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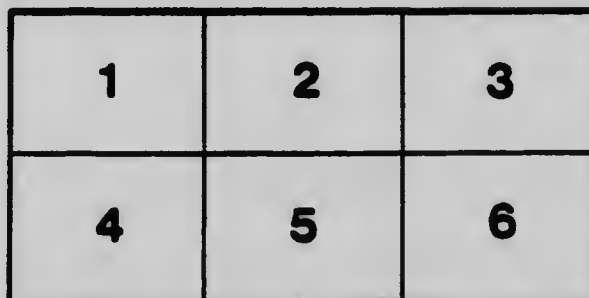
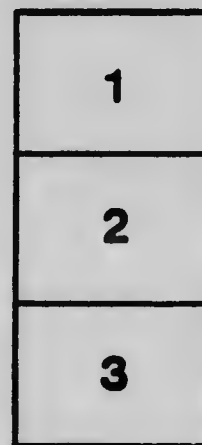
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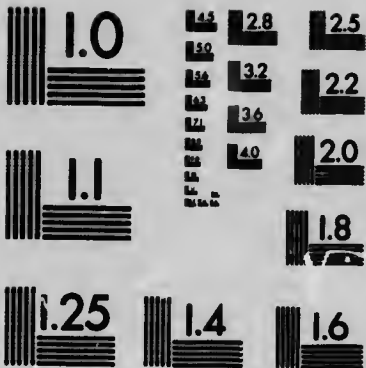
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SIR DAVID GILL, K.C.B.—THE GROWTH, THE
WORK AND THE CHARM OF A REAL
ASTRONOMER .

BY

JOHN A. PATERSON

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PLATE IV.



SIR DAVID GILL, 1843-1914.

From a photograph taken by Professor A. B. Macallum at Pretoria during the Meeting of the British Association for the Advancement of Science in South Africa in 1905.

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SIR DAVID GILL, K.C.B.—THE GROWTH, THE WORK
AND THE CHARM OF A REAL ASTRONOMER.

BY JOHN A. PATERSON.

CENTURIES ago a man rich in mind and power and wealth, holding sway over a great nation and favored of God, made this weighty statement, "Seest thou a man diligent in business, he shall stand before kings, he shall not stand before mean (that is common) men". Later on in the world's history a Scottish philosopher gave utterance to another weighty statement, "Produce, produce, produce something, even if it be but the pitifullest infinitesimal fraction of a product, produce it in God's name—the only monster in this world is the idle man. Blessed be the man who hath found his work, let him ask no other blessedness." Of the two, I frankly confess I prefer Carlyle to Solomon, for his proposition is more striking, it is more rugged, it is more democratic. The subject of our thought tonight illustrates each epigram. David Gill, the watch maker's apprentice, was truly diligent in his business and he did verily stand before the Queen of England, both good and great, and received at her hands a knighthood and thus "bore his blushing honours thick upon him." But in a yet nobler and higher

sense he stood not *before* but *among* kings and was the friend and confidant of prophets, priests, princes and kings of Science, divinely endowed with the very highest intellectual power. For he inhabited a world where dwelt such a galaxy as Lord Kelvin, Clerk Maxwell, Knobel, Darwin, Christie, Lockyer, Hale, J. Couch Adams, the discoverer of Neptune, Lord Lindsay, Newcomb, Airy, Huggins, Struve, Dollen and many more. These were kings indeed. He also not only touched but entered into the very Canaan of a social and aristocratic kingdom where dwelt such men as Sir Bartle Frere, Cecil Rhodes, Earl Grey, once Governor-General of our Dominion, the Khedive of Egypt, Lord Crawford and many more. He also fully illustrated in his life and work the Carlylean maxim, for he was indeed a producer in the realm of Astronomical Science; his work with the Cape heliometer, determination of the solar parallax from observations of Mars, geodetic survey of Rhodesia, his measurement of the arc of a meridian, observations on the comets of 1880, 1882, 1884, 1892, 1899, 1901, 1903, 1904 were but a few stars in the crown of his success. These were indeed far more than the "piti-fullest infinitesimal fraction of a product." And he verily found his work, and he therefore needed no other blessedness, although he rejoiced in many more. With David Gill astronomy was almost a religion. But in the words of Professor George Forbes his biographer "the reverence for his chosen science was tempered by human sympathies"; and we have a most interesting record of his delightful social and democratic life, his humour, his enjoyment of the world and his varied employments, among which even deer stalking occupied a special place. Not only was he skilled in shooting stars, but was an expert in shooting deer, and thus the range of his life was large and varied. He looked at it from so many angles that he was indeed a human polygon. He was not an astronomer for gain, or even for professional renown, or self advancement. He was an astronomer because he could not help it. He sang the song of his life just "as the linnets sing". In a word he did not live by astronomy but he lived for astronomy. To him it was not only a sentiment but a sacrifice, not only a feeling but a fact, not only an emotion but an energy. Duty is a word very much exalted in general estimation but it is cold, metallic, and hard, although admirable. A man for duty only goes at his work with

a tense nerve, a square jaw, a stiff back and an iron resolution, and he no doubt may succeed and he deserves applause. It is hard work, it is pumping up results from some lower depth with infinite labour and perspiration and even pain; but let love animate him and his life is changed, and instead of a laborious uplift his life product pours down as from a crystal fountain, freely, fully and joyfully. And joy is so much better than pain. Tennyson puts it thus:

Love took up the harp of life, and all its chords it struck with might,
Struck the cord of self, which trembling passed in music out of sight.

Gill loved his profession and the whole world loves a lover, he worshipped his science and the whole world revered a worshipper, even indeed if they do not agree with him or even understand him. Moreover, like most men of truly scientific mind, he was an earnest Christian, which characteristic was no doubt helped by his Scottish ancestry and education. General Gordon, known as "Chinese Gordon", bore his own testimony to him for he found a responsive chord to his own heart in Gill's character. On a certain occasion after leaving Gill with a friend he said quietly, as he jerked his thumb towards Gill, "of such is the salt of the earth". Could any man say more?

Following such men as Newton, Kelvin, and Clerk Maxwell, he had, to use Maxwell's words, "a contempt for that pseudo-science which seeks for the applause of the ignorant by professing to reduce the whole system of the Universe to a fortuitous sequence of uncaused events." To such men God was not "a majestic bundle of abstract nouns loosely tied up in impersonality." In his study of Nature he rose from Nature up to Nature's God.

In illustration of his religious character it is recorded that—A dear friend, writing to him in great trouble, received the following reply:

"I have the very deepest sympathy with what you tell me of your inner life—and am thankful that you have found the only solace and guide in all such troubles. We, however, never can have by instinct or by any other way a knowledge of God's purposes towards us—we can only try to do what we believe He would wish us to do.

"In our affections and the closest and dearest relations of life, instinct, if not rendered unreliable by passion or self-interest, is

generally a good guide . . . The simplest rule in all life is to ask one's self what Christ would have done in the circumstances, and then try to do what you honestly believe He would have done. None of us can always do that—but the better we try the better we shall bear and the better we shall be.

Often the things that seem to be the greatest trials in life turn out in the end to be the greatest blessings. You cannot grow a hardy flower in a hothouse—it is the trials of life that make the moral training, just as it is the poor soil, the winter blast, the unwilling harvest, that make the hardy Scot about whom we said not a little on Saturday night at St. Andrew's dinner."

And on another occasion Gill said to the Editor of "Great Thoughts":

There is no subject which appeals, or ought to appeal, more strongly to the imagination than that of Astronomy, nothing which lifts men, or ought to lift them to a higher plane of thought, or gives them a better grasp of the infinite power of the Creator: nothing that exemplifies more completely the unity of design that exists in Nature; nothing that teaches more the Christian lesson of humility and yet, at the same time, affords the highest proof of the intellectual possibilities open to man.

Gill's earthly life began in 1843 and he passed into the great Eternity in 1914. He first looked on the world in the City of Aberdeen, which has produced many other eminent men. His grandfather was a watchmaker, his father was a watchmaker and he himself became a watchmaker's apprentice by his father's direct command, and that direction was so faithfully obeyed for such a period as put all thought of a Cambridge degree out of the question, though he had in him the stuff out of which senior wranglers are made. He attended some sessions of Marischal College, Aberdeen, and was there inspired by contact with Prof. Clerk Maxwell which led to a lifelong friendship between them.

Repairing watches did not suit young David's inclination—we cannot drive a sawlog up-stream, and Pegasus resents being harnessed with a common dray-horse, and so it came about that David drifted away from the watch-maker's bench and soared to the stars. Professor David Thomson of Aberdeen exercised a mighty influence over the career of this weary young watchmaker and budding astronomer. As to the mathematical work of the

Scottish universities, it is worthy of note that in ten successive years in his day they sent to Cambridge five men who gained the senior wranglership in the mathematical Tripos, which is the highest honour Cambridge could give her sons. Gill never became a trained mathematical astronomer, his career had given him no opportunity to cultivate pure mathematics, but he nevertheless possessed what was more valuable, that is mathematical intuition or "*vous*." If he had devoted himself to the worship of the "cross-grained Muses of the cube and square" he would doubtless have become an equally great high priest in that service as he became a most noted and successful conqueror of the skies in the realm of observation. There is no doubt that the facility he acquired in his earlier years in the use of his fingers, handling tools, and executing delicate construction, and experience in mechanical drawing were of untold value to him, and trained him for the construction of delicate instruments and complicated machinery by which he assailed celestial problems, and, with more success than the fabled giants of old, not only reached for but grasped the sovereignty of the stellar universe.

His biographer Professor Forbes divides his life into three periods:

- (1) 1843-1879—The growth of a real Astronomer.
- (2) 1879-1907—The work of a real Astronomer.
- (3) 1907-1914—The charm of a real Astronomer.

At the age of twenty or thereabouts Urania, the Muse of Astronomy, touched his imagination and then fired him into action. He formed the idea of securing an accurate time service at Aberdeen. He met Professor Piazzi Smith at Edinburgh Observatory and succeeded in interesting Professor David Thomson in his efforts. A portable transit instrument, long out of use, was discovered at King's College, Aberdeen, the sidereal clock was overhauled and fitted with an apparatus for the electrical control of other clocks and the young watchmaker had a novel occupation in his leisure evenings. He soon developed further ambitions, and mounted equatorially a second-hand silver-on-glass mirror of twelve inches aperture and ten feet focal length, making the driving clock with his own hands. With this he made many excellent photographs of the moon. At that time Lord Lindsay, son of the Earl of Crawford,

was planning to erect an observatory at Dun-Echt, near Aberdeen, and became naturally attracted to this young Scottish enthusiast—he could not yet claim the title of Astronomer—and Gill became in 1872 the director of the Dun-Echt Observatory. This involved his giving up a flourishing lucrative business, and compelled a heavy pecuniary sacrifice, and with his young wife he took his first upward step into a career that promised no earthly emoluments. He, so to speak, burned his boats behind him and without thinking of fame, yet felt its impulse and followed the beckoning of his angel unconsciously forward to unknown conquests—and to gain crowns undreamed of. He was director of this infant observatory for four years, and there he designed and installed its fine equipment which was a fitting prelude to his greater work in after years at the Cape. At this period he made a visit to the island of Mauritius on the occasion of the transit of Venus in 1874. His use of the four inch heliometer began in preparation for this expedition; this heliometer was afterwards taken to the Cape and was the instrument by which many of his most celebrated researches were made until replaced by a larger one of seven inch aperture which cost £2,200. It may be profitable and even necessary here to define what a heliometer is. It is shortly described as an instrument for the accurate measurement of small angles in the heavens, consisting of a telescope whose objective is cut into halves that may be slid past each other so as to form two images of any object toward which it is pointed. The angular distance between two stars is determined by measuring the displacement of the halves of the objective necessary to cause one image of one of the stars to cover one image of the other star. In the hands of Gill, and especially in his great researches on solar and stellar parallax, it has been recognized as an instrument of the very highest accuracy, measuring the distance between stars correctly to less than a tenth of a second of arc. That angle was said by Sir George Airy, the Astronomer Royal, to be the smallest thing in the world. The wonderful work that Gill did with his heliometer was such that as he exhibited sheet after sheet of results he asked: "Will Airy deny now that there is such a thing as a hundredth part of a second of arc?" And in this connection no one enjoyed the following joke more fully than the Cape Astronomer. This small angle referred to ($0''.01$) is less than

that subtended by a three-penny bit at a distance of one hundred miles. Gill expressed it so in a lecture before a company of Marine Engineers as the most refined measurement attained by astronomers, and he thoroughly enjoyed narrating how the chairman at a dinner in the evening, when proposing the lecturer's health, said there could be no doubt about his nationality, because nobody but a Scotsman would bother about a three penny bit a hundred miles away. This sally had its pith in the fact that Gill's broad Aberdonian Doric and rolling r's not only revealed but proclaimed his nationality to the most casual hearer. But I am anticipating the sequence of history.

In 1877 Gill undertook an expedition to the Island of Ascension with the object of determining the parallax of the sun by observations on Mars, for in that year Mars was nearer to the earth than for the next hundred years and he wanted to do the best that could be done. Before this it had been thought that observations on the transit of Venus would unlock the secret and give the most accurate measurement of the sun's parallax and hence of the sun's distance from the earth. It is interesting to read how nearly the whole expedition was frustrated by an accident to the heliometer. It was mounted in the meeting room of the Royal Astronomical Society and Gill had been working with it and adjusting certain parts of its mechanism when suddenly a loud crash was heard. There stood the iron pillar, but the valuable instrument lay on the floor, and Gill, his face buried in his hands, down which blood was trickling as he had made an ineffectual clutch at the falling mass, called out that everything was ruined: himself, the instrument, the expedition. But his resolution and vitality revived and he said: "Let us see what can be done." He found that the divided object glass protected by a metal cap had escaped injury, but the eye pieces with their tubes were shattered. In the end everything was repaired and the expedition was an entire success. The island of the Ascension is a barren rock, near the island of St. Helena, inhabited by turtles; it is a sort of cinder or clinker ejected from some extinct volcano, and there Gill and his wife with a small party remained for six months in eager search for the secret of the sun's distance from the earth. At that time it was known to be between ninety and ninety-six millions of miles. Astronomers required to know it

within a thousandth of its amount. The result was a parallax of $8''.783$, and this gives the sun's distance as 93,080,000 miles. Later on at the Cape, by observations on minor planets, he worked out the parallax at $8''.802$, and the sun's distance at 92,870,000 miles, which has since been universally accepted. The problem was further attacked by using minor planets, Iris, Victoria and Sappho with a result differing from this by only $1/200$ of a second of arc. The importance of this measurement is very great because the sun's distance from the earth is the foot rule or unit of distance for all celestial measurements. With that as a basis the distances of all the planets can be ascertained by applying Kepler's law, as proved mathematically by Newton that the squares of their years vary as the cubes of their mean distances. The Gold Medal of the Royal Astronomical Society was awarded him in 1882 for his work on the solar parallax, and in the same year he received the Valz Medal of the French Academy of Sciences. In all this great work his charming wife shared with him his hopes, disappointments and triumphs and on that barren rock helped him in all his work in wresting from nature her deeply hidden secrets.

But Gill's greatest life work was when in 1779 he was, in the face of strong competition by W. H. Christie (afterwards Sir Wm. Christie, Astronomer Royal), the then chief assistant of Greenwich Observatory, appointed Her Majesty's Astronomer at the Cape of Good Hope. This position gave him his great and enduring fame as an observer and discoverer in the great realm of Astronomical Science. He was soon acclaimed as one of the prophets, priests and kings of science. Discoveries are often the result of great labour and inductive or deductive reasoning, but they are sometimes the result of accident. The great observing astronomer Kepler discovered his three great laws by a laborious compilation of observations—in a word by induction. Newton, the great mathematical astronomer, did not discover but deduced the same laws by deductive reasoning without observation; he could have worked them out even if he had been physically blind. But some happy chance has often been the parent of a great discovery, although slowly moving Oedipus with the lame foot solves the riddle of the fabled Sphinx, yet swiftly flying Mercury lights easily upon the topmost height of Olympus. Saul went forth to find his father's asses, and behold

he found a kingdom. Astronomy has also its corresponding counterpart. Sir Wm. Herschel, while attempting to measure the distances of double stars, discovered their orbital motions. Astronomers, as we know, were before Bradley's time puzzled at certain irregularities in the apparent motions of fixed stars in a most unaccountable way; they refused to appear where stars of regular habits ought to have appeared. While sailing on the Thames he observed the shifting of a vane on the mast as the boat altered its course, and having been assured that the motion of the vane meant that the boat and not the wind had altered its direction he realized that the position taken by the vane was determined by the motion of the boat and the direction of the wind. From that slight incident he transferred the explanation to the sky, and proved that the apparent shift in the position of a star was referred to a combination of the orbital movement of the earth and the velocity of light, and thus another of Nature's secrets was dragged from her unwillingly and the theory of the aberration of light—a corner stone in the edifice of Astronomical Science was established. When that curious law called Bode's law showed an extraordinary relation of the distances of the planets from the sun, the sequence of which was broken by a blank between Mars and Jupiter, Astronomers sought in vain to discover the missing member of the solar family, the lost sheep of the planetary fold, but had given it up and the perfection of Bode's law was unsatisfied. But Piazzi, when laboriously charting the stars in 1801, accidentally discovered the first minor planet—and Ceres took her place on the star maps as the first of the great family of asteroids which had, with such successful modesty, for untold centuries eluded the observation of their big sister the earth. But the most wonderful example of great discoveries from some accidental complication of circumstances is the well-known story of Newton's discovery of the theory of gravitation when he was driven by a prevailing epidemic to visit the country, and then and there some kindly gust of sportive wind loosened an apple from a tree which fell at the feet of the great philosopher, and awakened in his mind the question, why is this piece of matter here? And why did it fall? So also was it in 1882 when a brilliant comet appeared in the southern heavens at the Cape Observatory so brilliant that it was seen in full sunlight even near the sun's edge.

Gill wished his friends in England to share his joy, and it suddenly occurred to him to strap an ordinary portrait camera to the clock driven equatorial. He thus followed the comet for hours, keeping the cross-wires of the telescope on the head of the comet. The result was a tremendous advance in the pursuit of Astronomical Science and photographic star maps were made, and observers no longer were confined to fleeting observation, but now the possibilities and potentialities of the telescope were both enlarged. The retina of the human eye, although a matchless optical instrument, no doubt receives impressions but cannot hold them, but now the photographic plate receives impressions more completely than human vision, and holds them firmly, so that they can be conveyed from observatory to observatory, from continent to continent, from year to year and from this century to future centuries. The sun, the moon, the stars each writes its own story in luminous letters through the camera and perpetuates what it says. Photographic stars whose light cannot affect the retina of the eye, sensitive though it is, yet in hours of exposure reveal themselves on the sensitive plate of the camera, and are thus discovered and held. Astronomical observatories are no longer necessary for the education of the multitude, but their plates and charts are multiplied, and thus the wonders of the heavens flash their glories where they were formerly unknown and unappreciated. In very truth the branches of the tree of knowledge are brought down so low that the humblest man can reach up and grasp the fruit. Thus is the world enriched. All thanks to the comet of 1882 and to David Gill, this product of the watchmaker's bench. Thereupon was created the C.P.D., the "Cape Photographic Durchmusterung", or star catalogue. That started Dr. Barnard at the Lick Observatory to strap a portrait camera to the big equatorial, and, by eye correction of the driving clock, to produce those wonderful pictures of the Milky Way, and also set the greatest Observatory of Paris to produce those marvellous pictures of the moon that have made the moon a more familiar and friendly neighbour than ever before.

It was about this time that David Gill and Simon Newcomb, the great mathematic astronomer, became personal and scientific friends, and as iron sharpeneth iron, each of them became brighter and clearer. The great Scottish observer and the equally great

American theoretical astronomer found their counterpart each in the other, and each in his own way added many a beautiful pillar or graceful arch or solid column to the great temple of astronomical knowledge. It was really an *entente cordiale* between two great scientists of Anglo-Saxon blood. But they did not always agree; great men in any walk of life do not always agree. Gill would start a subject with Newcomb and then say: "There is where I differ with you. Now you give me your reply and we'll have a scrap." So they held different views as to the Transits of Venus, the last decimal place in the mass of Jupiter or the Moon, or in the constant of aberration and many other vital points in gravitational theory.

Among the princes of science who had the privilege of Gill's friendship was the great Dutch astronomer, Professor J. C. Kapteyn of Groningen, who became the highest authority on stellar motion investigations. He became a collaborator with Gill. The Cape astronomer supplied the plates and the Dutch astronomer undertook the measurement of the plates, the computation of the results and the formation of the Star Catalogue. It was indeed a happy combination. Kapteyn's greatest discovery in cosmical astronomy was announced first at St. Louis in 1904 and then at the Cape in 1905, when the meeting of the British Association was held there. This discovery was that the majority of stars near enough to us to show proper motion are moving in two great swarms in nearly opposite directions. The greatest authorities state that this great discovery has revolutionized our conceptions of the stellar universe, and no doubt it is the mere prelude to greater revelations yet to come. For the progress of the science of astronomy is illustrated by the story of a great painter who was asked what was the greatest picture he had produced and his reply: "That one I am about to paint." The greatest astronomical discovery made is the one which will yet be made. That is paradoxical, but science grows from more to more.

In 1887 Gill attended the Congress of Astronomers at Paris, where he was one of fifty-six units, but he little realized, although the other fifty-five did, that in knowledge and experience of the production and measurement of stellar photographs, and in consideration of their problems he was a very Saul among his fellows. So that from that year to 1914, the date of his death, the members

of that Congress or Comité Permanent would seek to be guided by his judgment towards the completion of the Astrographic Chart and Catalogue. He returned to the Cape in 1887 happy in the possession of his great heliometer and in the reflection that by the acclaim of the great astronomers of the world he had been assigned a position in the great astrographic work, and thus he realized a new feeling of power to do yet greater service. Next to his wife he loved his heliometer, and she records that when in his observatory after spending some hours with his second love, getting data for star distances, he would come into the house in the "wee sma' 'oors ayont the twal'" shouting and singing, and his wife recorded that he was just "daft laughing and joking and so it will be as long as his eye can look through a telescope." This practice would no doubt have been regarded as very objectionable and open to conjugal reproof by a less sympathetic wife, but it is doubtless more admirable to be uplifted with the joy of stellar parallaxes than to be lifted with that cheerfulness and alacrity of spirit that are derived from bottles taken from a cobwebbed cellar and the corks drawn out. The real character of a man is best known when he is off his guard and not posing under restraint or attitudinizing for effect upon the public, and thus it was with David Gill, the man as well as the astronomer. In the year 1900 he received from his sovereign the honour of knighthood, which he earned not only by eminent services to science, but by equally great services to the Empire in the South African War. The sound common sense even in political matters of this clear thinking Aberdonian and honorable patriotic Briton were of immense value to the administration of the South African government. Lord Milner and Sir David were close personal friends, and the Astronomer proved not only to be a mere academician but a valuable far-seeing adviser. On March 6th, 1900, he writes to a friend, "The time for three cheers and ten thousand hurrahs has come at last. Ladysmith relieved, Cronje and 4,000 of his men captured, and Kimberley open. It has been a terrible time of excitement. They all came into my room and some twenty-five of us drank the Queen's health and Roberts' and Kitchener's and Buller's and French's in my best champagne, and sang 'God Save the Queen'. I tried to make a speech and could not." An eye witness gives this account of his speech. "He rose to speak,

not a word could he succeed in uttering. After we had waited through two minutes of expectant silence he sat down at the table with his face between his hands and sobbed. It was the most eloquent speech he ever made." The astronomer was also a man, and he was a Celt; the terrible strain of these few years so suddenly relieved shook him to the very centre, as that same South African War and of this last Great War have almost shattered the pillars of many a man's self control. The tidal wave of his feelings overflowed its limits. But to a geographer of the skies, to a searcher for the limits of creation, those combats, mighty as they were, were in Tennyson's words only the struggle of ants "in the light of a million, million suns."

What are men that He should heed us?
Cried the King of sacred song;
Insects of an hour, but hourly work their brother insect wrong.
While the silent Heavens roll, and Suns along their fiery way
All their planets whirling round them, flash a million miles a day.

In 1905 the British Association for the advancement of Science visited Capetown. This meeting taxed Sir David's business and organizing energies so tremendously that he hardly ever recovered from the effects of it. He retired from the Directorship of the Observatory in 1907. His work as the Cape Astronomer during these twenty-eight years accomplished three great undertakings involving the highest accuracy attainable:

- (1) Geodetic triangulation and the measurement of an arc of meridian.
- (2) Observations of minor planets with a powerful heliometer to obtain a final definitive value of the sun's distance from the earth.
- (3) Observations of apparent stellar displacements, thus measuring star's distances from us.

This great work is thus described by his biographer Professor Forbes:

The force that attracted him to these three researches was the acknowledged difficulty and refinement of the necessary observations, and his belief in himself.

Probably it never occurred to him how intimately these were connected. If we take a broad outlook upon what he actually accomplished in these three directions we cannot fail to be impressed by the completeness of his undertaking. For his own measurements alone, and those under his immediate control, furnished the materials for measuring the distances of many stars, in metres, and comparing

these distances directly with the actual metallic bar which is preserved at Paris as the standard metre.

That he should have been the first systematically to attack the stellar distances, with an instrument which with his own hands and eyes he had proved to be equal to this difficult enterprise, was a splendid thing. But that he himself should have provided all the necessary steps of the measurement and triangulation, from the interior of the *Bureau des poids et des mesures* in Paris, where lies the standard metre, right on by continuous triangulation to α Centauri, Sirius, and a number of other stars, is a feat of measurement which has never been equalled, and is not likely ever to be surpassed.

It may have been an accidental concatenation of circumstances and temperament that led to his doing all this; it is very unlikely that he ever realized that he had accomplished the combined feat. That it was done, and done with such superlative accuracy, has evoked the enthusiasm of all astronomers.

Without dealing with details about precautions, and checks upon the work let us look broadly at a portion of what was accomplished in these three great researches.

First, he procured a measuring bar, transported it to Paris, and measured upon it the exact length of the standard metre.

Second, he took this to South Africa to measure a base line on the ground, a few miles long, and from this base, with a theodolite, he extended his survey by a series of triangles over an arc of meridian.

Third, latitude observations, at the two ends of this arc measured in metres gave him the means of determining the diameter of the earth in terms of the standard metre at Paris.

Fourth, taking a definite portion of this diameter of the earth, as a base line, over which he was carried by the earth's diurnal rotation, he extended his triangulation to the minor planet Victoria. This gave him the scale for measuring the solar system. Thus his triangulation gave him the diameter of the earth's orbit.

Fifth and finally, he still further extended the triangulation which was begun in South Africa, and, using as a base line the diameter of the earth's orbit, over which he was carried by the earth's revolution round the sun, he completed his triangulation from the bar of metal in the Paris bureau to the distant fixed stars.

Thus, without any extraneous help, he measured the distances of the stars with the Paris standard metre.

Stated thus, the stupendous nature of the triple problem captures the imagination. Meanwhile, practical astronomers, studying in sober earnest the voluminous records of the triple undertaking, are uplifted in admiration, not only at the unrivalled skill of hand and eye, not only as the mathematical instinct that guided his steps, but even more at the dogged persistence and steady effort, which enabled him to overcome every obstacle. Other astronomers have had the skill, other astronomers have had the instinct, and other astronomers have had the persistence and steady effort. There are few to whom all have been given to the degree required for the completion of this stupendous work.

In his early years Sir David was a 'crack' rifle shot, and if he had not been appointed as Her Majesty's Astronomer at the Cape would have become eminent as a marksman. At the Cape he was a successful deer stalker and in his later years, when he returned from South Africa, he was always a welcome guest on the moors and deer forests of Scotland and the English coverts. His great skill in observing, his handling the telescope and its many minute appurtenances, his steady hand, delicate touch and clear sight were simply sequences to his skill with the rifle.

On October 1906 Sir David Gill left the Cape but with no signs of failing vigour; on the contrary he plunged into a strenuous life of scientific activity in London. He became President and afterwards foreign Secretary of the Royal Astronomical Society, President of the British Association at Leicester, and in many other positions, became a centre of energy and initiative. Universities and learned societies through the world honoured themselves by ranking him on their Rolls of Distinction. Some of these may be stated: Knight of the Prussian Order pour le mérite; Commander of the Legion d'Honneur, Hon. LL.D. Aberdeen and Edinburgh, Hon. D.Sc. Oxford, Cambridge, Dublin and Cape of Good Hope. Rome, Amsterdam, Petrograd, Washington, Sweden, Boston, Philadelphia, South Africa were proud to inscribe his name on their rolls of fame. Science has indeed no geographical boundaries, no "pools of salt and plots of land" separating her devotees. Indeed we may add that her domain extends through the entire universe, wherever light shines, or orbs roll, or space extends, and also for all time, from when the morning stars sang together down to the remotest hour in the great everlasting. Her kings and prophets form a mighty army.

This address would however be less complete without some references to the human side of Sir David which illustrate the charm of the real astronomer and put him among his fellow-men.

After his retirement, when resident in London, he became what he called "a dress-coat astronomer", and many a table found him a genial companion and a brilliant raconteur. Earl Grey from Ottawa wrote to "my dear Astronomer" and they swapped yarns. Here follows one written to him at Johannesburg by the Earl from Government House, Ottawa:

Here is a story which will amuse you. A Custom House officer put the usual question to an American lady the other day on arrival at New York, as to whether she had any dutiable goods. "No, nothing but wearing apparel," she persisted, and showed some indignation when the Custom House officer, distrusting her word, proceeded to open her box and rummage right to the very bottom. With triumph he pulled out from below her dresses two big magnums of whisky, and holding them by the neck, asked the lady what she meant by saying that she had nothing in her box but wearing apparel. "I stated what was the truth", said the lady, "for you hold in your hand my husband's night-caps!" The official immediately withdrew his claims, and the lady withdrew in triumph.

Can you send me back a better one which I can tell Sir Wilfrid Laurier, whose story this is?

I am much distressed that you are not able to give me a better account of your delightful wife. Please give her every assurance of my continued devotion.

GREY.

Sir David was never at a loss for a *bon mot*, which is saying a good deal for a Scotchman and especially an Aberdonian, as for example:

One evening after his retirement he was a guest at a reception in a certain lady's London house. He and a most distinguished ecclesiastic were in close juxtaposition when their hostess advanced and addressed them in these words: "I want to make the greatest astronomer in the world and the greatest preacher in the world acquainted," and after introducing them, moved off. There was dead silence between the two men for some seconds. Then Gill looked his companion in the eyes, and said with his humorous twinkle: "It is not often that either of us meets such a distinguished man." This broke the ice.

Sir Flinders Petrie recalls a remarkable characteristic story of an astronomer. "At a Royal Society meeting Dr. G. E. Hale was describing his marvellous solar photographs in a single spectral ray. At the end of the address the President asked Sir David if he would say something. He rose slowly to his full height and said: "Wor-r-r-shipful admir-r-r-ation," and sat down again.

Here is another Gillianum. It was after a pheasant shoot, and at the supper when the day ended Gill told this: Two Scotsmen met one another. "Well hoo are ye, an' the wife". "Oh the wife's deid". "Ah so! and hoo was it?" "You see I found her poorly so I just gae her a powther the doctor had aince pit up for me that

I didn't use, and in twa hoors she was deid. Eh man I was terrible glad I had na ta'en it mysel!"

These are a few excerpts from the most interesting biography written by Professor Forbes, to which work I have been much indebted in preparing this sketch. These are only a few illustrations of this many-sided man's character,—a few pictures, so to speak, taken from the wall of his social life which to some degree reflect the charm of his private character. What would life be without humour? It is the slackening of the bow string, it is the mind's vacation which rests and thereby strengthens the mind's vocation. There are no great books, nor any great forces in human life which are devoid of it. As Sidney Smith says: "Man could direct his ways by plain reason, and support his life by tasteless food; but God has given us wit and flavour and brightness and laughter and perfumes to enliven the days of man's pilgrimage and to "charm his pained steps over the burning marle."

Sir David Gill's death followed not long after that of another famous astronomer, Sir Robert Ball, whose funeral he attended and there caught a chill, which eventually carried him off, and on the 24th of January, 1914, he bade goodbye to this proud world and went home. Thus did this great star computer rest from his earthly work and went hence where "the stars wander with golden feet", but yet are all shepherded by Almighty power and guided in their courses by Divine wisdom. And now we for a moment revert to our opening sentence for here was a "man diligent in his business". Astronomy does not suggest repose. It does not say to its votaries "Sleep on now and take your rest." On the contrary it calls us to industry, struggle and achievement. The never ending rush of the spheres rebukes man's idleness, it stimulates action and then energy is contagious. In these ever-circling orbs the Divine being has declared His own forcefulness and made proclamation that whatever man finds to do he should do it with all his might. Nature abhors a vacuum of matter, and these Scriptures of the Sky bid us abhor a vacuum of energy in our lives, and present to us an object lesson of ceaseless activity. Let such a lesson permeate and inspire each life, and let no one hide his talent, even if it be only one, but let it "produce something even if it be but the pitifullest infinitesimal fraction of a product". And thus we end where we began.

