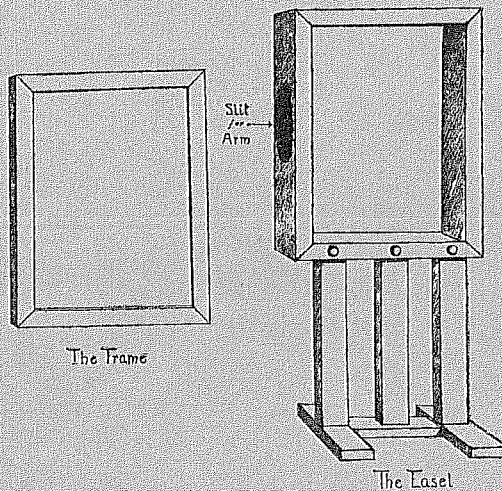# The Open Court

A MONTHLY MAGAZINE

Devoted to the Science of Religion, the Religion of Science, and the Extension of the Religious Parliament Idea

Founded by EDWARD C. HEGELER

MECHANISM USED FOR SPIRIT PICTURES.

This contrivance has puzzled investigators for years and has made many converts to mysticism, occultism and spiritism. (See pp. 246-249.)

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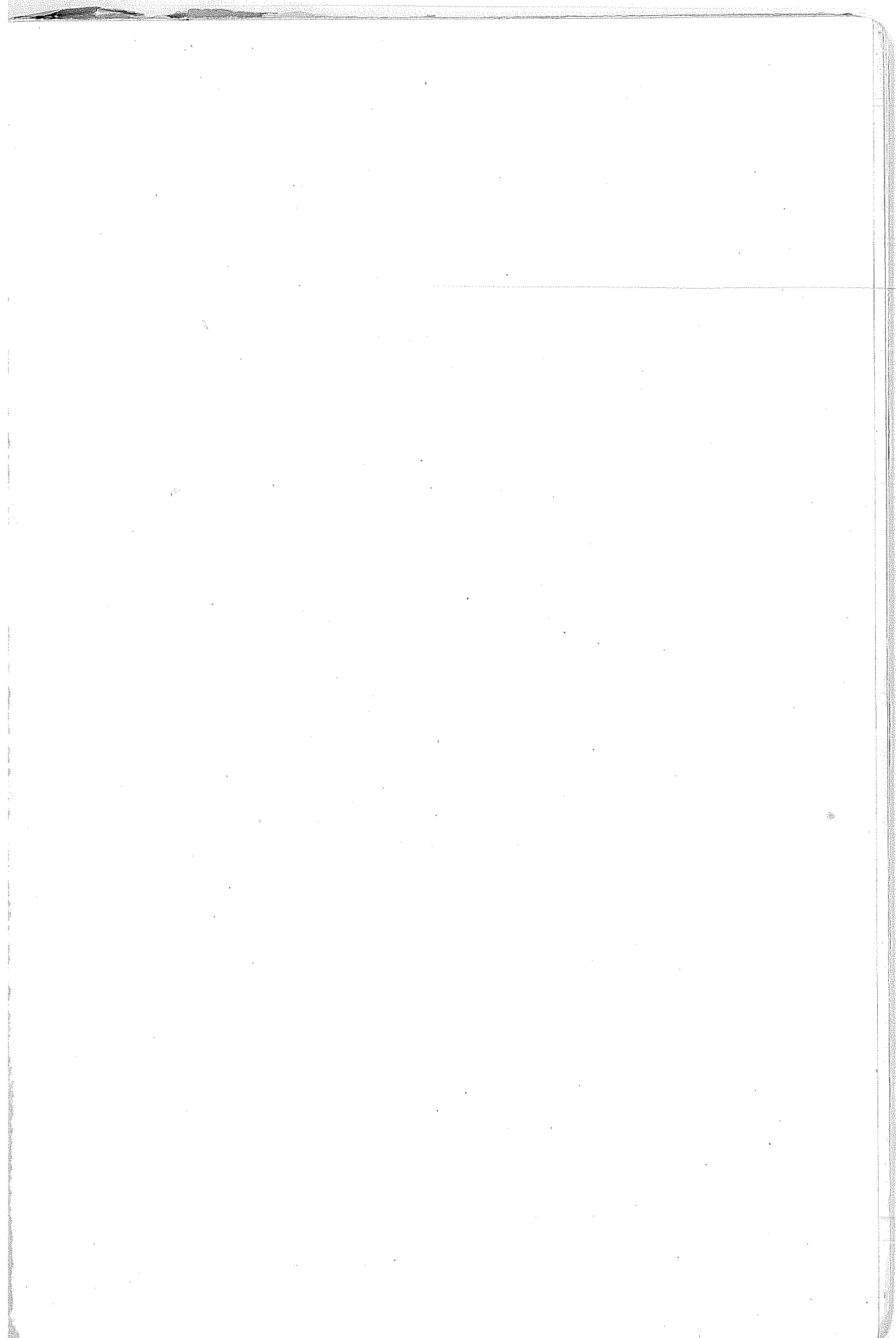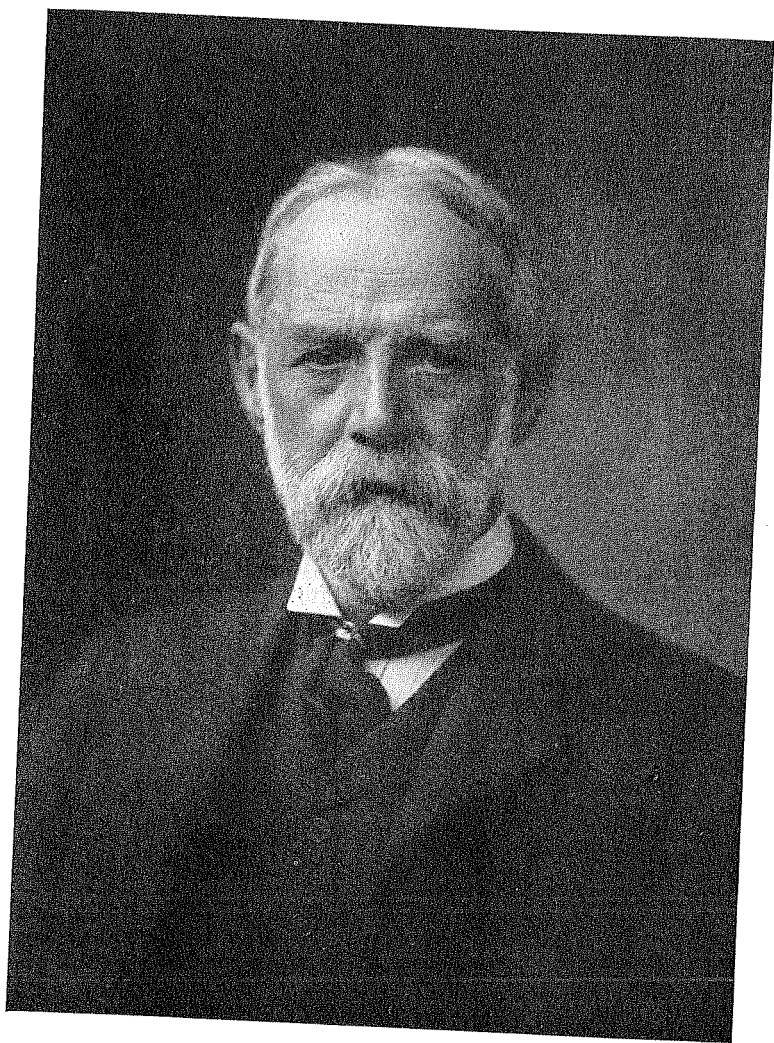
SIR GEORGE DARWIN.
(1845-1912.)
From a recent photograph.
Frontispiece to The Open Court.

SIR GEORGE DARWIN: A BIOGRAPHICAL SKETCH.

(1845-1912.)

BY PHILIP E. B. JOURDAIN.

I.

GEORGE HOWARD. DARWIN, the second son of Charles Darwin, was born at Down in Kent on July 9, 1845, at the house where Charles Darwin's experiments with plants were conducted. He and his three younger brothers—Sir Francis Darwin, Major Leonard Darwin, and Mr. Horace Darwin—give a most striking example of the inheritance of intellect. Mrs. Charles Darwin (Emma Wedgwood) was the youngest child of Josiah Wedgwood who was the second son of Josiah Wedgwood of Etruria, the great potter. It appears that George owed his mathematical tendency to the Wedgwoods and the Galtons, to whom he was also related, and not to the Darwins. The attractive character of Charles Darwin and the wonderfully charming family life of the Darwins are admirably described in Mr. (now Sir) Francis Darwin's *Life and Letters of Charles Darwin,* published in 1887, and in *Emma Darwin; Wife of Charles Darwin: A Century of Family Letters* (by her daughter H. E. Litchfield), privately printed at the Cambridge University Press in two volumes in 1904.

In such happy surroundings, George Darwin, a promising and merry child,[1] grew up. That quiet humor which seems to be one of the qualities which make all the Darwins so lovable, was possessed also by Mrs. Charles Darwin. In 1887 she wrote:[2]

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[1] *Emma Darwin,* Vol. II, p. 156.

[2] *Ibid.,* p. 379.

"I am wading through Emerson, as I really wanted to know what transcendentalism means, and I think it is that intuition is before reason (or facts). It certainly does not suit Wedgwoods, who never have any intuitions."

If this is true, and if George Darwin inherited his mathematical ability from the Wedgwoods, he would be an unconscious refutation of Kantianism! But, whatever mathematical heritage the Wedgwoods may have bequeathed does not appear to have been previously much used by them. The only Wedgwood, I think, who has made any mark in science is the invalid Thomas Wedgwood[3] (1771-1805), who, before Daguerre or Talbot, made experiments in photography, and anticipated von Groese in devising an operation for the cure of conical cornea.

Besides this quiet humor, other characteristics which seem to be common to all Darwins are a charming modesty and a winning and childlike *naïveté*. It is sometimes difficult to distinguish between the quiet humor and the *naïveté*. One of Sir George's daughters, when a small child some years ago, attended a drawing-class in Cambridge. The drawing-mistress had just explained the great similarity of human and monkey's bones; so the child, with real or assumed innocence, asked shrilly: "Wasn't there a man once who said we were all descended from monkeys?"

George Darwin, like Charles Darwin's other children, greatly helped his father in his scientific work. To him are due some of the illustrations in, for example, *Insectivorous Plants*; and it was he who worked out the problem of the fertilization of the orchid where pollenization is done by a microscopic fly which carries off the pollen bags on its two front legs.

II.

George Darwin went to the school kept by the Rev. Charles Pritchard, a Fellow of the Royal Society and afterwards Savilian Professor of Astronomy at Oxford. Under Pritchard's able tuition, he made such good progress in mathematics that he came to Trinity College, Cambridge, in 1864, as a mathematical scholar, took his degree as second "Wrangler"[4] in 1868, and, in the same year, was second Smith's prizeman. In this year, too, he was elected a Fellow of Trinity. After some years of residence at Cambridge he had the

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[3] See *The Value of a Maimed Life. Extracts from the Manuscript Notes of Thomas Wedgwood;* selected by M. O. Tremayne, with an introduction by (Mrs.) M. E. Boole, London, 1912.

[4] The present Lord Moulton (Fletcher Moulton, the eminent King's Counsel) was senior wrangler in that year.

idea of becoming a barrister, and was called to the Bar in 1874, but never practised.

In 1870, after accepting the offer to make one of the Government party going to Gibraltar to see an eclipse of the sun, George Darwin narrowly escaped shipwreck.[5] From the period before his election to a professorship at Cambridge date a statistical memoir on the marriage of first cousins, an early example of the present exact investigations in cognate biological domains, and the beginnings of his striking contributions to the subject of the evolution of the solar system—especially the system of the moon and the earth—and to cosmogony in general.

Considerations of health had prompted his return to Cambridge, where he had devoted himself to researches in dynamical astronomy. He was elected to the Plumian chair of Astronomy and "Experimental Philosophy"[6] in 1883, and in 1884 was reelected Fellow of Trinity, his Fellowship having expired in 1878. In 1884 he married Maud, daughter of Charles Dupuy of Philadelphia and niece of Lady Jebb.

III.

His long and close friendship with Sir William Thomson (Lord Kelvin) probably influenced Darwin's work considerably. Darwin took up, organized, and greatly extended the systematic observation of the tides initiated by Lord Kelvin, and in the second edition of Thomson and Tait's *Treatise on Natural Philosophy* the important chapter on the tides was written by Darwin. The preface to his *Collected Scientific Papers* contains an eloquent expression of the warmth of Darwin's feeling for Kelvin. The first volume of these *Papers*—of which the fourth and last was issued by the Cambridge University Press in 1911—relates to tidal theory, was dedicated to Kelvin, and contains the words:

"Early in my scientific career it was my good fortune to be brought into close relationship with Lord Kelvin. Many visits to Glasgow and to Largs have brought me to look up to him as my master, and I cannot find words to express how much I owe to his friendship and to his inspiration."

It is certain, as Sir J. J. Thomson says, that there were few

[5] *Emma Darwin,* Vol. II, pp. 235-236.

[6] Since the time of Newton the word "philosophy" has often been used in England as synonymous with "science." Sometimes the substitution of "philosophical" for "scientific" had the most comical results. Thus, at the beginning of the nineteenth century, a certain hairdresser in London used to advertise that he cut hair on "philosophical" principles.

men of science to whose opinion Kelvin would pay the attention that he paid to George Darwin's. The practical developments of tidal theory and prediction, worked out mainly by Darwin, were published in a series of reports to the British Association from 1883 onward.

The recognition of lunar tidal friction as a cause of lengthening of the day goes back to Kant.[7] The problem as to how the tidal loss of energy is divided between the earth's rotation and the lunar orbit had baffled Airy; it had been shown by Purser that the principles of energy and momentum conjointly can lead to its solution; but it remained for Darwin (1879) to develop, by the aid of graphical representations which have become classical, most striking inferences regarding the remote past history of our satellite. This discovery was the starting point of a series of memoirs in the next subsequent years, which applied similar procedure to the precession of the equinoxes and to other features of the solar system.

It was in these researches that Darwin began to work in the same domain of science as Henri Poincaré, whose regretted death also took place last year. Both engaged in the examination of the mutual attractions of rotating spheres of fluid, such as primitive planets, suns, and satellites may be supposed to be. For a number of years the two mathematicians, French and English, worked at the task, supplementing one another's work, adding something to it here and criticizing there till in certain cases solutions of the problem were obtained. Some forms of the solution were popularly indicated by Darwin in his presidential address to the British Association when it met in South Africa in 1905. A spinning liquid planet, as its rotation increased, would eventually become egg-shaped. Then, he went on to point out, one of the two ends of the egg would begin to swell; and the swelling would become a well-marked protrusion or filament. The protruding filament would next become bulbous at one end, and would be joined to the main mass only by a gradually thinning neck. Finally the neck would break and we should be left with two separated masses which might be called planet and satellite.

In some such wise Darwin imagined the moon to have become separated from the earth, and the place of mathematical reasoning with which his name will always be associated is that of having estimated the effects of tidal friction during the separation of the

[7] *Allgemeine Naturgeschichte und Theorie des Himmels oder Versuch von der Verfassung und dem mechanischen Ursprunge des ganzen Weltgebäudes, nach Newtonischen Grundsätzen abgehandelt* (1755). There is a convenient edition of this edited by A. J. von Oettingen, in No. 12 of *Ostwalds Klassiker*.

earth and the moon and the gradual increase of distance between these two bodies under the operation of tidal effects. The article on "Tides" in the ninth edition of the *Encyclopædia Britannica* and a summary, in an easily intelligible form, of his reasoning in a volume entitled *The Tides and Kindred Phenomena in the Solar System,* published in 1898[8] and being developed from a course of Lowell lectures delivered at Boston, are in some sense epitomes of a mass of work ranging over many years, and contained in papers published in the *Proceedings* and *Philosophical Transactions* of the Royal Society of London. Other and kindred topics were the mechanical conditions which exist in a swarm of meteorites; and the consideration of periodic orbits.

The last-named subject was intimately connected with special cases of the most complex of all problems of mathematical astronomy, the "problem of three bodies." Newton worked out the problem of two bodies which mutually attract one another. When a third body is added for consideration the complexities are such that no general solution can be obtained by any mathematical method known. Darwin referred as follows to his own contributions to special cases of the problem when addressing, as president, the International Congress of Mathematicians held at Cambridge in August last: "To the layman the problem of three bodies seems so simple that he is surprised to learn that it cannot be solved completely, and yet we know what prodigies of mathematical skill have been bestowed on it. My own work on the subject cannot be said to involve any such skill at all, unless, indeed, you describe as skill the procedure of a housebreaker who blows in a safe door with dynamite instead of picking the lock. It is thus by brute force that this tantalizing problem has been compelled to give up a few of its secrets, and great as has been the labor involved, I think it has been worth while. To put at their lowest the claims of this clumsy method, which may almost excite the derision of the pure mathematician, it has served to throw light on the celebrated generalizations of G. W. Hill (an American mathematician) and Poincaré."

Sir Joseph Larmor says of Sir George Darwin:

"His studies in astronomical evolution necessarily required him to push the history of the motions of the planetary bodies back into the past, far beyond the times for which the usual practical approximations of gravitational astronomy are suitable or valid. To this end he began to apply a process of step-by-step plotting to the

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[8] The preparation of a new edition of this book, expanded, and in part rewritten to include recent developments, was one of the last works of his life.

determination of orbits in the classical problem of three bodies, essayed in simpler cases by Lord Kelvin, but in its adequate use laborious, and demanding skill in arrangement of arithmetical processes; this work culminated in an extensive memoir in *Acta Mathematica* in 1896. The maps of families of orbits there published attracted the attention of other mathematicians. In particular, Poincaré—utilizing the general mode of discrimination and classification which he had already employed with signal success in Lord Kelvin's and George Darwin's problem of the forms possible for fluid rotating planets—pointed out the necessary existence of some intermediate classes that had escaped the analysis. And S. S. Hough, Royal Astronomer at the Cape, who had in his Cambridge days collaborated with Darwin in tidal theory, followed with a memoir devoted to fuller developments. This fascinating subject continued to occupy Darwin's attention up to the end of his life; one of his last public appearances in London was to communicate a paper on it to the Royal Astronomical Society."

In the same strain, Sir J. J. Thomson says:

"Any one turning over the pages of the four volumes of his *Collected Papers* published by the University Press must be struck by the extraordinary laborious nature of the work of which they are the record. Other distinguished mathematicians have indulged in laborious arithmetical calculations from time to time, sometimes as a grim sort of recreation, for example, Adams calculated Bernoulli's numbers to an almost extravagant degree of accuracy, but with Darwin these calculations went on uninterruptedly. Many of his most important discoveries were made by doing a prodigious quantity of 'sums' rather than by any refinement of analysis. For example, his celebrated paper on orbits, in which results of the highest scientific importance and suggestiveness are obtained, is a kind of apotheosis of arithmetic. Mathematicians have not as yet discovered any general method of dealing with these orbits; Darwin calculated them, so to speak, inch by inch. Few have the qualifications to wield this method; it requires not merely exceptional industry and doggedness, but also a kind of genius for order and symmetry, otherwise the work will degenerate into mere tabulation of numbers. Darwin possessed to the full the Darwinian characteristic of sticking doggedly at a problem until he had found a satisfactory solution. The amount of work he got through is all the more surprising from the fact that his health was never very robust; indeed, I remember hearing him say some years ago that he could

hardly remember a day in which he had not suffered acute physical discomfort."

For the benefit of mathematicians, it may be remarked, as an example of the tremendous labor which some of Darwin's work involved, that the papers on the pear-shaped figure required a reduction of ellipsoidal harmonics to a form suitable for arithmetic, and the processes were all carried to squares. Now, even the reduction of spherical harmonics to squares is sufficiently laborious. The work on periodic orbits was done by pure quadratures.

IV.

These gigantic calculations were rather a contrast to some of his lectures. His eldest son, Mr. C. G. Darwin, wrote to me: "I attended my father's lectures once, and there were a lot of interesting deductions in the theory of potential worked out in some way different from the ordinary one, and very simple.... There were other very nice questions discussed, such as what size might be an irregular lump of granite before it would collapse under its own gravitation. In his lectures, I think that the thing with which he was most pleased was a simple exposition of the very complicated mathematics in Hill's Lunar Theory. Indeed, he suggested to me not long ago that it would be worth while considering whether it might be published."

I well remember hearing a friend of mine, just after coming from one of Darwin's professorial lectures on dynamical astronomy, express his enthusiastic admiration of the way in which Darwin subjugated his problems by extremely simple mathematical methods. The successful use of simple methods in science is again a Darwinian *trait,* but a *trait* which Darwins share with some others of the world's greatest men. With some of these, too, Charles Darwin and George Darwin share the glory of living laborious lives and doing work of the highest order under the burden of an almost ceaseless physical discomfort.

V.

After his presidency of the British Association in 1905, Darwin was knighted. He had received a Royal Medal from the Royal Society in 1884, and, in 1911, gained the highest distinction that England can confer on a man of science, namely the Copley Medal of the Royal Society. On this occasion he protested that its early bestowal was due in his case to the merely practical applicability of some of his investigations. One of these was concerned with the

pressure of loose earth, a subject of supreme interest to engineers and one for which he received another medal from the Institute of Civil Engineers. His experiments for the paper were made in his rooms at Trinity with a wooden box, a piece of tarpaulin, a heap of sand and a biscuit tin. One day when he was ladling sand from box to biscuit tin he said to his observant bedmaker: "This is a funny sort of job, Mrs. Pleasants;" to which she responded, "Oh, yes, sir, but it amuses you." That, remarked Sir George to his audience, was the attitude of the British people towards science.

<p style="text-align:center">VI.</p>

Sir George Darwin's last appearance in public was as president of the fifth International Congress of Mathematicians at Cambridge on August 22 to 28 of last year. Those who attended the Congress will remember the energy and charm of Sir George and Lady Darwin during what many would find arduous and tedious functions. A few weeks afterwards it became known that he was suffering from a disease from which there was no prospect of recovery. He died on December 7, 1912.

Sir George Darwin was an honorary member of practically every scientific society of repute in Europe and America. As president of the British Association when it met in South Africa in 1905, his own personality and that of Lady Darwin helped to make the meeting a great success. Indeed, Lady Darwin's kindliness and hospitality were as great as her organizing capacity; and, besides being on numerous committees—such as the Girton Laundry and the Boys' Employment Registry—and taking a large part in the management of the Arts and Crafts guild and the technical classes, she was secretary to the Ladies Discussion Society of Cambridge for a long and prosperous period. This society, it is interesting to recall, was started by Mrs. Creighton, Mrs. Lyttleton, Mrs. Marshall, and Mrs. Sidgwick; the first secretary was Mrs. Prothero, Mrs. Horace Darwin followed her and in time was followed by Lady Darwin.

Sir George not only organized tidal and meteorological observations. His invaluable aid and powers were given to university and college administration and organization as well as to the Royal Society and Government and especially to the great trigonometrical survey of India, the predecessor of the vast geodetical operations now being carried out in the United States. Sir George was the British representative on the International Geodetic Association; a very successful meeting of it at London and Cambridge in 1909 was

organized by his care, and he was preparing to go to its meeting at Hamburg last September when prevented by his fatal illness.

He also, as Sir J. J. Thomson remarks, "did his full share of the irksome work of reporting on papers for scientific societies, for the university, and for Trinity College. Again, the subject of the tides and the evolution of the solar system, on which he was recognized to be the leading authority, is one that attracts many people who have more enthusiasm than scientific training or sound judgment, and who expend years on developing theories which they embody in papers of great length. I know nothing more distressing than to have to deal with papers of this kind; the authors have often spent the best years of their lives on these theories, they write with a modesty which but ill conceals their confidence that they have made an epoch-making discovery which has but to be published to make them immortal; in general their work is quite worthless, and one has the hateful task of dimming their bright expectations. Darwin always seemed to me very sympathetic in such cases. If he could discover a lucid spot he made the most of it, and certainly, in one instance at least, turned a crank into a useful worker in science. As an example of the care with which he read essays submitted to him, I may mentions that shortly after I had taken my degree I received from him a letter of eight closely written pages, containing most valuable advice and criticism on an essay of mine on which he had to adjucate."

I must acknowledge my indebtedness, in preparing this biography, to Sir Joseph Larmor's notice in *Nature* of Dec. 12, 1912; to Sir J. J. Thomson's in *The Cambridge Review* of Jan. 16, 1913, to a biography in the *Morning Post*,[9] to Mrs. Litchfield for kind permission to quote from a book that was edited by her and privately printed; and to the Hon. Mrs. Horace Darwin, Mrs. Cornford, and Mr. C. G. Darwin, for some other details.

[9] There is also a good notice of Darwin's work in *The Observatory* for January of this year.