributed many brief notes to the New York Independent, and wrote many reviews for that weekly and for The Critic. He also occasionally wrote at the request of the editors of New York newspapers, which did not at that time crave sensational articles so much as now. Probably the financial stress, so familiar (and perhaps ultimately beneficial) in the experience of college teachers, was also a partial motive for some of these contributions.

He contributed for Professor Newcomb's admirable "Popular Astronomy" a statement of his views upon the constitution of the sun, and, at the request of Professor Vogel, editor of the third German edition of that work, he revised that statement to correspond with the increase of our knowledge up to 1904. This was also printed in English in the magazine "Popular Astronomy."

In 1884, in conjunction with Prof. E. C. Pickering, he edited for the Proceedings of the American Academy of Arts and Sciences the researches of the late Dr. Henry Draper on astronomical spectrum-photography.

Professor Young's reputation as an author, already well established by his many semi-popular articles, was widened still more on the appearance, in 1881, of his book, "The Sun," which at once took a commanding place among works of its class. While it is a volume constantly needed by specialists in solar physics, it is written in such a simple and interesting manner as to attract and hold the intelligent general reader. It has passed through several editions, and has been translated into foreign languages.

His rare experience as a teacher was finally crystallized in his "General Astronomy," which appeared in 1888, and was widely adopted in college use. It emphasized one of his fundamental pedagogical principles, that the things taught "must be correct and accurate as far as they go." It contains ideas suggestive to the investigator, as well as teacher and student, and did much to encourage accurate thinking on the part of pupils who have studied it. The successive issues of the book were altered and enlarged by notes until a revised edition was necessary in 1898. Nearly 30,000 copies of this work have been printed. It called, however, for some rather difficult thinking for students not specializing in science, and a more elementary book, entitled "The Elements of Astronomy" (with Uranography), appeared shortly thereafter and was used still more widely in schools and colleges. Responding to the demand for a work available for quite young pupils, the "Lessons in Astronomy" appeared in 1891, and over 60,000 copies have been sold. A text-book intermediate between the "General Astronomy" and the "Elements" was called for, and was issued in 1902 under the title of "Manual of Astronomy." It was a handsomer book than the "General" and omits little of importance that is contained in the latter. An edition, revised by his niece, Miss Anne S. Young, professor of astronomy in Mount Holyoke College, is now appearing.

The very considerable labor involved in the preparation of these text-books was not given at the expense of research, as the condition of his health had prevented him from much observing after the early nineties. By a strict regimen he kept in check the inroads of a very serious disease, from which his physician could pronounce him as practically recovered only a very short time before his death.

His influence as a teacher was greatly widened by the large use of his text-books, and the position of authority which they gave him carried with it the burden of an increasing correspondence and the answering of many queries from all sorts of readers. He was also consulted very generally by teachers planning new equipment, by young men undertaking spectroscopic work, and by the many who valued his scientific and educational experience.

Upon the establishment, in 1895, of the Astrophysical Journal he became a member of its advisory board, known at first as associate editors, later as collaborators, and he retained this connection until his death.

Insufficient allusion has been made to Professor Young's appreciation for and skill in mechanical matters. He devised an improved clock escapement which has performed satisfactorily for many years at Princeton, and a suggestion of his is incorporated in most of the conical pendulum driving clocks in use in this country. In practical astronomy he would have made more contributions had his time not been occupied with solar physics; but he proposed a method of investigating pivot errors, detected the serious effect of flexure in the "broken transit," and showed how it could be corrected, and investigated in his own way the color-correction of achromatic object-glasses. He also wrote on such physical topics as "Mr. Edison's dynamometer, dynamo-machine, and lamp," and he kept abreast with the new discoveries of physics and related branches of science.

Professor Young's personal characteristics were so obvious that it is hardly necessary to allude to them in addressing his contemporaries in the National Academy; to those who have missed the great opportunity of knowing him, it may be said that he was thoroughly infused with the true scientific spirit—ever ready to modify theory to accord with newly discovered facts, and to accept the revision of what were once the best data available as new information was obtained by experiment and observation. He was entirely free from the dogmatism that often grows upon men after they have long been looked up to as authorities upon a subject. His modesty, even humility, in the consideration of the great laws of nature was a true characteristic of his greatness. This impressed itself upon his thousands of students and upon the many auditors at his lectures. As a teacher, his methods and manner were simple and straightforward; his remarks were enlivened by a quaint humor which also pervades his writings. He took a genuine interest in his pupils, and it was remarkable how quickly he learned and retained the names of the members of the large classes which always attended his courses, attracted probably less by the subject than by the teacher, who was affectionately nicknamed "Twinkle."

Professor Young was small of stature, growing a trifle stout in later life; he was not especially fond of physical exercise and had no hobbies in the way of recreation, but he took a real interest in college sports. The writer has a very distinct mental picture of him in the early seventies, playing on his well-kept lawn the then popular game of croquet, for which several of his colleagues regularly gathered. He always aimed at skill in whatever he undertook. At Princeton he found recreation in whist, playing a good hand of an occasional evening.

The life in his home was ideal, and its gentle courtesy is remembered by the many who were welcomed to its cheer. Astronomers from foreign countries, traveling in America, always included a visit to Princeton in their itinerary when possible, of course far more to see the man than the excellent observatories under his charge.

Mrs. Young was a singularly attractive woman, who playfully diverted her husband's mind from his work when he was off duty, and by her devotion to him and attention to household details, gave him the opportunity for performing his many duties with as little disturbance as possible. Her failing health greatly depressed him, and her death in 1901 was a blow from which he could not recover. Other serious anxieties and sorrows came to him before this: the dangerous accident to his oldest son from an electric shock, causing paralysis from which recovery was long doubtful and never complete; the death of his daughter's husband, Prof. Hiram A. Hitchcock, of Dartmouth, after a short married life.

Upon reaching the age of seventy, in December, 1904, Professor Young sent to the trustees of Princeton his resignation, to be effective in the following June, when his service of twenty-eight years would be completed. Evidences of appreciation of his long and useful service, and of his own personality, came to him from all directions during the remainder of the academic year, and brought much quiet satisfaction to him. He was made professor emeritus, and also came under the provisions of the retirement fund of the Carnegie Foundation.

A farewell dinner, which brought out in a striking manner the unusual feeling of regard toward him on the part of his colleagues and the university authorities, was given him on May 17, 1905, and a handsome silver loving cup was presented to him. At commencement, a month later, the degree of doctor of laws was conferred upon him at Princeton, with further expressions of deep feeling.

The poem in the New York Sun by Robert Bridges, a former pupil, gives the real spirit of his teaching:

"THE ASTRONOMER.

The destined course of whirling worlds to trace;
To plot the highways of the universe,
And hear the morning stars their songs rehearse,
And find the wandering comet in its place:
This was the triumph written in his face,
And in the gleaming eye that read the Sun
Like open book, and from the spectrum won
The secrets of immeasurable space!

But finer was his mission to impart
The joy of learning, the belief that law
Is but the shadow of the power he saw
Alike in planet and in throbbing heart—
The hope that life breaks through material bars,
The faith in something that outlives the stars!"

He returned to his early home at Hanover, where his daughter, with her son, lived with him. The enfeebled condition of his health did not permit him to undertake much work, however, and he again was afflicted by the long illness and death of his daughter. During the last months of his life he was recovering from the Bright's disease which had beset him for years, and there was hope that he might have some period of health, but after a brief attack of pneumonia he died peacefully on January 3, 1908. He was survived by two sons, Charles Ira, of the Westinghouse Electric Company, and Frederick A., of the U. S. Coast and Geodetic Survey, and by his grandson, Charles Young Hitchcock.

Many honors naturally came to him during his career. He was made associate of the American Academy of Arts and Sciences in 1869, of the Royal Astronomical Society in 1872, and later of the Philosophical Societies of Manchester and of Cambridge, England, and of the Società degli Spettroscopisti Italiani. He became a member of the National Academy of Sciences in 1872, and of the American Philosophical Society in the same year. He was made a foreign correspondent of the British Association for the Advancement of Science in 1887. In 1891 he received the Janssen medal of the French Academy of Sciences for his spectroscopic researches. Honorary degrees were bestowed upon him liberally—that of doctor of philosophy by Pennsylvania in 1870, and by Hamilton in 1871; that of doctor of laws by Wesleyan in 1876, Columbia in 1887, Western Reserve in 1893, Dartmouth in 1903, and Princeton in 1905.

Throughout his whole life Professor Young retained the strong religious convictions of his youth: he was essentially a man of faith. There is an especial appropriateness in the inscription upon his tomb in the old cemetery at Hanover:

"For now we see through a glass, darkly; but then face to face."

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NOTE.—The portrait accompanying this memoir was taken at Princeton in April, 1897, and is the original for Harrison's painting.

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