

The Story of the Herschels

Anonymous

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THE STORY OF THE HERSCHELS

A FAMILY OF ASTRONOMERS.

SIR WILLIAM HERSCHEL
SIR JOHN HERSCHEL
CAROLINE HERSCHEL.

"Stars

Numberless, as thou seest, and how they move;
Each has his place appointed, each his course."

MILTON.

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PREFATORY NOTE

From the best available sources have been gathered the following biographical particulars of a remarkable family of astronomers--the Herschels.

They will serve to show the young reader how great a pleasure may be found in the acquisition of knowledge, and how solid a happiness in quietly pursuing the path of duty.

On the value of biography it is unnecessary to insist. It is now well understood that we may learn to make our own lives good and honest and true, by carefully and diligently following the example of the good and honest and true who have gone before us. And certain it is that the lessons taught by the lives of the Herschels are such as young readers will do well to lay to heart.

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THE STORY OF THE HERSCHELS.

CHAPTER I.

Of all the sciences, none would seem to yield a purer intellectual gratification than that of Astronomy. Man cannot but feel a sense of pleasure, and even of power, when, through the instruments constructed by his ingenuity, he finds himself brought within reach, as it were, of the innumerable orbs that roll through the domains of space. He cannot but feel a sense of pleasure, and even of power, when the telescope reveals to his gaze not only the worlds that constitute his own so-called Solar System, but the suns that light up the borders of the

Universe, system upon system, sun upon sun, covering the unbounded area almost as thickly as the daisies cover a meadow in spring. He cannot but feel a sense of pleasure, and even, of power, when he tracks the course of the flashing comet, examines into the physical characteristics of the Sun and Moon, and records the various phases of the distant planets. But if such be his feeling, it is certainly tempered with awe and wonder as he contemplates the phenomena of the heavens,--the beauty of the stars, the immensity of their orbits, the regularity with which each bright world performs its appointed course, the simplicity of the laws which govern its motions, and the mystery which attends its far-off existence. It has been said that "an undevout astronomer is mad;" and if Astronomy, of all the sciences, be the one most calculated to gratify the intellect, surely it is the one which should most vividly awaken the religious sentiment. Is it possible to look upon all those worlds within worlds, all those endless groups of mighty suns, all those strange and marvellous combinations of coloured stars, all those remote nebulous clusters,--to look upon them in their perfect order and government,--to consider their infinite number and astonishing dimensions,--without acknowledging the fulness of the power of an everlasting God, who created them, set them in their appointed places, and still controls them? Is it possible to be an astronomer and an atheist? Is it possible not to see in their relations to one another and to our own little planet an Almighty Wisdom as well as an Almighty Love? Could any "fortuitous concourse of atoms" have strewed the depths of space with those mighty and beautiful orbs, and defined for each the exact limits of its movements? Alas! to human folly and human vanity everything is possible; and men may watch the stars in their courses, and delight in the beauty of Sun and Moon, and perceive all the wonders of the sunrise and all the glories of the sunset, without any recognition in their hearts of Him who made them--of Him in whom we and they alike live and move and have our being! Yet it is not the less true that only the devout and thankful heart can adequately and thoroughly sympathize with the love and wisdom and power which are written in such legible characters on the face of heaven. Astronomy gives up all its treasures only to him who enters upon its study in a reverent spirit. It affords the purest intellectual gratification only when its pursuits are undertaken with a humble acknowledgment of the littleness of man and the greatness of God. Half the wonder, half the mystery of creation is lost, when we fail to recognize the truth that it is governed by eternal laws springing from an Almighty Intelligence. Take the Creator out of creation, and it becomes a hopeless puzzle--a dreary problem, incapable of solution. But we restore to it all its brightness, all its beauty, all its charm, when we are able to lift up our hearts with the Psalmist and to say: "Praise ye the Lord. Praise ye the Lord from the heavens; praise him in the heights. Praise ye him, sun and moon: praise him, all ye stars of light. Let them praise the name of the Lord: for his name alone is excellent: his glory is above the earth and heaven."

And it is to be observed that the soul cannot be satisfied without this religious view of Nature. The heavens and the earth are as nothing to man, if they do not excite his awe and call forth his thanksgiving. We might almost suppose that it is for this purpose that the sea rolls its waves on the shore, and the violet smiles by the wayside, and the moon floods the night with its silver radiance. As a recent writer has observed,[1] the beauty of Nature is necessary for the perfection of praise; without it the praise of the Creator would be essentially weakened; our hearts must be roused and excited by what we see. "It may seem extraordinary," adds our authority, "but it is the case, that, though we certainly look at contrivance or machinery in Nature with a

high admiration, still, with all its countless and multitudinous uses, which we acknowledge with gratitude, there is nothing in it which raises the mind's interest in nearly the same degree that beauty does. It is an awakening sight; and one way in which it acts is by exciting a certain curiosity about the Deity. In what does God possess character, feelings, relations to us?--all unanswerable questions, but the very entertainment of which is an excitement of the reason, and throws us upon the thought of what there is behind the veil. This curiosity is a strong part of worship and of praise. To think that we know everything about God, is to numb and deaden worship; but mystical thought quickens worship, and the beauty of Nature raises mystical thought. So long as a man is probing Nature, and in the thick of its causes and operations, he is too busy about his own inquiries to receive this impress from her; but place the picture before him, and he becomes conscious of a veil and curtain which has the secrets of a moral existence behind it,--interest is inspired, curiosity is awakened, and worship is raised. 'Surely thou art a God that hidest thyself.' But if God simply hid himself and nothing more, if we knew nothing, we should not wish to know more. But the veil suggests that it is a veil, and that there is something behind it which it conceals."

[Footnote 1: Professor Mozley, "University Sermons," pp. 145, 146.]

Now, this is the feeling which the study of Astronomy very certainly awakens. Every day the astronomer discovers something which quickens his curiosity to discover more. Every day he catches new glimpses of the Almighty Wisdom, which stimulate his desire for a further revelation. And all he learns, and all he anticipates learning, combine to produce in him an emotion of awe. What grandeur lies before him in that endless procession of worlds--in that array of suns and stars extending beyond the limits of the most powerful telescopic vision! How marvellous it is! How beautiful! Observe the combination of simplicity with power; note how a great principle of "law" underlies the apparent intricacy of eccentric and intersecting orbits. And then the field of inquiry is inexhaustible. The astronomer has no fear of feeling the satiety of an Alexander, when he lamented that he had no more worlds to conquer. What Newton said of himself is true of every astronomer,--he is but as a child on the sea-shore, picking up a shell here and a shell there, but unable to grasp a full conception of the mighty ocean that thunders in his ears!

And, therefore, because Astronomy cherishes the feelings of awe and reverence and praise, because it inspires a continual yearning after additional knowledge, because it reveals to us something of the character of God, we conceive that of all the sciences it affords the purest intellectual gratification. Certainly it is one of the most absorbing. Its attraction seems to be irresistible. Once an astronomer, always an astronomer; the stars, we may fancy, will not relax the spell they lay upon their votary. He willingly withdraws himself from the din and gaiety of social life, to shut himself up in his chamber, and, with the magic tube due to the genius of a Galileo, survey with ever-new delight the celestial wonders. So was it with Tycho Brahe, and Copernicus, and Kepler; so was it, as the following pages will show, with that remarkable family of astronomers--astronomers for three generations--the HERSCHELS.

CHAPTER II.

In the quiet city of Hanover, nearly a century and a half ago, lived a professor of music, by name Isaac Herschel, a Protestant in religion, though presumably of Jewish descent. He had been left an orphan at the early age of eleven, and his friends wished him to adopt the vocation of a landscape-gardener; but being passionately fond of music, and having acquired some skill on the violin, he left Dresden, his birthplace, in order to seek his fortune; wandering from place to place, until at Hanover, in 1731, he obtained an engagement in the band of the Guards. Soon afterwards he married; and by his wife, Anna Ilse Moritzen, had ten children, four of whom died in infancy. Of the others, two--a brother and a sister--lived to distinguish themselves by their intellectual power; and all true lovers of science will regard with reverence the memories of William and Caroline Herschel.

Frederick William Herschel was born on the 15th of November 1738. Like his father, he displayed an innate musical ability, which was sedulously cultivated and constantly developed; while his general mental training was left to the care of the master of the garrison-school. Those who are gifted with a love and a capacity for music sometimes show to little advantage in other pursuits; but such was not the case with William Herschel, who progressed so rapidly in all his studies that the pupil soon outstripped the teacher. Although, we are told, four years younger than his brother Jacob, the two began French together, and William mastered the language in half the time occupied by his senior. His leisure time out of school, when not given up to practice on the oboe and the violin, was devoted to the acquisition, of Latin and arithmetic.

His father in 1743 was present at the battle of Dettingen; and the exposure consequent on a night spent on the rain-soaked battle-field afflicted him with an asthmatic complaint and a partial paralysis of the limbs, which darkened for years the musician's peaceful household. He himself, however, was greatly cheered by the musical proficiency of his two sons, and the intellectual refinement of Frederick William. "My brothers," says Caroline Herschel, "were often introduced as solo performers and assistants in the orchestra of the court; and I remember that I was frequently prevented"--she was then a child about five years old--"from going to sleep by the lively criticism on music on [their] coming from a concert, or conversations on philosophical subjects, which lasted frequently till morning, in which my father was a lively partaker, and assistant of my brother William by contriving self-made instruments." She adds that she often kept herself awake in order to listen to their animating remarks, feeling inexpressibly happy in _their_ happiness,--an indication of that devoted and unselfish affection which afterwards consecrated her whole life. But, generally, their conversation branched out into philosophical subjects; and father and son argued with so much fervour, that the fond mother's interference became necessary,--the immortal names of Leibnitz, Newton, and Euler ringing with a clarion-like peal that boded ill for the repose of the younger members of the family. "But it seems," says Caroline, "that on the brothers retiring to their own room, where they shared the same bed, my brother William had still a great deal to say; and frequently it happened that, when he stopped for an assent or a reply, he found his hearer had gone to sleep; and I suppose it was not till then that he bethought himself to do the same. The recollection of these happy scenes confirms me in the belief that, had my brother William not then been interrupted in his philosophical pursuits, we should have had

much earlier proofs of his inventive genius. My father," she continues, "was a great admirer of astronomy, and had some knowledge of that science; for I remember him taking me, on a clear frosty night, into the street, to make me acquainted with several of the most beautiful constellations, after we had been gazing at a comet which was then visible. And I well remember with what delight he used to assist my brother William in his various contrivances in the pursuit of his philosophical studies; among which was a neatly-turned four-inch globe, upon which the equator and ecliptic were engraved by my brother."

* * * * *

In 1755, the tranquil family circle was broken up--the Hanoverian regiment in whose band William and Jacob were engaged having been ordered to England. The parting was very sorrowful; for the invalid father had derived much support as well as enjoyment from the company of his sons. At first, the English experiences of the young Germans were somewhat severe. They endured all the pangs of poverty; pangs endured with heroic composure, while William relaxed not a whit in his devotion to the pursuit of knowledge. Happily, however, his musical proficiency attracted the attention of Lord Durham, who offered him the appointment of bandmaster to a militia regiment stationed in the north of England. In this position he gradually formed a connection among the wealthier families of Leeds, Pontefract, and Doncaster, where he taught music, and conducted the public concerts and oratorios with equal zeal and success. In 1764 he paid a brief but happy visit to his family, much to the joy of his faithful sister, Caroline. Returning to England, for which country he cherished a strong affection, he resumed his career of patient industry, and in 1765 was appointed organist at Halifax. He was now in receipt of an income which secured him due domestic comforts, and enabled him to remedy the defects of his early education. With the help of a grammar and a dictionary he mastered Italian. He also studied mathematics and the scientific theory of music, losing no opportunity of adding to his stores of knowledge.

In 1766 he obtained the lucrative post of organist to the Octagon Chapel at Bath. Increased emoluments, however, brought with them increased obligations. He was required to play almost incessantly, either at the oratorios or in the rooms at the Baths, at the theatre, and in the public concerts. When his sister Caroline joined him, in 1772, she found him immersed in his various labours. For the choir of the Octagon Chapel he composed anthems, chants, and complete morning and evening services. A part of every day was occupied in giving lessons to his numerous pupils. In truth, he was one of the busiest men in England; yet in all his arrangements he was so methodical that he found time for everything--and time, more particularly, for the studies in which his soul delighted. His life furnishes an admirable example of what may be accomplished by a man with a firm will and a strong purpose, who sets before himself an end to be attained, and controls all his efforts towards its attainment. He toiled so hard as a musician, because he wanted to be something more. Every spare moment of the day, and frequently many hours of the night, he gave up to the pursuits which were gradually leading him into the path best fitted for his genius. The study of mathematics proved but a preliminary to the study of optics; and an accident made him once for all an astronomer.

A common two-foot telescope falling into his hands, revealed to him the wonders of the heavens. His imagination was inspired by their contemplation; with ever-increasing enthusiasm he gazed on the revolving

planets, on the flashing stars; he determined to fathom more profoundly the constellated depths. A larger instrument was necessary, and Herschel wrote to London for it; but the price demanded proved far beyond the resources of the sanguine organist. What should he do? He was not the man to be beaten back by a difficulty: as he could not buy a telescope, he resolved to make one; an instrument eighteen or twenty feet long, which would reveal to him the phases of the remotest planets. And straightway the musician entered on a multitude of ingenious experiments, so as to discover the particular metallic alloys that reflected light with the greatest intensity, the best means of giving the parabolic figure to the mirrors, the necessary degree of polish, and other practical details. In his eager pursuit he enlisted the services of his loving and intelligent sister. "I was much hindered in my musical practice," she writes, "by my help being continually wanted in the execution of the various contrivances; and I had to amuse myself by making the tube of pasteboard for the glasses which were to arrive from London--for at that time no optician had settled at Bath. But when all was finished, no one besides my brother could get a glimpse of Jupiter or Saturn, for the great length of the tube would not allow it to be kept in a straight line. This difficulty, however, was soon removed, by substituting tin tubes."

The work went on famously, as might be expected from so much ardour, perseverance, and ingenuity. Of a Quaker resident at Bath, the musician-astronomer purchased a quantity of patterns, tools, hones, polishers, and unfinished mirrors. Every room in the house was converted into a workshop. In a handsomely-furnished drawing-room might be seen a cabinetmaker constructing a tube and stands of all descriptions; while Herschel's brother Alex was engaged in a bedroom in putting up a gigantic turning-machine. Meantime, the claims of music could not be ignored: there were frequent rehearsals for the public concerts; lessons to pupils; the composition of glees and catches, and the like; the superintendence of the practice of the chapel choir; and the study of sonatas and concertos for public performance. But all the leisure that could be made or stolen was occupied in labours which proved their own reward. Straight from the concert-platform rushed the musician to his workshop, and many a lace ruffle was torn by nails or bespattered by molten pitch; to say nothing of the positive danger to which Herschel continually exposed himself by the precipitancy of his movements. For example: one Saturday evening, when the two brothers returned from a concert between eleven and twelve o'clock, William amused himself all the way home with the idea of being at liberty to spend the next day, except the few hours' duty at chapel, at the turning-bench; but recollecting that the tools wanted sharpening, they ran with them and a lantern to their landlord's grindstone in a public yard, where, very naturally, they did not wish to be seen on a Sunday morning. But William was soon brought back by his brother, almost swooning with the loss of one of his finger-nails.

This incident took place in the winter of 1775, at a house situated near Walcot turnpike, to which Herschel had removed in the summer of the previous year. Here, on a grass plot behind the house, he made active preparations for the erection of a twenty-foot telescope. So assiduous was his devotion to this work, that while he was engaged in polishing the mirror, his sister was constantly obliged to feed him by putting his victuals into his mouth. Otherwise he would have reduced himself to a condition of positive emaciation! Once, when finishing a seven-foot mirror, he did not take his hands from it for sixteen consecutive hours; for in these days machinery had not been devised as a substitute for

manual toil. He was seldom unemployed at meals; but at such times employed himself in contriving or making drawings of whatever occurred to his fertile fancy. Usually his sister Caroline read to him while he was engaged at the turning-lathe, or polishing mirrors; choosing such books as "Don Quixote," the "Arabian Nights," the novels of Sterne and Fielding; and tea and supper were served without any interruption to the task in which Herschel was absorbed.

In Miss Herschel's charming letters we find a vivid sketch of the family avocations at this period:---

"My brother applied himself to perfect his mirrors, erecting in his garden a stand for his twenty-foot telescope: many trials were necessary before the required motions for such an unwieldy machine could be contrived. Many attempts were made by way of experiment against a mirror before an intended thirty-foot telescope could be completed, for which, between whiles (not interrupting the observations with seven, ten, and twenty-foot, and writing papers for both the Royal and Bath Philosophical Societies), gauges, shapes, weights, &c, of the mirror were calculated, and trials of the composition of the metal were made. In short, I saw nothing else and heard nothing else talked of but about these things when my brothers were together. Alex was always very alert, assisting when anything new was going forward; but he wanted perseverance, and never liked to confine himself at home for many hours together. And so it happened that my brother William was obliged to make trial of my abilities in copying for him catalogues, tables, &c, and sometimes whole papers which were lent [to] him for his perusal. Among them was one by Mr. Michel, and a catalogue of Christian Mayer in Latin, which kept me employed when my brother was at the telescope at night. When I found that a hand was sometimes wanted when any particular measures were to be made with the lamp micrometer, or a fire to be kept up, or a dish of coffee necessary during a night's long watching, I undertook with pleasure what others might have thought a hardship."

The astronomer-musician's patient survey of the heavens was rewarded, on the 13th of March 1781, by the discovery of a new planet, situated on the borders of our Solar System. In every way this was a discovery of signal importance. It broke up the traditional conservatism of astronomers, which had almost refused to regard as possible the existence of any planets beyond the orbit of Saturn, because for so many years none had revealed themselves to the watchful gaze. Men's minds were widened, so to speak, at a bound; their conceptions strengthened and enlarged; for the discovery of Georgium Sidus--as the new planet was designated by its discoverer, in honour of George III.--rendered possible and probable the discovery of other planets, and thus extended immeasurably the limits of the Solar System. Herschel, whose reputation as a musician had hitherto been local, now sprang into world-wide fame as an astronomer. George III., who was a true lover of science, and not disinclined to bestow his patronage on men and things of Hanoverian origin, summoned him to his presence; and was so much pleased with his modest and interesting account of the long labours which had led to the great result, that, after a brief interval, he bestowed upon him an annual pension of three hundred guineas, and a residence, first at Clay Hall, and then at Slough.

But before this well-deserved good fortune fell to him, Herschel continued his industrious career as both musician and astronomer. During the concert season, which lasted five or six months, he had never a night disengaged, but was conducting oratorios at Bath or Bristol, arranging for public concerts, attending rehearsals, and superintending the performances of his choir. As soon as a lull came, the indomitable man, assisted by his faithful sister, returned to his astronomical pursuits. To gain a fuller and clearer knowledge of the starry worlds scattered over the vast fields of space, Herschel from the first had seen that instruments of much greater power were necessary than any hitherto used by astronomers. He set to work, therefore, on the construction of a thirty-foot telescope; the metallic mirror of which must, of course, be of proportionate dimensions. This huge mirror was to be cast in a mould of loam prepared from horse-dung, of which an immense quantity was to be pounded in a mortar, and sifted through a fine sieve; an arduous and almost endless task, undertaken by Caroline Herschel and her brother Alex. Then a furnace was erected in a back-room on the ground-floor; and every preparation having been made, a day was set apart for the casting. The day came, and Herschel and his collaborateurs looked forward to the consummation of their hopes. The metal was placed in the furnace; but, unfortunately, just when it was ready for pouring in a molten stream into the mould, it began to leak, and both the Herschels, and the caster with his men, were compelled to fly from the apartment, the stone flooring exploding, and flying about in all directions, as high as the ceiling. The astronomer, exhausted with heat and exertion, fell on a heap of brickbats; exhausted, but not dismayed. The work was renewed; and a second casting being attempted, it proved entirely successful, and a very perfect metal was formed in the mould.

CHAPTER III.

In August 1782 the Herschels removed to Datchet. Their new home was "a large neglected place; the house in a deplorably ruinous condition, the garden and grounds overgrown with weeds." Nor were the domestic arrangements more favourable. For a fortnight the little family were without a female servant; and an old woman, the gardener's wife, showed Miss Herschel the shops, where the high prices of every article, from coals to butcher's meat, appalled her. But of these inconveniences Herschel took no account. Enough for him that he was released from the drudgery of teaching, and free thenceforth to devote himself to the heavens and their wonders. A man whose thoughts are always with the stars can hardly be expected to trouble himself about the price of tallow-candles! Were there not capacious stables in which mirrors of any size could be ground; and a roomy laundry capable of easy conversion into a library, with one door opening on a large lawn, where the "small twenty-foot" was to take its stand? Compared with advantages such as these, what mattered the scarcity of "butcher's meat"? Herschel laughingly assured his sister that they could live on eggs and bacon; which, he confidently asserted, would cost next to nothing, now that they were really in the country!

And so he settled down to a life of quiet, industry at Datchet; his admirable sister being formally adopted as his assistant and secretary.

Never had master a more devoted, a more enthusiastic, or a more intelligent servant! She shared in all his night-watches, with her eye constantly on the clock, and the pencil in her hand; with unerring accuracy she made all the complex calculations so frequently required; she made three or four copies of every observation in separate registers, co-ordinating, classifying, and analyzing them. If the scientific world, says Arago, saw with astonishment the unexampled rapidity with which Herschel's works succeeded one another for many years, they were greatly indebted for this affluence of production to the affectionate ardour of his sister Caroline. Her enthusiasm never failed; her industry knew no check; and her brother's fame was dearer to her than life.

In one of her letters she describes with graphic simplicity the "interior" at Datchet:--

"I found that I was to be trained for an assistant-astronomer; and by way of encouragement, a telescope adapted for 'sweeping' (or rapidly surveying a wide extent of space), consisting of a tube with two glasses, was given [to] me. I was to 'sweep for comets;' and I see by my journal that I began August 22nd, 1782, to write down and describe all remarkable appearances I saw in my 'sweeps.' But it was not till the last two months of the same year that I felt the least encouragement to spend the starlit nights on a grass-plot covered with dew or hoar-frost, without a human being near enough to be within call. I knew too little of the real heavens to be able to point out every object so as to find it again without losing too much time by consulting the Atlas. But all these troubles were removed when I knew my brother to be at no great distance, making observations with his various instruments on double stars, planets, and the like; and I could have his assistance immediately when I found a nebula, or cluster of stars, of which I intended to give a catalogue. I had the comfort to see," she continues, "that my brother was satisfied with my endeavours to assist him when he wanted another person either to run to the clocks, write down a memorandum, fetch and carry instruments, or measure the ground with poles,--of which something of the kind every moment would occur."

The conscientious care and assiduous industry with which Herschel made his measurements of the diameter of the Georgium Sidus (now called Uranus), and his interesting observations of other planets, of double stars with their coloured light, of cometary and nebulous appearances, were truly remarkable; as may be seen by the various papers which he wrote at this time for the Royal Society. In addition to all this labour, he perfected a twelve-inch speculum of vast magnifying power before the spring of 1784; and many hours were spent at the turning-bench, as not a night clear enough for observing ever passed without the devising of improvements in the mounting and motion of the various instruments then in use, or the test and trial of newly-constructed "eyepieces," most of which were executed by Herschel's own hands. "Wishing to save his time, he began to have some work of that kind done by a watchmaker, who had retired from business, and lived on Datchet Common; but the work was so bad, and the charges [were] so unreasonable, that he could not be employed. It was not till some time afterwards, in his frequent visits to the meetings of the Royal Society (made in moonlight nights), that he had an opportunity of looking about

for mathematical workmen, opticians, and founders. But the work seldom answered expectation, and it was kept to be executed with improvements by Alexander during the few months he spent with us."

* * * * *

In July 1783 Herschel began his observations with his large twenty-foot telescope, though it was in an unfinished state; and his sister watched and waited with much apprehension when she knew him to be elevated some fifteen feet or more on a temporary crossbeam instead of a safe gallery. Here it is needful to explain, perhaps, that these huge astronomical telescopes are not used like ordinary glasses, to one end of which the observer applies his eye; the objects towards which the tube is directed being thrown upon a large mirror, which is attached to it externally at some distance from the ground. The observer, therefore, needs to be mounted on an elevated platform or gallery, from which he can conveniently inspect the mirror. One night, in a very high wind, Herschel had scarcely descended from his station before the whole apparatus came down; and his sister was in continual apprehension of some serious accident. One such, indeed, occurred, and to herself. The evening of the 31st of December had been cloudy, but as a few stars shone forth about ten o'clock, hurried preparations were made for observing. Herschel, standing at the front of the telescope, directed his sister to make a certain alteration in the lateral motion, which was done by machinery, on which the point of support of the tube and mirror rested. At each end of the machine or trough was an iron hook, such as butchers use for suspending their joints of meat; and having to run in the dark across ground covered a foot deep with melting snow, Miss Herschel fell on one of these hooks, which entered her right leg above the knee. To her brother's injunction, "Make haste!" she could answer only by a pitiful cry, "I am hooked!" He and the workmen hastened immediately to her assistance, but they could not disentangle her without leaving nearly two ounces of her flesh behind. For some weeks she was an invalid, and at one time it was feared that amputation might be necessary.

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Not satisfied with the magnifying power of any of the instruments he had hitherto constructed, Herschel resolved, in 1784, to attempt a forty-foot telescope. Such a work, however, was far beyond his limited private resources; and he did not venture to undertake it until promised a royal bounty of L2000. Then he removed from Datchet to Clay Hall, Old Windsor; and again, in 1786, to Slough, where he finally settled, and succeeded in erecting a commodious and well-equipped observatory. "We may confidently assert," says Arago, "relative to the little house and garden of Slough, that it is the spot of all the world where the greatest number of discoveries have been made. The name of that village will never perish: science will transmit it religiously to our latest posterity."

At Slough, as at Datchet, prevailed the most enthusiastic industry; and the house was soon as full of well-ordered labour as a bee-hive. Smiths were kept constantly at work on different parts of the new telescopic leviathan; and a whole troop of labourers was engaged in grinding the tools required for shaping and polishing its mirror. Had not a cloudy or moonlight night sometimes intervened, Herschel and his sister must have died of sheer exhaustion, for they toiled with unremitting ardour both day and night. With the morning came the workpeople, of whom no fewer

than between thirty and forty were at work for upwards of three months together: some employed in felling and rooting out trees, some digging and preparing the ground for the bricklayers, who were laying the foundation for the telescope. Then there were the carpenter and his men; and, meanwhile, the smith was converting a wash-house into a forge, and manufacturing complete sets of tools for his own share of the labour. In short, the place was at one time a complete workshop for the manufacture of optical instruments; and it was a pleasure to enter it for the purpose of observing the fervour of the great astronomer, and the reverent attention given to his orders.

It is impossible not to refer here to the sisterly devotion of Caroline Herschel, who was in every respect worthy of her noble-minded, tender-hearted, and enthusiastic brother.

She stood beside him to the last, sharing his labours, brightening his life. In the days, says her biographer, when Herschel gave up a lucrative career that he might dedicate all his energies to astronomical pursuits, it was through her care and thriftiness that he was spared from the unrest of pecuniary anxieties. As she had been his helper and assistant during his career as a popular musician, so she became his helper and assistant when he gave himself up, like the Chaldeans of old, to the study of the stars. By dint of a resolute will and a love that shrank from no sacrifice or exertion, she acquired such a knowledge of mathematics and calculations, mysterious as these generally seem to the feminine mind, that she was able to formulate with exactness the result of her brother's researches. She never failed to be his willing fellow-labourer in the workshop; she helped him to grind and polish his mirrors; she stood beside his telescope, in order to record his observations, during the dark and bitter mid-winter nights, when the very ink was frozen in the bottle. It may be said, without exaggeration, that she kept him alive by her care: thinking nothing of herself, she lived for him, and him alone. She loved him, she believed in him, she aided him with all her heart and all her strength. Her mental powers were very considerable; and undoubtedly she might have attained to eminence on her own account, for she herself discovered no fewer than eight comets. But she shunned self-glorification; she desired to live in her brother's shadow; she worked for him, never for herself; and in her elevated character no feature more strongly demands our admiration than her heroic though unconscious self-denial. Happy the man who has such a sister; happy the sister whose brother is worthy of so much devotion! It is pleasant to know that William Herschel deserved the love so lavishly poured out at his feet; that great as were his achievements in science, lofty and broad as was his genius, they were fully sustained and ennobled by the beauty and worth of his inner life. Who can contemplate their twofold career in all its singleness of purpose, its purity, its unselfishness, its sublime disregard of worldly pleasures, without emotion? The lessons told by such a life are worth all the moral treatises ever written.

To Miss Herschel's diary we again refer, for a glimpse of the occupations of her brother and herself at Slough in the first two years of their residence. These two years, to use an apt expression of her own, were spent in a perfect chaos of business. The garden and workrooms swarmed with labourers and workmen--smiths and carpenters speeding to and fro between the forge and the forty-foot machinery; and so incessant was the vigilance of Herschel, that not a screw-bolt in the whole apparatus was fixed except under his eye. "I have seen him," writes his sister, "lying stretched many an hour in the burning sun, across the top

beam, whilst the iron-work for the various motions [of the great telescope] was being fixed." At one time no fewer than twenty-four men, in relays of twelve each, were engaged in grinding and polishing day and night; and Herschel never left them, taking his food without allowing himself time to sit down to table.

"In August 1787," writes the diarist, "an additional man-servant was engaged, who would be wanted at the handles of the motions of the forty-foot,"--that is, to raise or lower it, or move it from side to side, as might be required,--"for which the mirror in the beginning of July was so far finished as to be used for occasional observations on trial. Such a person was also necessary for showing the telescopes to the curious strangers, as by their numerous visits my brother and myself had for some time past been much incommoded. In consequence of an application made through Sir J. Banks to the king, my brother had in August a second sum of L2000 granted for completing the forty-foot, and L200 yearly for the expense of repairs; such as ropes, painting, &c., and the keep and clothing of the men who attended at night. A salary of L50 a year was also settled on me, as an assistant to my brother. A great uneasiness was by this means removed from my mind; for though I had generally (and especially during the last busy six years) been almost the keeper of my brother's purse, with a charge to provide for my personal wants, only annexing in my accounts the memorandum '_For Car_' to the sums so laid out. When cast up, they hardly amounted to seven or eight pounds per year since the time we had left Bath. Nothing but bankruptcy had all the while been running through my silly head, when looking at the sums of my weekly accounts, and knowing they could be but trifling in comparison with what had been and had yet to be paid in town. I will only add, that from this time the utmost activity prevailed to forward the completion of the forty-foot."

In recognition of his scientific triumphs, the honorary degree of LL.D was conferred upon Herschel, in 1786, by the University of Oxford. They were triumphs that well merited such a recognition. He had already made some important observations on the nature of double stars, on the dimensions of the telescopic planets, and had begun his famous investigations into the composition of the nebulae,--those clusters of stars and nebulous matter which had previously proved such a problem to astronomers. The remarkable phenomenon of a periodical change of intensity in certain stars, which wax and wane in radiance like a revolving light, had also excited his attention. Further, he had entered upon the experiments which ultimately showed that the Sun positively moves; that in this, as in other respects, the magnificent orb of day must be ranged among the stars; that the apparently inextricable irregularities of numerous sidereal proper motions arise in great part from the displacement of the Solar System; that, in short, the point of space toward which Earth and its sister planets are annually advancing, is situated in the constellation of Hercules.

"Let us," says a French writer, "to these immortal labours add the ingenious ideas that we owe to Herschel on the nebulae, on the constitution of the Milky Way, on the Universe as a whole,--ideas which almost by themselves constitute the actual history of the formation of the worlds,--and we cannot but have a deep reverence for that powerful genius that scarcely ever erred, notwithstanding the ardour of its

imagination."

The ordinary spectator, looking upon the face of the heavens through a telescope, had, prior to Herschel's time, felt his curiosity excited by the appearance here and there of filmy patches, vague in structure and irregular in shape, which, from their resemblance to clouds, received the name of *_nebulae_*. What these were, no astronomer had succeeded in defining. It was left for Herschel, with his rare powers of patient and discriminating observation, assisted by the more powerful instruments which his ingenuity succeeded in constructing, to discern in them innumerable groups of worlds, in various stages of formation! A new light was thrown upon the history of the Universe. Man was able to assist, as it were, at the process of creation, and to watch the development of a mass of incoherent matter into a perfect star. This alone was a discovery which might well have immortalised the name of Herschel.

But we owe to him the elements of our knowledge of the Sun's physical constitution. He swept aside the erroneous theories and conjectures which had previously prevailed, and guided the astronomical inquirer into the right path. He convinced himself, by long and patient researches, that the luminous envelope of the great "orb of day" was neither a liquid nor an elastic fluid; that it was in certain respects analogous to the clouds which wreath our mountain-summits and fertilize our plains; that it floated in the solar atmosphere. Thence he came to the conclusion that the Sun has two atmospheres, endowed with motions quite independent of each other. An elastic fluid, now known as the *_photosphere_*, is in course of continual formation on the dark rugged surface of the solar mass; and rising, on account of its specific lightness, it forms the *_pores_* in the stratum of reflecting clouds; then, combining with other gases, it produces the irregularities or furrows in the luminous cloud-region. When the ascending currents are powerful, they create those appearances which astronomers designate the *_nuclei_*, the *_penumbrae_*, the *_faculae_*.

Such was Herschel's explanation of the mode of formation of the solar spots; and allowing it to be well-founded, we must expect to find--what is, indeed, the case--that the Sun does not always and regularly pour forth equal quantities of light and heat. It is true that Herschel's hypothesis has been modified by later astronomers; but his is the credit of having directed them into the right course of inquiry and observation.

* * * * *

The physical constitution of the Moon was a subject which also engaged the attention of our indefatigable enthusiast. As early as 1780 he attempted the measurement of the lunar mountains, and came to the conclusion that few of them exceeded 2600 feet in height. Later research, however, has proved these figures to be inadequate. Next he addressed himself to a study of the lunar volcanoes, three of which he declared to be in a state of ignition; two of them apparently on the decline, the third still active. He was so convinced of the reality of the phenomenon, that on the 20th of April 1787 he wrote:--"The volcano burns with greater violence than it did last night." The real diameter of the volcanic light he estimated at 16,400 feet. Its intensity he described as superior to that of the nucleus of a comet then flashing across our system. The objects situated near the crater were fully illuminated by the glare of its burning matter.

It may seem strange that, after observations so exact and minute, few astronomers now admit the existence of active volcanoes in the Moon. The reasons for their incredulity are thus stated:--

The various parts of the Moon do not all reflect with the same intensity. Here, that intensity may be dependent on the form; elsewhere, on the nature of the materials. Those persons who have examined the lunar orb with telescopes, know how very considerable the difference arising from these two causes may be,--with how much keener and stronger a radiance one point of the Moon will sometimes shine than those around it. Well, it would seem to be obvious that the ratio of intensity between the brilliant parts and the faint parts must always be the same, whatever the origin of the illuminating light. In that portion of the lunar sphere which receives the glow and glory of the sun, we know that some points exist, the brightness of which is extraordinary compared with the feeble flickering gleam of those around them. And these same points, when seen in the dim reflection of the Earth, will still predominate in intensity over the neighbouring regions. In this way Arago and others explain the observations of Herschel, without admitting the existence of active volcanoes in the Moon. That volcanoes there are, is a familiar fact; but they would seem to have exhausted their activity in long-past ages. The lunar surface is now a dreary waste of rugged lava and ashes, covered with the matter ejected from craters once in a state of furious eruption. The Moon, in fact, is a world which has burned itself out. How strange the thought that in a far-back period the inhabitants of Earth, had Earth then been inhabited, might have seen the glare of countless volcanoes diffused, lurid and threatening, over the face of their satellite! How strange the thought that the once active fires should all have died away, and the Moon have thus been prepared for the better reception and reflection of the solar radiance in order to illuminate the nights of Earth!

The planets, needless to say, were the objects of Herschel's assiduous attention. Mercury was the one which least interested him; but he ascertained the perfect circularity of its disc. With respect to Venus, he endeavoured to determine the time of its rotation from 1777. We owe to him the discovery of the true shape of the "red planet Mars,"--that, like the Earth, it is an oblate spheroid, or flattened at the poles. After Piazzi, Olbers, and Harding had discovered the small planets, Ceres, Pallas, Juno, and Vesta, he applied himself to the measurement of their angular diameters. His researches led him to the conclusion that these four new bodies could not properly be ranked with the planets, and he proposed to call them Asteroids--a name now generally adopted. Since Herschel's time, the number of these minor planets known to astronomers has increased to upwards of one hundred.

With respect to Jupiter, our astronomer arrived at some important facts in connection with the duration of its rotation. He also made numerous observations on the intensities and comparative magnitudes of its satellites.

We come next in order to Saturn, the gloomy planet which the ancient astrologers regarded with so much dislike. Here, too, we find traces of Herschel's labours. Not only has he enlarged our knowledge of its equatorial compression, of its physical constitution, and of the rotation of its luminous belt or ring, but he added two to the number of its satellites. Five only of these were known at the close of the seventeenth century; of which Cussiric discovered four, and Huygens one.

It was universally believed that the subject was exhausted.

But, on the 28th of August 1780, Herschel's colossal tube revealed to his delighted gaze a satellite nearer to the Saturnian ring than those previously observed. And a few days later, on the 17th of September, a seventh and last satellite crossed his field of vision. It was situated between the former and the ring; that is, it is the nearest to it of the seven.

But the most remarkable of Herschel's achievements was the discovery of the planet Uranus, and the detection of its satellites.

On the 13th of March 1781, between ten and eleven o'clock at night, the great astronomer was engaged in examining the small stars near H in the constellation Gemini, with a seven-foot telescope, bearing a magnifying power of two hundred and twenty-seven times. It appeared to him that one of these stars was of an unusual diameter; and he came to the conclusion, therefore, that it was a comet. It was under this denomination that it was discussed at the meeting of the Royal Society. But the researches of Herschel at a later period showed that the orbit of the new body was circular, and accordingly it was elevated to the rank of a planet. As already stated, Herschel named it, in compliment to George III., the Georgium Sidus; in this copying the example of Galileo with his "Medicean stars." Afterwards, astronomers christened it Herschel, and subsequently Uranus, in conformity with the mythological nomenclature of the other planets.

The immense distance of Uranus from our Earth, its small angular diameter, and the feebleness of its light, seemed to preclude the hope that, if it were attended by satellites of the same dimensions in proportion to its own magnitude as those of the satellites of Jupiter and Saturn in proportion to their magnitude, they could be descried by any human observer. The patient, persevering, reverent temper of Herschel took no account, however, of any discouraging or unpropitious circumstances. What he did was to substitute for telescopes of the ordinary construction the new and gigantic forty-foot tube already described; and, thus, with unremitting vigilance and intense zeal, he arrived at the discovery (between January 4, 1787, and February 28, 1794) of the six satellites of Uranus; in other words, he revealed to man the completeness of a new system,—a system which will always be identified with his name.

* * * * *

Those singular meteors, the comets, which flash through heaven with long trails of light, and of old astonished the nations as if they were harbingers of some overwhelming calamity, were also the frequent subjects of our astronomer's investigations. He brought some of his fine and powerful instruments to bear on a comet discovered by Mr. Pigott in 1807, and closely and carefully investigated its physical constitution.

The nucleus, or head, was circular and well determined, and evidently shone by its own light. Very small stars seemed to grow pale, "to hide their diminished heads," when seen through its coma or tail. It is true, however, that this faintness may have been only apparent, and due to the circumstance of the stars being projected on a luminous background. Such was Herschel's explanation. A gaseous medium, capable of absorbing sufficient solar radiance to efface the light of some "lesser stars," appeared to him to possess in each stratum a sensible

quantity of matter. Hence it would cause a real diminution of the light transmitted, though nothing would indicate the existence of such a cause.[1]

[Footnote 1: This conclusion is disputed by many astronomers.]

Herschel examined the beautiful comet of 1811 with equal accuracy. "Large telescopes showed him, in the midst of the gaseous head, a rather reddish body of planetary appearance, which bore strong magnifying powers, and showed no sign of phase (that is, of change of aspect, as in the case of the Moon). Hence Herschel concluded that it was self-luminous. Yet, if we reflect that the planetary body under consideration was not a second in diameter, the absence of a phase," says Arago, "does not appear a demonstrative argument."

The same writer adds:--

"The light of the head had a bluish-green tint." Was this a real tint, or did the central reddish body, only through contrast, make the surrounding vapour appear to be coloured? Herschel did not examine the question from this point of view.

"The head of the comet appeared to be enveloped at a certain distance, on the side towards the Sun, by a brilliant narrow zone, embracing about a semicircle, and of a yellowish colour. From the two extremities of the semicircle arose, towards the region away from the Sun, two long luminous streaks which limited the tail. Between the brilliant circular semi-ring and the head, the cometary substance appeared to be dark, of great rarity, and very diaphanous.

"The luminous self-ring floated: one day it seemed to be suspended in the diaphanous atmosphere by which the head of the comet was surrounded, at a distance of 322,000 English miles from the nucleus.

"This distance was not constant. The matter of the semi-annular envelope seemed even to be precipitated by slow degrees through the diaphanous atmosphere; finally, it reached the nucleus; the earlier appearances vanished; the comet was reduced to a globular nebula.

"During its period of dissolution, the ring appeared sometimes to have several branches.

"The luminous shreds of the tail apparently underwent rapid, frequent, and considerable variations of length. Herschel discerned symptoms of a rotatory movement both in the comet and its tail; a movement which carried unequal shreds from the centre towards the border, and the border towards the centre. On examining at intervals the same region of the tail--the border, for example--sensible changes of length must have been perceptible; which, however, had no reality in them. Herschel thought that both the comet of 1811 and that of 1807 were self-luminous. The second comet of 1811 appeared to him to shine only by borrowed light. It must be acknowledged that these conjectures did not rest on anything demonstrative.

"In attentively comparing the comet of 1807 with the beautiful

comet of 1811, relative to the changes of distance from the Sun, and the modifications resulting thence, Herschel put it beyond doubt that these modifications have something individual in them,--something relative to a special state of the nebulous matter. On one celestial body the changes of distance produce an enormous effect, on another the modifications are insignificant."

We have reproduced these observations by a distinguished French astronomer, in order to show the reader what was the nature, and how great was the importance, of Herschel's labours, and in how remarkable and comprehensive a manner he conducted his survey of the celestial phenomena. We now return to our brief narrative of his life.

Such a life, absorbed in tranquil and incessant studies, presents no curious, romantic, or surprising incidents. It was the life of a reverent, patient, gentle, and devoted man of genius, who dedicated himself to the task of making known the "wondrous works of God" to his fellow-men, and who in all his social and domestic relations was without blot or stain.

In 1788 he married the widow of John Pitt, Esq., with whom he received a considerable fortune, and thus for the remainder of his life he was enabled to give himself up to his favourite pursuits unembarrassed by pecuniary anxieties. His marriage was in every respect a happy one, and effectually secured his domestic peace. By his wife he had an only son,--the late Sir John Herschel,--who worthily maintained the scientific dignity of his name.

It is said, by the highest of all authority, that a prophet is not honoured in his own country. But our astronomer was not without the reward of his work, even in his lifetime. The University of Oxford conferred upon him the illustrious honorary degree of D.C.L. In 1816 he received the Guelphic order of knighthood; and in 1820 he was chosen the first president of the Astronomical Society.

From his sister's diary we gather a few particulars illustrative of his mode of life.

On the 4th of October 1806 she writes:--

"My brother came from Brighton. The same night two parties from the castle [Windsor] came to see the comet, and during the whole month my brother had not an evening to himself. As he was then in the midst of polishing the forty-foot mirror, rest became absolutely necessary after a day spent in that most laborious work; and it has ever been my opinion, that on the 14th of October his nerves received a shock of which he never got the better afterwards; for on that day (in particular) he had hardly dismissed his troop of men, when visitors assembled, and from the time it was dark till past midnight he was on the grass-plot, surrounded by between fifty and sixty persons, without having had time for putting on proper clothing, or for the least nourishment passing his lips.

"_February 6th, 1807_.--When I came to Slough to assist my brother in polishing the forty-foot mirror, I found my nephew[1] very ill with an inflammatory sore throat and fever.

"_February 9th_--Still very ill; and my brother obliged to go on with the polishing of the great mirror, as every arrangement had been made for that purpose.--_Mem_. I believe my brother had reasons for choosing the cold season for this laborious work, the exertion of which alone must put any man into a fever, if he were ever so strong.

"_February 10th_--From this day my nephew's health kept on mending.

"_February 19th_--My nephew mending, but my brother not well.

"_February 26th_--My brother so ill that I was not allowed to see him, and till March 8th his life was despaired of; and by March 10th I was permitted to see him, but only for two or three minutes, as he was not allowed to speak.

"_March 22nd_--He (Sir William) went for the first time into his library, but could only remain for a few moments."

[Footnote 1: Afterwards Sir John Herschel.]

From this dangerous attack Sir William recovered, but thenceforth it was clear to his friends that his strength gradually decreased, though not his enthusiasm or his industry. He persevered in his life-long labours with all his old intellectual force. What failed him was neither his tender affections nor his mental powers; but his body refused to answer all the demands made upon it by the resolute will,--the sword was slowly but surely wearing out the scabbard. Under the date of April 2, 1819, we meet with an ominous entry in his loving and faithful sister's diary:--

"My brother left Slough, accompanied by Lady Herschel, for Bath, he being very unwell; and the constant complaint of giddiness in the head so much increased, that they were obliged to be four nights on the road both going and coming. The last moments before he stepped into the carriage were spent in walking with me through his library and workrooms, pointing with anxious looks to every shelf and drawer, desiring me to examine all, and to make memorandums of them as well as I could. He was hardly able to support himself; and his spirits were so low, that I found difficulty in commanding my voice so far as to give him the assurance he should find on his return that my time had not been misspent.

"When I was left alone, I found that I had no easy task to perform, for there were packets of writings to be examined which had not been looked at for the last forty years. But I did not pass a single day without working in the library as long as I could read a letter without candlelight, and taking with me papers to copy, which employed me for best part of the night; and thus I was enabled to give my brother a clear account of what had been done at his return. But (May 1) he returned home much worse than he went, and for several days hardly noticed my handiwork."

To this same year of decay and decline (1819) belongs a small slip of

yellow paper, inscribed with the following lines in a tremulous and feeble handwriting, which is jealously preserved by the illustrious astronomer's descendants:--

"LINA,--There is a great comet. I want you to assist me. Come to dine, and spend the day here. If you can come soon after one o'clock, we shall have time to prepare maps and telescopes. I saw its situation last night,--it has a long tail.

"_July 4, 1819_."

Then follows:--

"I keep this as a relic! Every line _now_ traced by the hand of my dear brother becomes a treasure to me.

"C. HERSCHEL."

We know of nothing more touching in literary history than this noble, self-sacrificing, generous affection of the sister towards her eminent brother. Such instances of absolute self-denial and all-absorbing love elevate our opinion of human nature generally, and prove that something of the Divine image lingers in it still.

Herschel was now bordering upon the ripe old age of eighty, and it is no wonder that, after a life of incessant study, his strength should daily diminish. In 1822 it became painfully evident to his attached relatives and friends that the end was not far off; and on the 25th of August he passed away to his rest. We owe an account of his last days to his sister, but for whose pious care, indeed, very little of his private life would have been known, and Herschel could have been judged only from the recorded results of his immense labours.

"_May 20th_.--The summer proved very hot; my brother's feeble nerves were very much affected, and there being in general much company, added to the difficulty of choosing the most airy rooms for his retirement.

"_July 8th_.--I had a dawn of hope that my brother might regain once more a little strength, for I have a memorandum in my almanac of his walking with a firmer step than usual above three or four times the distance from the dwelling-house to the library, in order to gather and eat raspberries, in his garden, with me. But I never saw the like again.

"The latter end of July I was seized by a bilious fever, and I could for several days only rise for a few hours to go to my brother about the time he was used to see me. But one day I was entirely confined to my bed, which alarmed Lady Herschel and the family _on my brother's account_. Miss Baldwin [a niece of Lady Herschel] called and found me in despair about my own confused affairs, which I never had had time to bring into any order. The next day she brought my nephew to me, who promised to fulfil all my wishes which I should have expressed on paper; he begged me not to exert myself, for his father's sake, of whom he believed _it would be the immediate death if anything

should happen to me_."

Afterwards she wrote:--

"Of my dear nephew's advice I could not avail myself, for I knew that at that time he had weighty concerns on his mind. And, besides, my whole life almost has passed away in the delusion that, next to my eldest brother, none but Dietrich was capable of giving me advice where to leave my few relics, consisting of a few books and my sweeper [that is, the seven-foot telescope with which she was accustomed to sweep the heavens for comets]. And for the last twenty years I kept to the resolution of never opening my lips to my dear brother William about worldly concerns, let me be ever so much at a loss for knowing right from wrong."

Miss Herschel proceeds to note that on the afternoons of the 11th, 12th, 13th, and 14th of August, she, "as usual," spent some hours with her brother.

On the 15th she hastened to the accustomed place, where she generally found him, with the newspaper which she was to read aloud for his amusement. But, instead, she found assembled there several of his nearest friends, who informed her that her aged brother had been compelled to return to his room. She lost no time in seeking him. He was attended by Lady Herschel and his housekeeper, who were administering everything which was likely to keep up his failing strength.

Miss Herschel observed that he was much irritated, with the irritation natural to old age and extreme bodily feebleness, at his inability to grant a friend's request for some token of remembrance for his father. No sooner did he see Miss Herschel, the loving companion and fellow-worker of so many years, than he characteristically employed her to fetch one of his last papers, and a plate (or map) of the forty-foot telescope. "But, for the universe," says Miss Herschel, "I could not have looked twice at what I had snatched from the shelf; and when he faintly asked if the breaking up of the Milky Way^[1] was in it, I said, 'Yes,' and he looked content." I cannot help remembering this circumstance; it was the last time I was sent to the library on such an occasion. That the anxious care for his papers and workrooms never ended but with his life, was proved by his frequent whispered inquiries if they were locked and the key safe; of which I took care to assure him that they were, and the key in Lady Herschel's hands.

[Footnote 1: The Via Lactea, or "Milky Way," had long been supposed to consist of a nebulous, vague, luminous matter, but Herschel showed that it was really made up of stars and systems of stars.]

After struggling for some thirty minutes against his rapidly increasing weakness, the great astronomer, bowed by his burden of years and labours, was forced to retire to his bed, with little hope that he would ever rise from it again. For ten days and nights his wife and sister watched by his side in painful suspense, until, on the 25th of August, the end came. Peacefully closed a life which had passed in a peace and quietness not often vouchsafed to man.

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Herschel, says a brother astronomer, will never cease to occupy an eminent place in the small group of our contemporary men of genius, while his name will descend to the most distant posterity. The variety and the magnificence of his labours vie with their extent. The more they are studied, the more they are admired. For it is with great men as it is with great movements in the Arts and in national history,--we cannot understand them without observing them from different points of view.

What a brilliant roll of achievements is recalled to the mind by the name of William Herschel! The discovery of Uranus, and of its satellites; of the fifth and sixth satellites of Saturn; of the many spots at the poles of Mars; of the rotation of Saturn's ring; of the belts of Saturn; of the rotation of Jupiter's satellites; of the daily period of Saturn and Venus; and of the motions of binary sidereal systems,--added to his investigations into nebulae, the Milky Way, and double, triple, and multiple stars;--all this we owe to his patient, his persevering, his daring genius! He may almost be styled the Father of Modern Astronomy.

CHAPTER IV.

We now propose to furnish a brief sketch of the life of Sir John Frederick William Herschel, the only son of Sir William, and not less illustrious as a man of science.

He was born at Slough, in the year 1792. Evincing considerable talents at a very early age, he received a careful private education under Mr. Rogers, a Scottish mathematician of distinguished merit; and afterwards was sent to St. John's College, Cambridge, always famous as a nursery of mathematical and scientific prodigies! Here he pursued his studies with remarkable success, suffering no obstacles to daunt him, and wasting no opportunities of improvement. His fellow-collegians regarded him as one who would add to the high repute of the college, and rejoiced at the brilliant ease with which he passed every examination. In 1813 he took his degree of B.A., and consummated a long series of successes by becoming "senior wrangler," and "Smith's prizeman;" these being the two highest distinctions to which a Cambridge scholar can attain.

In the same year, when he was hardly twenty-one, he published a work entitled, "A Collection of Examples of the Application of the Calculus to Finite Differences." To our young readers such a title will convey no meaning; and we refer to it here only to illustrate the industry and careful thought of the young student, which had rendered possible such a result.

Returning to Slough, he continued his studies in mathematics, chemistry, and natural philosophy, and in various publications exhibited that faculty of observation and analyzation, that intelligence and scrupulousness in collecting facts, and that boldness in deducing new inferences from them, which were characteristic of his illustrious father. The subjects he took up were so abstruse, that we could not hope to make our readers understand what he accomplished, or how far he excelled his predecessors in his grasp and comprehension of them. For instance: if we tell them that in 1820 he wrote a paper "On the Theory and Summation of Series;" communicated to the Cambridge Philosophical

Society his discovery that the two kinds of rotatory polarization in rock crystal were related to the plagihedral faces of that mineral; and issued an able treatise "On Certain Remarkable Instances of Deviation from Newton's Tints in the Polarized Tints of Uniaxal Crystals,"--they will gain no very distinct idea of the significance or value of these researches. Again: it will not be very intelligible to them to be informed that, in 1822, he communicated to the Royal Society of Edinburgh a paper "On the Absorption of Light by Coloured Media", in which he enunciated a new method of measuring the dispersion of transparent bodies by stopping the green, yellow, and most refrangible red rays, and thus rendering visible the rays situated rigorously at the end of the spectrum. But they will understand that these results could have been attained only by the most assiduous industry and the most unflinching perseverance. And it is on account of this industry and this perseverance that we recommend Herschel as an example to our readers. They may not make the same progress in science, or achieve the same reputation. It is not necessary they should. Humble work is not less honourable, if it be done conscientiously, and with a sincere desire to do the best that it is in our power to do.

An interesting feature in the younger Herschel's character was his loving care for his father's fame. He was ever most anxious that the full measure of his services to science should be recognized and appreciated. Thus, in 1823, he writes to his aunt:--

"I have been long threatening to send you a long letter, but have always been prevented by circumstances and want of leisure from executing my intention. The truth is, I have been so much occupied with astronomy of late, that I have had little time for anything else--the reduction of those double stars, and the necessity it has put me under of looking over the journals, reviews, &c, for information on what has already been done, and in many cases of re-casting up my father's measures, swallows up a great deal of time and labour. But I have the satisfaction of being able to state that our results in most instances confirm and establish my father's views in a remarkable manner. These inquiries have taken me off the republication of his printed papers for the present.

"I think I shall be adding more to his fame by pursuing and verifying his observations than by reprinting them. But I have by no means abandoned the idea. Meanwhile, I am not sorry to hear they are about to be translated into German.... I hope this season to commence a series of observations with the twenty-foot reflector, which is now in fine order. The forty-foot is no longer capable of being used, but I shall suffer it to stand as a monument."

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In reference to this famous telescope, we may digress to state that its remains have been carefully preserved.

The metal tube of the instrument, carrying at one end the recently cleaned mirror of four feet ten inches in diameter, has been placed horizontally in the meridian line, on solid piles of masonry, in the midst of the circle where the apparatus used in manoeuvring it was formerly placed. On the 1st of January 1840, Sir John Herschel, his

wife, their seven children, and some old family servants, assembled at Slough. Exactly at noon the party walked several times in procession round the instrument; they then entered the gigantic tube, seated themselves on benches previously prepared, and chanted a requiem with English words composed by Sir John Herschel himself. Then issuing from the tube, they ranged themselves around it, while its opening was hermetically sealed.

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In March 1821, the younger Herschel, in conjunction with Sir James South, undertook a series of observations on the distances and positions of three hundred and eighty double and triple stars, by means of two splendid achromatic telescopes of five and seven focal length. These were continued during 1822 and 1823, and have proved of great service to astronomers.

Having pursued with much zeal the study of optics, and experimented largely and carefully on the double refraction and polarization of light, he compiled a treatise on the subject for the "Encyclopaedia Metropolitana" It has been translated into French by M. Quetelet; and both foreign and English men of science have been accustomed to regard it as indicating a new point of departure in the important branch of science to which it is devoted.

Astronomy, however, became for him, as for his father, the great pursuit of his laborious life; and having constructed telescopes of singular magnitude and power, he entered upon a study of the Sidereal World. In 1825 he commenced a careful re-examination of the numerous nebulae and starry clusters which had been discovered by his father, and described in the "Philosophical Transactions," fixing their positions and investigating their aspects. He devoted eight years to this _magnum opus_, completing it in 1832. The catalogue which he then contributed to the "Philosophical Transactions" includes 2306 nebulae and star-clusters, of which 525 were discovered by himself. While engaged in this difficult task, Herschel discovered between three and four thousand double stars, which he described in the Memoirs of the Astronomical Society. His observations were made with an excellent Newtonian telescope, twenty feet in focal length, and eighteen and a half inches in aperture; and having obtained, to use his own expression, "a sufficient mastery over the instrument," the idea occurred to him of making it available for a survey of the southern heavens. Accordingly, he left England on the 13th of November 1833, and arrived at Cape Town on the 16th of January 1834. Five days later he wrote to his aunt as follows:--

"Here we are safely lauded and comfortably housed at the far end of Africa; and having secured the landing and final storage of all the telescopes and other matters, as far as I can see, without the slightest injury, I lose no time in reporting to you our good success _so far_. M---[1] and the children are, thank God, quite well; though, for fear you should think her too good a sailor, I ought to add that she continued sea-sick, at intervals, during the whole passage. We were nine weeks and two days at sea, during which period we experienced only one day of contrary wind. We had a brisk breeze 'right aft' all the way from the Bay of Biscay (which we never entered) to the 'calm latitudes;' that is to say, to the space about five or

six degrees broad near the equator, where the trade-winds cease, and where it is no unusual thing for a ship to lie becalmed for a month or six weeks, frying under a vertical sun. Such, however, was not our fate. We were detained only three or four days by the calms usual in that zone, but never quite still, or driven out of our course; and immediately on crossing 'the line' got a good breeze (the south-east trade-wind), which carried us round Trinidad; then exchanged it for a north-west wind, which, with the exception of one day's squall from the south-east, carried us straight into Table Bay. On the night of the 14th we were told to prepare to see the Table Mountain. Next morning (N.B., we had not seen land before since leaving England), at dawn, the welcome word land' was heard; and there stood this magnificent hill, with all its attendant mountain-range down to the farthest point of South Africa, full in view, with a clear blue ghost-like outline; and that night we cast anchor within the Bay. Next morning early we landed, under escort of Dr. Stewart, M---'s brother, and you may imagine the meeting. We took up our quarters at a most comfortable lodging-house (Miss Robe's), and I proceeded, without loss of time, to unship the instruments. This was no trifling operation, as they filled (with the rest of our luggage) fifteen large boats; and, owing to the difficulty of getting them up from the hold of the ship, required several days to complete the landing. During the whole time (and indeed up to this moment) not a single south-east gale, the summer torment of this harbour, has occurred. This is a thing almost unheard of here, and has indeed been most fortunate, since otherwise it is not at all unlikely that some of the boats, laden as they were to the water's edge, might have been lost, and the whole business crippled.

[Footnote 1: Herschel married a Miss Stewart in February 1826.]

"For the last two or three days we have been looking at houses, and have all but agreed for one--a most beautiful place within four or five miles out of town, called 'The Grove.' In point of situation it is a perfect paradise, in rich and magnificent mountain-scenery, and sheltered from all winds, even the fierce south-easter, by thick surrounding woods. I must reserve for my next all description of the gorgeous display of flowers which adorns this splendid country, as well as of the astonishing brilliancy of the constellations, which the calm, clear nights show off to great advantage."

Mr. Herschel settled at Feldhausen, about 142 feet above the sea, and in long. 22 deg. 46' 9".11 E., and lat. 33 deg. 58' 26".59 S. Here he entered upon his great series of observations of the southern heavens, which he continued with unwearied ardour for a period of four years. The results were afterwards published, at the cost of the Duke of Northumberland, in a work entitled "Results of Astronomical Observations made in 1834-35-36-37-38, at the Cape of Good Hope." In this superb work, which placed its author on an equality with the most brilliant and illustrious astronomers, he defined and described 4015 of the nebulae and star-groups in the southern hemisphere, and 2995 of the double stars; besides entering into a variety of valuable particulars relative to Halley's comet, the solar spots, the satellites of Saturn, and the measurement of the apparent magnitude of stars.

On his return to England (in 1838) the astronomer received a noble welcome. Honours poured in upon him. The Gold Medal of the Astronomical Society was conferred upon him for a second time. William IV. had previously distinguished him with the Hanoverian order of K.H.; but, on the coronation of Queen Victoria, he received a baronetcy; and in 1839 the University of Oxford made him a D.C.L.

Continuing his career of scientific industry, he issued, in 1849, his important and very valuable treatise entitled "Outlines of Astronomy." In 1845, he was appointed President of the British Association; and in 1848, of the Royal Astronomical Society. To his other honours was added that of Chevalier of the Prussian order, "Pour la Merite," founded by Frederick the Great, and bestowed at all times with a discrimination which renders it a deeply-coveted distinction. Of the academies and leading scientific institutions of the Continent and the United States, he was also an honorary or corresponding member.

Besides his works on meteorology and physical geography, he published, in 1867, an admirable little volume--"Familiar Lectures on Scientific Subjects." In this he showed that he could write with as much ease and

intelligibility for the general public as for the higher order of scientific inquirers. His style in this valuable manual of information has a charm of its own, and entices the reader into the consideration of subjects apparently abstruse. He is earned on from page to page without any great mental effort, and finds himself rapidly mastering difficulties which he had been accustomed to regard as insuperable.

Let us take the first lecture on "Volcanoes and Earthquakes," and obtain a glimpse of Herschel's mode of treatment. He refers to the greater and more permanent agencies which affect the configuration of our planet. Everywhere, he says, and along every coast-line, we see the sea warring against the land, and overcoming it; wearing it and eating it down, and battering it to pieces; grinding those pieces to powder; carrying that powder away, and spreading it out over its own bottom, by the continued effect of the tides and currents. What a scene of continual activity is presented by the chalk-cliffs of Old England! How they are worn, and broken up, and fantastically sculptured by the influence of winds and waters! Precipices cut down to the sea-beach, constantly hammered by the waves, and constantly crumbling; the beach itself made of the flints outstanding after the softer chalk has been ground down and washed away; themselves grinding one another under the same ceaseless discipline--first rounded into pebbles, then worn into sand, and then carried further and further down the slope, to be replaced by fresh ones from the same source. Here the likeness of an old Gothic cathedral, with lofty arch, and shapely pinnacle; there the similitude of a mass of medieval fortifications, with crumbling battlements and shattered towers!

The same thing, the same waste and wear, is going on everywhere, round every coast. The rivers contribute their share to the great work of change. Look at the sand-banks at the mouth of the Thames. What are they, says Sir John Herschel, but the materials of our island carried out to sea by the stream? The Ganges carries away from the soil of India, and delivers into the sea, twice as much solid substance weekly as is contained in the Great Pyramid of Egypt. The Irawaddy sweeps off from Burmah sixty-two cubic feet of earth in every second of time, on an average. Sometimes vast amount of earthy materials is transferred from one locality to another by river agency, as is the case in the deltas

of the Nile and the Mississippi.

These changes operate silently, continuously, and unperceived by the ordinary observer; but Nature does not limit herself always and everywhere to such peaceful agencies. At times, and in certain places, she acts with startling abruptness and extraordinary violence. Let the volcano and the earthquake attest the immensity of her power. Let the earthquake tell how, within the memory of man, the whole coast-line of Chili, for 100 miles about Valparaiso, with the mighty chain of the Andes, was hoisted at one blow, and in a single night (November 19, 1822), from two to seven feet above its former level, leaving the beach below the old low-water mark high and dry. One of the Andean peaks upheaved on this occasion was the colossal mass of Aconcagua, which overlooks Valparaiso, and measures nearly 24,000 feet in height. On the same occasion, at least 10,000 square miles of country were estimated as having been upheaved; and the upheaval was not confined to the land, but extended far away to sea,—which was proved by the soundings off Valparaiso and along the coast having been found considerably shallower than they were before the shock.

In the year 1819, in an earthquake in India, in the district of Cutch, bordering on the Indus, a tract of country more than fifty miles long and sixteen miles broad was suddenly raised ten feet above its former level. The raised portion still stands up above the unraised, like a long perpendicular rampart, known by the name of Ullah Bund, or God's Wall.

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With a similar fertility of illustration, Herschel sets before us the phenomena of volcanic eruptions and their extraordinary effects.

In a district of Mexico, between the two streams of the Cintimba and the San Pedro, on the 28th of September 1789, a whole tract of ground, from three to four miles in extent, surged up like a foam-bubble, or the swell of a wave, to a height of upwards of 500 feet. Flames, lurid and crackling, broke forth over a surface of more than half a square league; and the earth, as if softened by heat, was seen to rise and sink like the rolling tide. Vast chasms opened in the earth, into which the two rivers poured their waters headlong; reappearing afterwards at no great distance from a cluster of hornitos, or small volcanic cones, which sprang out of the mighty mud-torrent that gradually covered the entire plain. Wonderful and awful as were these phenomena, they were surpassed by the sudden opening of a chasm which vomited forth fire, and red-hot stones and ashes, until they accumulated in a range of six large mountain masses,—one of which, now known as the volcano of Jorullo, attains an altitude of 1690 feet above the ancient level.

In like manner Sir John proceeds to describe an eruption of Mount Tomboro, in the island of Sumbawa, the influence of which was felt to a distance of 1000 miles from its centre, in strange tremulous motions of the earth, and in the clash and clang of loud explosions. He says that he had seen it computed that the quantity of ashes and lava ejected in the course of this tremendous eruption would have formed three mountains of the size of Mont Blanc.

As to the nature of the forces which operate to produce this astounding result, Herschel puts forward a theory of singular simplicity and directness.

"The origin," he says, "of such an enormous power thus occasionally exerting itself, will no doubt seem very marvellous--little short, indeed, of miraculous intervention; but the mystery, after all, is not quite so great as at first it seems. We are permitted to look a little way into these great secrets of Nature; not far enough, indeed, to clear up every difficulty, but quite enough to penetrate us with admiration of that wonderful system of counterbalances and compensations, that adjustment of causes and consequences, by which, throughout all nature, evils are made to work their own cure, life to spring out of death, and renovation to tread in the steps and efface the vestiges of decay." And he finds the clew to the secret, the key of the whole matter, in the earth's vast central heat. This it is which produces the convulsions that change the terrestrial configuration, and fill the minds of men with fear and awe. Conceive of "a sea of fire, on which we are all floating, land and sea,"--a boiling, seething, incandescent reservoir in the centre of our planet; and the solution of the problem will seem to you not difficult. Such a sea would necessarily roll its liquid matter to and fro; and the removal of ever so small a portion from one point to another on the earth's surface would tend to disturb the equilibrium of the floating mass; just as, when a ship is launched into the river, the water it displaces is carried to the opposite bank with greater or less violence, according to the amount of displacement.

It is impossible, adds Herschel, but that this increase of pressure in some places and relief in others must be very unequal in their bearings. So that at some point or another our planet's floating crust must be brought into a state of strain, and if there be a weak or a soft part a crack will at last take place. This is exactly what happened in the earthquake which originated the Allah Bund, or God's Wall, in Cutch.

Volcanic eruptions are easily explicable on this principle,--the volcano being simply a vent for the passage of heated and molten matter, which the elevating pressure of the liquid below tends to eject. It is a well-known fact that volcanoes and earthquake-centres are nearly all situated on the borders or in the immediate neighbourhood of seas and oceans; and the reason would seem to be, that at such positions the accumulation of transported matter would necessarily attain its maximum, to whatever cause it might be due. Then again, as Herschel points out, the eruption of scorite and lava from the mouths of volcanoes, the result of the upward movement of the fiery liquid below, compensates in some degree for the downward transfer of material by detritus and alluvial deposits. Hence it may be inferred that, on the whole, the quantity of solid matter above the ocean-level probably remains nearly always at the same amount.

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It is with this ease and lucidity that Sir John deals with scientific subjects of the greatest importance,--his genius resembling the elephant's trunk, which can balance a straw or rend an oak. In private life he displayed a simplicity of manner in harmony with the general unassumingness of his character. In his books as in society, in society as in his books, he was the same,--that is, free from all ostentation, free from self-pride, free from the arrogance of superior knowledge, and as ready to unbend himself to a child as to discourse with men of science.

His career was a tranquil and a prosperous one, and, apart from the

record of his discoveries and his honours, presents nothing of interest. He was peculiarly happy in his domestic relations; and in the wide circle of friends attracted by the mingled charm of his intellect and manners. A devout Christian, a man of generosity and culture, a philosopher of great breadth of view and infinite patience of research,--we can place few better or brighter examples before our English youth than Sir John Herschel.

CHAPTER V.

We could not conclude our notice of this remarkable family without some further allusion to its not least remarkable member--Caroline Lucretia Herschel.

To her varied accomplishments, her astronomical researches, and, above all, to her unwearied and unselfish devotion to her brother William, we have already made frequent allusion. She seemed to live for him and in him, to live for his fame and prosperity; and she poured out at his feet the treasures of an inexhaustible affection. To assist him in his labours, at whatever sacrifice, was her sole object in life; and she was certainly more careful for his reputation than was he himself. During his declining years she was his principal stay and support, and she was in daily attendance to note down or to calculate the results of his observations. His death was a severe blow to her; but, with characteristic courage, she retired to Hanover, gave herself up to scientific pursuits, and in comparative solitude spent her later years.

Her biographer writes:--

"When all was over, her only desire seems to have been to hurry away. Hardly was her brother laid in his grave than she collected the few things she cared to keep, and left for ever the country where she had spent fifty years of her life, living and toiling for him and him only. 'If I should leave off making memorandums of such events as affect or are interesting to me, I should feel like what I am,--namely, a person that has nothing more to do in this world.' Mournful words! doubly mournful, when we know that the writer had nearly half an ordinary lifetime still between her and that grave which she made haste to prepare, in the hope that her course was nearly run. Who can think of her, at the age of seventy-two, heart-broken and desolate, going back to the home of her youth in the fond expectation of finding consolation, without a pang of sympathetic pity? She found everything changed."

That, indeed, is to all of us the greatest grief, when we return to the home of our youth. It is as if, during the years of our absence, we had expected everything to stand as still as in the palace of the Sleeping Beauty while the charm rested upon it. We are fain to see the trees in their young greenness as when they sheltered our childhood, to find the hedgerows blooming with the same violets, to hear the mill-stream murmuring with the same music. Time furrows our brows with wrinkles, and streaks our hair with silver; our hearts grow colder; our minds lose their elasticity and freshness; our friends pass away from our side. But still we think to ourselves that in the old scenes all

things are as they were. We say to ourselves: The bird sings as of old in the elm-trees at the garden-foot; the rose-bush blossoms as of old against our favourite window.

"The varying year with blade and sheaf
Clothes and re-clothes the happy plains;
Here rests the sap within the leaf,
Here stays the blood along the veins.
Faint shadows, vapours lightly curled,
Faint murmurs from the meadows come,
Like hints and echoes of the world
To spirits folded in the womb."

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But we regain the old familiar places, and, alas! we find that change has been as busy with them as with us. The signs of decay are upon the trees; the brook has ceased to flow; the rose-bush has withered to the ground. There are trees as green and streams as musical and flowers as sweet as in our youth; but they are not the streams or flowers or trees which delighted us, and to us they can never be as dear. But a worse alteration has taken place than any visible in the face of nature. We discover that we have lost the old habits, the old capacity of enjoyment; and we soon discover that it was the sympathies, the hopes, the aspirations of youth which, after all, lent to these early scenes their rare and irrecoverable attraction.

And thus it was that Miss Herschel found everything changed. A life of fifty years spent in a certain routine and upon certain objects, had unfitted her to tread in the old paths. It soon became clear to her that all her ideas and feelings had been shaped and influenced in a totally different path. More bitter still, we are told, she came to know that in her great sorrow and inextinguishable love she was all alone. And bitterest of all was the feeling that, in losing her brother she had lost the glory of her life, the source of her intellectual enjoyment. "You don't know," she wrote to a friend, "the blank of life after having lived within the radiance of genius." Yet to live in this blankness, and to do the best she could with it, became the work of Caroline Lucretia Herschel at the age of threescore years and ten,—an age when most of us have already put off our cares and anxieties, but when she began to enter on a new life, with new habits, new duties, and new associations.

Her interest in astronomical pursuits never slackened, and she watched with eagerness the labours and successes of her nephew. The respect paid to her in society as a "woman of science" was not unwelcome, though she affected to make light of it. "You must give me leave," she wrote to Sir John, "to send you any publications you can think of, without mentioning anything about paying for them. For it is necessary I should every now and then lay out a little of my spare cash in that, for the sake of supporting the reputation of being a learned lady; (there is for you!) for I am not only looked at for such a one, but even stared at here in Hanover!" It was with unaffected modesty she deprecated the honorary membership of the Irish Academy, conferred on one who, she said, had not for many years discovered even a comet; yet she was by no means insensible to the distinction. Every man of scientific eminence who visited Hanover visited this aged lady; and her presence in the theatre, even in her latest years, was a constant source of attraction. Such was the simple frugality of her habits, that she experienced an actual

difficulty in disposing of her income. She affirmed that the largest sum she could spend upon herself was L50 a year; and the annual pension of L100, left by her brother, she refused, or else devoted the quarterly or half-yearly payment to the purchase of some handsome present for her nephew or niece.

Such was Caroline Lucretia Herschel; and as such she was a remarkable proof that the rarest womanly gifts of affectionate forethought and loving devotion may exist in combination with intellectual strength and scientific enthusiasm.

Of the force, keenness, and permanency of her sisterly love, an illustration of a pathetic character occurs in a letter which she addressed to her nephew, February 27, 1823:--

"I am grown much thinner than I was six months ago: when I look at my hands, they put me so in mind of what your dear father's were, when I saw them tremble under my eyes, as we latterly played at backgammon together."

It has long been the reproach of England that she treats, or rather that her Government treats, her men of science, her artists, and her litterateurs with a disgraceful parsimony. It would appear from the following letter that Sir William Herschel was inadequately rewarded, and that his sister felt this keenly:--

"There can be no harm," she says, "in telling my own dear nephew that I never felt satisfied with the support your father received towards his undertakings, and far less with the ungracious manner in which it was granted. For the last sum came with a message that more must never be asked for. (Oh! how degraded I felt, even for myself, whenever I thought of it!) And after all it came too late, and was not sufficient; for if expenses had been out of question, there would not have been so much time, and labour, and expense, for twenty-four men were at times by turns, day and night, at work, wasted on the first mirror, which had come out too light in the casting (Alex more than once would have destroyed it secretly, if I had not persuaded him against it); and without two mirrors, you know, such an instrument cannot be always ready for observing.

"But what grieved me most was that to the last your poor father was struggling above his strength against difficulties which he well knew might have been removed if it had not been attended with too much expense. The last time the mirror was obliged to be taken from the polisher on account of some obstacle, I heard him say (in his usual manner of thinking aloud on such occasions), 'It is impossible to make the machine act as required without a room three times as large as this.'

"I must say a few words of apology for the good King (George III.), and ascribe the close bargains which were made between him and my brother to the _shabby, mean-spirited advisers_ who were undoubtedly consulted on such occasions; but they are dead and gone, and no more of them."

In February 1828, the great services which this high-souled woman had

rendered to astronomical science were fitly rewarded by the presentation to her of the Royal Astronomical Society's gold medal,--the greatest honour which an astronomer can receive.

Mr. South, himself an astronomer of deserved repute, was charged with the duty of presenting the medal; and in the course of his address he dwelt on the labours of her brother, and the share she had had in them.

Sir William's first catalogue of new nebulae and clusters of stars, he said, amounting in number to one thousand, was compiled with observations made from a twenty-foot reflector in the years 1783, 1784, and 1785. By the same instrument he was enabled to discover the positions of a second thousand of these distant worlds in 1785 to 1788; while the places of five hundred others were registered on the celestial map between 1788 and 1802. What, we may ask, were the discoveries of Columbus compared with these? He revealed to Europe the existence of only a single continent; Herschel unfolded to man the mysteries of the depths of the heavens.

But, continued Mr. South, when we have thus enumerated the results obtained in the course of "sweeps" with this instrument, and taken into consideration the extent and variety of the other observations which were at the same time in progress, a most important part yet remains untold. Who participated in his toils? Who braved with him all the experiences of inclement weather? Who shared, and consoled him in, his privations? A woman. And who was she? His sister. Miss Herschel it was who by night acted as his amanuensis; she it was whose pen conveyed to paper his observations as they issued from his lips; she it was who noted the various aspects and phenomena of the objects observed; she it was who, after spending the still night beside the wonder-exhibiting instrument, carried the rough, blurred manuscripts to her cottage at daybreak, and by the morning produced a clean copy and register of the night's achievements; she it was who planned the labour of each succeeding night; she it was who reduced into exact form every calculation; she it was who arranged the whole in systematic order; and she it was who largely assisted her illustrious brother to obtain his imperishable renown.

Miss Herschel's claims to the gratitude of men of science, and to the admiration of all who can appreciate the beauty of self-sacrifice, did not end here. She was herself an astronomer, and an original observer. At times her brother was enabled to dispense with her attendance. You would suppose that such leisure nights she would gladly give up to rest. Not she. Her brother might, at some unforeseen moment, require her aid, and consequently she preferred to be close at hand. A seven-foot telescope planted on the lawn helped to while away the hours of waiting; and it was to the occupation of these hours that science owed the discovery of the comet of 1786, of the comet of 1788, of the comet of 1791, of the comet of 1793, and of that of 1795, now connected with the name of Encke. Many, also, of the nebulae contained in Sir William Herschel's catalogues were detected by her keen and accurate gaze during these nights of lonely observation. Indeed, as South remarked, when looking at the joint-labours of these two enthusiasts, we scarcely know whether the warmer praise should be given to the intellectual might of the brother or the ardent industry of the sister.

In 1797, continued her eulogist, she presented to the Royal Society a catalogue of 560 stars, taken from Flamsteed's observations, the exact positions of which had not been previously defined.

Soon after the death of him to whom she had given up so much of her life, her best energies, and her ripest faculties, she returned to Hanover,--unwilling, however, to relinquish the astronomical researches which had been so pure and permanent a source of pleasure. She undertook and completed the laborious "reduction" or registration of the places of 2500 nebulae, down to the 1st of January 1800; thus presenting in one view the results of all the observations Sir William Herschel had made upon those wonderful bodies, and triumphantly bringing to a close half a century of scientific toil.

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We return to Miss Herschel's biography, in order to gather up a few particulars of her last years, and to exhibit some of the tenderer features of her character.

On the occasion of her nephew's marriage, in 1829, she wrote to him in the following terms:--

"MY DEAREST NEPHEW,--I have spent four days in vain endeavours to gain composure enough to give you an idea of the joyful sensation your letter of February 5th has caused me. But I can at this present moment find no words which would better express my happiness than those which escaped in exclamation from my lips, according to Simeon (see St. Luke ii. 29), 'Lord, now lettest thou thy servant depart in peace.'

"I have now some hopes of passing the few remainder of my days in as much comfort as the separation from the land where I spent the greatest portion of my life, and from all those which are most dear to me, can admit. For, from the description given me of the dear young lady of your choice, I am confident my dear nephew's future happiness is now established.

"I beg you will give my love to your dear lady, and best regards to all your new connections where they are due, in the best terms you can think of, for I am at present too unwell for writing all I could wish to say.

"I have suffered much during this severe winter, and have not been able to leave my habitation above three or four times for the last three months; and feel, moreover, much fatigued by sitting eight times within the last ten days to Professor Tiedemann for having my picture taken--which he did at my apartment, and now he has taken it home to finish. I must conclude, for I wish to say a few words to your dear mother. It is now between eleven and twelve, and perhaps you are at this very moment receiving the blessing of Dr. Jennings; in which I most fervently join by saying, 'God bless you both!'"

Though eighty-three years old, Miss Herschel retained all her old powers of memory; and in a letter to her new niece, Lady Herschel, written in 1833, she narrated some amusing reminiscences of her nephew's early childhood.

He was only in his sixth year, she said, when she was separated for a while from the family circle. But this did not hinder "John" and her

from remaining the most affectionate friends, and many a half or whole holiday he spent with her, devoting it to chemical experiments, in which all kinds of boxes, tops of tea-canisters, pepper-cruets, tea-cups, and the like, served for the necessary vessels, and the sand-tub furnished the matter to be analysed. Miss Herschel's task was to prevent the introduction of water, which would have produced havoc on her carpet. For his first notion of building, "John" was indebted to the affection of his aunt, who, on his second or third birthday, lifted him in the trenches to lay the south corner-stone of the building which was added to Sir William's original house at Slough. On further reflection, she felt convinced that this incident occurred in the second year of her nephew's age, for she remembered being obliged to use "a deal of coaxing" to make him part with the money he was to lay on the corner-stone.

About the same time, when she was sitting near him one day, listening to his prattle, her attention was drawn to his repeated and formidable hammering. On investigating into its object, she found that it was the continuation of the labour of many days, during which he had undermined the ground about the corner of the house, had entirely removed the corner-stone, and was zealously toiling to overthrow the next! His aunt gave the alarm, and old John Wiltshire, a favourite carpenter, ran to the spot, exclaiming, "Heaven bless the boy! if he is not going to pull the house down!"

* * * * *

In 1834, Sir John, as already stated, made a voyage to the Cape of Good Hope, in order to undertake a series of observations of the southern heavens. His aunt had now reached the ripe old age of eighty-four, an age attained by few,--and when attained, bringing with it in almost every case a painful diminution of physical energy, and a corresponding decline in mental force. But such was not the case with this remarkable woman. She still continued an active correspondence with her nephew, and manifested the liveliest interest in all his movements. It is astonishing to mark the vivacity and clearness of the letters she wrote at this advanced period of her life. Thus, on the 1st of May 1834, she writes to Sir John:--

"Both yourself and my dear niece urged me to write often, and to write always twice; but, alas! I could not overcome the reluctance I felt of [at] telling you that it is over with me for getting up at eight or nine o'clock, dressing myself, eating my dinner alone without an appetite, falling asleep over a novel (I am obliged to lay down to recover the fatigue of the morning's exertions), awaking with nothing but the prospect of the trouble of getting into bed, where very seldom I get above two hours' sleep. It is enough to make a parson swear! To this I must add, I found full employment for the few moments, when I could rouse myself from a melancholy lethargy, to spend in looking over my store of astronomical and other memorandums of upwards of fifty years' collecting."

Later in the year she writes:--

"I know not how to thank you sufficiently for the cheering account you give of the climate agreeing so well with you and

all who are so dear to me, and that you find all about you so agreeable and comfortable;... so that I have nothing left to wish for but a continuation of the same, and that I may only live to see the handwriting of your dear Caroline, though I have my doubts about lasting till then, for the thermometer standing 80 deg. and 90 deg. for upwards of two months, day and night, in my rooms (to which I am mostly confined), has made great havoc in my brittle constitution. I beg you will look to it that she learns to make her figures as you find them in your father's MSS., such as he taught me to make. The daughter of a mathematician must write plain figures.

"My little grand-nephew making alliance with your workmen shows that he is taking after his papa. I see you now in idea, running about in petticoats among your father's carpenters, working with little tools of your own; and John Wiltshire (one of Pitt's men, whom you may perhaps remember) crying out, 'Dang the boy, if he can't drive in a nail as well as I can!'

"I thank you for the astronomical portion of your letter, and for your promise of future accounts of uncommon objects. It is not _clusters of stars_ I want you to discover in the body of the Scorpion [the astronomical sign, so called], or thereabout, for that does not answer my expectation, remembering having once heard your father, after a long, awful silence, exclaim, 'Hier ist wahrhaftig ein loch ein Himmel!' [Here, indeed, is a great gap in Heaven!], and, as I said before, stopping afterwards at the same spot, but leaving it unsatisfied."

These extracts may seem trivial to some of our readers, but they are not so, rightly considered. They illustrate the wonderful mental vivacity of their venerable writer, and in this respect are useful; but still more useful in showing how cheerfully she bore the burden of her years, and with what intellectual serenity she looked forward to her end.

We own that the lives of the Herschels are what the world would call uneventful. The discovery of a new planet, or of the orbit of a star, seems less romantic to the vulgar taste than the slaughter of ten thousand men on a field of battle. It will seem to the unthinking that the victorious general or the daring seaman, the leader of a forlorn hope, or the captain who goes down with his sinking ship, affords an example worthier of imitation than the patient, watchful, enthusiastic astronomer or his devoted sister. _His_, they will say, was a noble life. Be it so; but every life is noble which is spent in the path of duty. Do what comes to your hand to do with all honesty and completeness, and you will make _your_ life noble. Subdue your passions, master your evil thoughts, observe the laws of temperance and purity, be truthful, be firm, be honest, and keep ever before you the law of Christ as the law of your daily work, and you will make _your_ life noble. We cannot all be great commanders or daring captains, we cannot all be distinguished men of science; but we can all be righteously-living men, endeavouring to raise others by our example, and it is a higher aim to live purely than to live successfully. We cannot all command the success, just as we do not all enjoy the intellectual powers, of a Herschel; but we can emulate the industry and perseverance of the astronomer, we can copy the devoted affection and self-denial of his sister. The sorriest mistake of which men can be guilty,--yet it is a mistake which has clouded many lives,--is to suppose that duty is less imperative in its claims on the humble and unknown than on men raised or

born to eminent position. Let it be understood and remembered that each one of us can rise to a standard of true heroism, by cultivating the graces of the Christian character, and doing the work which God has appointed.

* * * * *

Sir John Herschel returned to England in 1838, and in July of the same year he and his little son paid a visit to Miss Herschel. It is characteristic that her intense anxiety as to the proper treatment of her little grand-nephew--his sleep, his food, his playthings--greatly disturbed her peace. "I rather suffered him," she writes, "to hunger, than would let him eat anything hurtful; indeed, I would not let him eat anything at all unless his papa was present." Her biographer remarks, that great as was her joy to see once more almost the only living being upon whom she poured some of that wealth of affection with which her heart never ceased to overflow, yet it was on the disappointments and shortcomings of those few days, those precious days, that she chiefly dwelt; and the abrupt termination of her nephew's visit filled her with the deepest sorrow. With the generous, but, as it proved, mistaken intention of sparing her feelings, her nephew left without informing her beforehand of the exact time of his departure, simply bidding her good-night prior to his return to his inn. Great was her distress when she found that he and his son had quitted Hanover at four o'clock on the following morning.

Her introduction to her grand-nephew, as described by his father, Sir John, was exceedingly quaint:--

"Now, let me tell you how tilings fell out. Dr. Groskopff took Willie with him to Aunty, but without saying who he was. Says she, 'What little boy is that?' Says he, 'The son of a friend of mine. Ask him his name.' However, Willie would not tell his name. 'Where do you come from, little fellow?' 'From the Cape of Good Hope,' says Willie. 'What is that he says?' 'He says he comes from the Cape of Good Hope.' 'Ay! and who is he? What is his name?' 'His name is Herschel.' 'Yes,' says Willie. 'What is that he says?' 'He says he comes from the Cape of Good Hope.' 'Ay! and who is he? What is his name?' 'His name is Herschel.' 'Yes,' says Willie, 'William James Herschel.' 'Ach, mem Gott! das nicht moeglich; ist dieser kleines neffeu's sohn?' And so it all came out; and when I came to her all was understood, and we sat down and talked as quietly as if we had parted but yesterday."

* * * * *

In a letter which she wrote to Lady Herschel in 1838, we find some reminiscences of her early years. She says that when, at the age of twenty-two, she first visited England, there was no kind of ornamental needle-work, knitting, plaiting hair, stringing beads and bugles, and the like, of which she did not make samples by way of mastering the art. As she was the only girl, and consequently the Cinderella, of the family, she could not find time, however, for much self-improvement. She was not, for instance, a skilled musician, but she was able to play the second violin part of an overture or easy quartette. And it is worth notice that the Herschels were something more than astronomers only. Both Sir William and his son, great as they were in their special department of science, took care to cultivate their minds generally;

were mathematicians, chemists, geologists, and men of letters. And here is a lesson for our younger readers. The mind should always be diverted towards one particular object; it should be the aim of everybody to attain towards supreme excellence, if possible, in some one pursuit. On the other hand, he should gather knowledge, more or less, in every field, so as to avoid narrowness of view and poverty of idea.

Versatility does not necessarily mean superficiality; we may know much of many things, and more of one thing. A man who is only a botanist, shuts himself out from all the truest and deepest pleasures of knowledge. It may be very clever for a violinist to play on a single string; but he must play on all, if he would bring out the full harmonies of his instrument, and do justice to its extraordinary powers.

* * * * *

Miss Herschel's enjoyment of life, which, when not carried to an excess, is a Christian duty, continued to the very last. When she was in her ninetieth year, she rose as usual every day, dressed, ate, drank, rested on her sofa, read and conversed with her numerous visitors; still taking an interest in science and literature, even in public affairs, and still occupying herself with all that concerned the evergrowing reputation of her nephew. Of course, she could not escape the infirmities of old age, but by cheerfulness and patience she did her best to alleviate them. In recalling incidents of her early life, she frequently gave evidence of her good-humoured contentment. In 1840, writing to her niece, she refers to an incident which occurred in the early part of the forty-foot telescope's existence, when "God save the King" was sung in it by her brother and his guests, who rose from the dinner-table for the purpose, and entered the tube in procession. She adds that among the company were two Misses Stows, one of whom was a famous pianoforte player; some of the Griesbachs (well-known musicians), who accompanied on the oboe, or any instrument they could get hold of; and herself, who was one of the nimblest and foremost to get in and out of the tube. "But now," she adds, "lack-a-day! I can hardly cross the room without help. But what of that? Dorcas, in the Beggar's Opera, says, 'One cannot eat one's cake and have it too!'"

She relates, in the same letter, a curious anecdote of the old and celebrated tube. Before the optical apparatus was finished, many visitors took a pleasure in walking through it,—among the rest, on one occasion, King George III. and the Archbishop of Canterbury. The latter following the king, and finding it difficult to proceed, his majesty turned and gave him his hand, saying, "Come, my Lord Bishop; I will show you the way to heaven!"

Then, with that astonishing memory of hers, which kept its greenness until the very last, she notes that this occurred on August 17, 1787, when the King and Queen, the Duke of York, and some of the princesses were of the company.

* * * * *

From another letter we take a lively little picture of a Christmas in Hanover:--

She had been told that keeping Christmas in the German sense was coming to be very general in England; but her shrewd, practical turn of mind induced her to hope that the English would never go "such lengths in foolery." At Hanover, she wrote, the tradespeople had been for many

weeks in full employ, framing and mounting the embroideries of the ladies and girls of all classes; of _all_ classes, for not a folly or extravagancy existed among the great but it was imitated by the little. The shops were beautifully lighted up by gas, and the last three days before Christmas all that could tempt or attract was exhibited in the market-places in booths lighted up in the evening, whither everybody hastened to gaze and to spend their money. Cooks and housemaids presented one another with knitted bags and purses; the cobbler's daughter embroidered "neck-cushions" for her friend the butcher's daughter. These were made up by the upholsterer at great expense, lined with white satin; the upper part, on which the back rested, being wrought with gold, silver, and pearls.

* * * * *

But we must no longer delay the reader by our gossip. Enough has been said to illustrate the character of a remarkable woman, and of those features of it--her cheerfulness, her patience, her industry, her devoted affection, her unselfishness--which all of us may be the better for studying and imitating. Our limits compel us to draw our simple narrative to a close, and we must pass over the delight with which she received and read Sir John Herschel's great work, "Cape Observations,"--a noble monument of the perseverance and strenuous labour of genius; but of twofold interest to her, because it not only testified to the eminent qualities of her nephew, but brought to a noble conclusion the vast undertaking of that nephew's father and her own beloved brother--the survey of the nebulous heavens.

A letter written by her friend Miss Becksdorff, on the 6th of January 1848, describes Caroline Herschel's last days:--

"Her decided objection to having her bed placed in a warmer room had brought on a cold and cough; and so firm was her determination to preserve her old customs, and not to yield to increasing infirmities, that when, upon her doctor's positive orders, I had a bed made up in her room, before she came to sit in it one day, it was not till two o'clock in the night that Betty could persuade her to lie down in it. Upon going to her the next morning, I had the satisfaction, however, of finding her perfectly reconciled to the arrangement; she now felt the comfort of being undisturbed, and she has kept to her bed ever since. Her mental and bodily strength is gradually declining. But a few days ago she was ready for a joke. When Mrs. Clarke told her that General Halkett sent his love, and 'hoped she would soon be so well again that he might come and give her a kiss, as he had done on her birthday,' she looked only archly at her, and said, 'Tell the general that I have not tasted anything since I liked so well.' I have just left her, and upon my asking her to give me a message for her nephew, she said, 'Tell them I am good for nothing,' and went to sleep again."

On the 9th of January 1848 she breathed her last, passing away with a Christian's tranquillity.[1]

[Footnote 1: The particulars recorded in the foregoing pages are chiefly taken from Mrs. John Herschel's very interesting "Memoir and Correspondence of Caroline Herschel."]

* * * * *

Her body was followed to the grave by many of her relatives and friends, the royal carriages forming part of the funeral procession. The coffin was adorned with garlands of laurel and cypress and palm branches, sent by the Crown-Princess from Herrnhausen; and the service was conducted in that same garrison-church in which, nearly a century before, she had been christened, and afterwards confirmed. And, as proving her love and fidelity to the last, in her coffin were placed, by her express desire, "a lock of her beloved brother's hair, and an old, almost obliterated almanac that had been used by her father."

* * * * *

May our readers be induced, by their perusal of these pages, to emulate the Herschels--brother, sister, nephew--in all the bright and lovely qualities that ennoble life; in their fixity of purpose, their elevation of thought, their purity of character, their self-denial, their industry, their hopefulness, and their faith!

[The following inscription is engraved on Miss Herschel's tomb. It begins: "Hier ruhet die irdische Huelle von CAROLINA HERSCHEL, Geboren zu Hannover den 16ten Marz 1750, Gestorben, den 9ten Januar 1848." But, for the convenience of our young readers, we give it in English:--

HERE RESTS THE EARTHLY CASE OF
C A R O L I N E H E R S C H E L.
BORN AT HANOVER, MARCH 10, 1750.
DIED JANUARY 9, 1848.

"The eyes of her now glorified were, while here below, directed towards the starry heavens. Her own discoveries of comets, and her share in the immortal labours of her brother, William Herschel, bear witness of this to succeeding ages.

"The Royal Irish Academy of Dublin, and the Royal Astronomical Society of London, enrolled her name among their members.

"At the age of 97 years 10 months, she fell asleep in calm rest, and in the full possession of her faculties; following into a better life her father, Isaac Herschel, who lived to the age of 60 years, 2 months, 17 days, and has lain buried not far off since the 29th of March 1767."

This epitaph was mainly written by Miss Herschel herself, and the allusion to her brother is characteristic.]

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