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Mary Somerville (*née* Fairfax) was born at Jedburgh on December 26, 1780, and died on November 30, 1872, at Naples, aged nearly ninety-two years. In considering her education, we have not to mention important seminaries, where skilled teachers make it their chief business to impart to others the knowledge for which they are themselves eminent, but to speak only of studies pursued in the calm of a quiet home. This, rightly understood, is perhaps the most remarkable feature of her career. There are few mathematicians so eminent as she deservedly was, in whose fame great public schools and universities do not in some degree partake. But we owe almost to accident the discovery of the powers of Mary Fairfax's mind, while the gradual development of those powers proceeded under the guidance of tutors unknown to fame, and with access only to such assistance as could be given by the friends of her own family.

Mrs. Somerville has herself described how it chanced that the peculiar powers of her mind came first to be recognised. She was in the habit of working at her needle in the window-seat, while her brother took his lessons in geometry and arithmetic. Fortunately (in her case) the work which is regarded as most suitable to the capacity of women leaves the mind unoccupied; and consequently there was nothing to prevent Mary Fairfax from attending to the lessons intended for her brother. She gradually became interested in the subject of these lessons, and took care not only to be present regularly, but to study her brother's books in her own room. It happened that, on one occasion, young Fairfax failed to answer a question addressed to him, and his sister involuntarily prompted him. The tutor was naturally surprised that the quiet Mary Fairfax should have any ideas beyond the needlework which had apparently engaged her attention; but, being a sensible man, he was at the pains to ascertain the degree and soundness of her knowledge; and, finding that she had really grasped the first principles of mathematics, he "took care that she should have liberty to go on in her own way." If a boy had shown similar fitness for mathema-

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tical research, anxious attention would have been devoted to the choice of books and teachers, school and university; but the case of a girl showing such tastes seemed to be adequately met by according to her the privilege of following her own devices. We shall never know certainly, though it may be that hereafter we shall be able to guess, what science lost through the all but utter neglect of the unusual powers of Mary Fairfax's mind. We may rejoice that, through an accident, she was permitted to reach the position she actually attained; but there is scarcely a line of her writings which does not, while showing what she was, suggest thoughts of what she might have been.

While studying mathematics "in her own way," she found a difficulty which for a time threatened to interfere with her progress. She was unable to read the *Principia*, because she could not understand Latin. In this strait, she applied, "after much hesitation," to Prof. Playfair. She asked if a woman might, without impropriety, learn Latin. After ascertaining the purpose which the young lady had in view—possibly in doubt lest she might follow in the steps of Anne Dacier—Prof. Playfair told her that it would not, in his opinion, do her any harm to learn Latin in order to read the *Principia*. It is noteworthy, as having probably a bearing on the course which Mrs. Somerville's reading subsequently took, that Playfair was one of the few in this country who at that time appreciated the methods of the higher mathematical analysis, and had formed a just opinion of their power—"a power, however," as Sir John Herschel well remarks, "which he was content to admire and applaud rather than ready to wield." His excellent review of the *Mécanique Celeste* probably gave (as Herschel suggests) a stronger impulse to the public mind in the direction of the higher analysis than he could have communicated by any researches of his own.

It was not, however, as a mathematician that Mrs. Somerville first became known to the world. A subject of research, exceedingly difficult and only to be pursued successfully under very favourable conditions, was undertaken by her during the life of her first husband, Captain Greig, son of High Admiral Greig of the Russian Navy. She sought to determine by experiment the magnetising influence of the violet rays of the solar spectrum. "It is not surprising," says Sir John Herschel on this subject, "that the feeble though unequivocal indications of magnetism which she undoubtedly obtained should have been regarded by many as insufficient to decide the question at issue." Nevertheless it was justly regarded as a noteworthy achievement that in a climate so unsuitable as ours any success should have been attained in a research of such extreme difficulty. That she achieved, and, what is more, deserved success, will be inferred from the words in which Sir John Herschel indicates his own opinion of the value of her results: "To us," he says, "their evidence appears entitled to considerable weight; but it is more to our immediate purpose to notice the simple and rational

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manner in which her experiments were conducted, the absence of needless complication and refinement in their plan, and of unnecessary or costly apparatus in their execution, and the perfect freedom from all pretension or affected embarrassment in their statement."

In 1832 Mrs. Somerville published the work on which, in our opinion, her fame in future years will be held mainly to depend. The *Mechanism of the Heavens* was originally intended to form one of the works published by the Society for the Diffusion of Useful Knowledge, though it soon outgrew the dimensions suited for such a purpose. Indeed, it is remarkable that either Mrs. Somerville herself or Lord Brougham, at whose suggestion the work was undertaken, should suppose it possible to epitomise Laplace's *Magnum Opus*, or so to popularise it as to bring it within the scope of the Society's publications.

It will be well, in weighing the value of the book, to consider it first with reference to the purpose of its author, though a judgment based on that consideration alone would not be a fair one. These, then, are the words in which Mrs. Somerville presents the scope and purpose of her work:—

"A complete acquaintance with physical astronomy can only be attained by those who are well versed in the highest branches of mathematical and mechanical science: such alone can appreciate the extreme beauty of the results, and the means by which these results are obtained. Nevertheless, a sufficient skill in analysis to follow the general outline, to see the mutual dependence of the several parts of the system, and to comprehend by what means some of the most extraordinary conclusions have been arrived at, is within the reach of many who shrink from the task, appalled by difficulties which perhaps are not more formidable than those incident to the study of the elements of every branch of knowledge, and possibly overrating them by not making a sufficient distinction between the degree of mathematical acquirement necessary for making discoveries and that which is requisite for understanding what others have done. That the study of mathematics, and their application to astronomy, are full of interest, will be allowed by all who have devoted their time and attention to these pursuits; and they only can estimate the delight of arriving at truth, whether it be the discovery of a world or of a new property of numbers."

It cannot be doubted that Mrs. Somerville here indicates her belief in the possibility of presenting her subject in a form suited to the capacities of a large number of readers, and to some extent advocates this as her object. Whether she succeeded or failed in this purpose must therefore be the first question to engage our attention. Sir John Herschel considers that she succeeded, "for all those parts of" her subject, at least, which the work "professes to embrace, that is to say, the general exposition of the mechanical principles employed,—the planetary and lunar theories, and those of *Jupiter's* satellites, with the incidental points

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naturally arising out of them." With the utmost respect for the authority of one who was so thorough a master of the subject which Mary Somerville endeavoured to popularize, we venture to express a different opinion. We find it impossible to come to any other conclusion than that, as respects the main purpose of her work, Mrs. Somerville failed entirely; though we hasten to qualify this statement by the remark that in our opinion success was altogether impossible. We believe, in fact, that neither Mrs. Somerville nor Sir John Herschel thoroughly apprehended the difficulty of conveying to the general reader clear ideas respecting even the elements of the subjects they severally endeavoured to expound. But we feel bound to add that Mrs. Somerville's failure, inevitable from the very nature of her task, would in any case have been brought about by the manner in which the task was accomplished. It will presently be seen that in saying this, we are, in fact, touching on the most remarkable and distinguishing quality of Mrs. Somerville's mind.

There are two essential requisites in a treatise intended to introduce a difficult subject to general readers. First, there must be a clear apprehension of the position of such readers, of what they can and of what they cannot understand, and of the form in which what is written for them may most usefully be presented. It is not too much to say that if just ideas had been entertained by Mrs. Somerville on this point, the attempt to present the *Mechanism of the Heavens* in a popular form would never have been made. But secondly, it is essential that in any work of the kind, each statement—each sentence, in fact—should be presented in terms so precise as to be absolutely unmistakable. This is not so necessary in advanced treatises,—indeed, it is too well known how large a proportion of our works on advanced science are wanting in strict precision of expression. But it is absolutely necessary in works intended to popularize science. It is a somewhat remarkable circumstance that in the *Mechanism of the Heavens*,—the boldest attempt ever made, perhaps, in this direction,—not only is precision of expression not a notable feature, but, on the contrary, the most striking fault in the work is the inexactness of the language. Even Sir John Herschel, whose perfect familiarity with the subject of the work, would tend to render the fault less striking to him, was nevertheless struck by it: "The most considerable fault we have to find," he wrote, "with the work before us consists in an habitual laxity of language, evidently originating in so complete a familiarity with the *quantities* concerned as to induce a disregard of the *words* by which they are designated, but which, to any one less intimately conversant with the actual analytical operations than its author, must infallibly become a source of serious errors, and which, at all events, renders it necessary for the reader to be constantly on his guard."

These words form the penultimate sentence of Sir John Herschel's critique. We have preferred to speak first of the sub-

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ject touched on, so as to pass without reservation to a more pleasing topic,—the real and unquestionable value of Mrs. Somerville's chief work. And after all, the good qualities of the work are intrinsic, while its main fault relates to a purpose which the work never could have fulfilled, no matter how carefully the fault had been avoided.

It is in this sense,—regarding the work apart from its special purpose, and judging of it only as a contribution to advanced scientific literature,—that we may fairly say, with Sir John Herschel, that the work is one of which any geometer might be proud. There is, indeed, ample evidence of the disadvantage under which Mrs. Somerville laboured, in the want of thorough mathematical training; but so much the more wonderful is it that she should have completely mastered her subject. Every page indicates her appreciation of the methods employed by Laplace and Lagrange. Where she does not strictly follow the *Mécanique Céleste*, she evidences a clear recognition of the purposes to be subserved by adopting a different course. We would not be understood as commending all the departures thus made, on the contrary, there are cases where it appears to us that on the whole it would have been preferable to have followed the processes of the *Mécanique Céleste* more closely, while there are others where certain more modern processes might perhaps with advantage have been introduced. But even in such instances we recognise in the course pursued by Mrs. Somerville the decision of one perfectly familiar with the subject in hand. And many of the changes must undoubtedly be regarded either as improvements, or else as altogether desirable when the scale of Mrs. Somerville's treatise is taken into account. Amongst instances of the former kind must be classed the method employed in the investigation of the equations of continuity of a fluid; amongst instances of the latter, we would specially cite the treatment of the theory of elliptic motion, in the opening chapters of the second book.

If, however, we were asked to point out the feature of this work which in our opinion most strikingly indicated the powers of Mrs. Somerville's mind, we should unhesitatingly select the preliminary dissertation. In this we have an abstract of the Newtonian philosophy such as none but a master-mind could have produced. Apart from its scientific value—and it has great scientific value—it is a work of great literary merit. If it is not in plan and purpose altogether original, inasmuch as it must be regarded as to some degree an abstract of Laplace's *Système du Monde*, it is, nevertheless, as Herschel has well remarked, "an abstract so vivid and judicious as to have all the merit of originality, and such as could have been produced only by one accustomed to large and general views, as well as perfectly familiar with the particulars of the subject."

Three years after the appearance of the *Mechanism of the Heavens*, Mrs. Somerville published the work by which she

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is probably best known to general readers. The *Connexion of the Physical Sciences* was, we believe, written at the suggestion of Lord Brougham, as an expansion of the admirable introduction to the *Celestial Mechanism*. It is a work full of interest, not only to the student of advanced science, but to the general reader. In saying this we indicate its chief merit and its most marked defect. It is impossible to conceive that any reader, no matter how advanced or how limited his knowledge, could fail to find many most instructive pages in this work; but it is equally impossible to conceive that any one reader could find the *whole* work, or even any considerable portion, instructive or useful. The fact was that Mrs. Somerville recognised, or, which is practically the same thing, wrote as if she recognised no distinction between the recondite and the simple. She makes no more attempt at explanation, when speaking of the perturbations of the planets or discussing the most profound problems of molecular physics, than when she is merely running over a series of statements respecting geographical or climatic relations. It would almost seem as though her mind was so constituted that the difficulties which ordinary minds experience in considering complex mathematical problems had no existence for her. A writer, to whom we owe one of the best obituary notices of Mrs. Somerville which hitherto has appeared, tells us that the sort of pressure Mrs. Somerville underwent from her publisher as the earlier editions of the *Connexion of the Physical Sciences* "convinced her of her own unfitness for popularising science. When there was already no time to lose in regard to her proof-sheets, she had hint upon hint from Mr. Murray that this and that and the other paragraph required to be made plainer to popular comprehension. She declared that she tried very hard to please Mr. Murray and others who made the same complaint, but that every departure from scientific terms and formulas appeared to her a departure from clearness and simplicity; so that, by the time she had explained and described to the extent required, her statements seemed to her cumbrous and confused. In other words, this was not her proper work."

Respecting her two other works, we shall merely remark that the *Physical Geography* appeared in 1848, and the *Molecular and Microscopic Science* in 1869, when she had reached the advanced age of eighty-eight years.

We may be excused for regarding Mary Somerville's life, in these pages, with reference rather to her astronomical and mathematical researches than to her proficiency in other branches of science. In this aspect of her career it is difficult, great as was the reputation she deservedly obtained, not to contemplate with regret those circumstances, the effects of unfortunate prejudices, whereby she was prevented from applying the full powers of her mind to the advancement of science. It is certain that no department of mathematical research was beyond her powers, and that in any she could have done original work. In mere mental grasp

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few men have probably surpassed her; but the thorough training, the scholarly discipline, which can alone give to the mind the power of advancing beyond the point up to which it has followed the guidance of others, had unfortunately been denied to her. Accordingly, while her writings show her power, and her thorough mastery of the instruments of mathematical research, they are remarkable less for their actual value, though their value is great, than as indicating what, under happier auspices, she might have accomplished.

We have mentioned that Mrs. Somerville was twice married. By her first marriage she had one son, Mr. Woronzow Greig, since deceased. A few years after Captain Greig's death she married her cousin, Dr. Somerville, by which marriage she had three daughters, two of whom survive her. The latter years of her life (twenty-three years, we believe) were passed in Italy. It has been said by one who was well acquainted with the circumstances that "the long exile which occupied the latter portion of her life was a weary trial to her. She carried a thoroughly Scotch heart in her breast; and the true mountaineer's longing for her native country sickened many an hour of many a tedious year. She liked London life, too, and the equal intercourses which students like herself can there enjoy; whereas, in Italy, she was out of place. She seldom met any one with whom she could converse on the subjects which interested her most; and if she studied, it could be for no further end than her own gratification. It was felt by her friends to be a truly pathetic incident that, of all people in the world, Mrs. Somerville should be debarred the sight of the singular comet of 1843; and the circumstance was symbolical of the whole case of her exile. The only Italian observatory which afforded the necessary implements was in a Jesuit establishment, where no woman was allowed to pass the threshold. At the same hour her heart yearned towards her native Scotland, and her intellect hungered for the congenial intercourse of London; and she looked up at the sky with the mortifying knowledge of what was to be seen there but for the impediment which barred her access to the great telescope at hand. With all her gentleness of temper, and her lifelong habit of acquiescence, she suffered deeply, while many of her friends were indignant at the sacrifice."

We shall venture to quote, in conclusion, some remarks of Sir Henry Holland on features of Mrs. Somerville's character and life which have been hidden from general knowledge:— "She was a woman not of science only," he tells us, "but of refined and cultivated tastes. Her paintings and musical talents might well have won admiration, even had there been nothing else beyond them. Her classical attainments were considerable, derived, probably, from that early part of life when the gentle Mary Fairfax—gentle she must ever have been—was enriching her mind by quiet study in her Scotch home. . . . A few words more on the moral part of Mrs. Somerville's character; and

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here, too, I speak from intimate knowledge. She was the gentlest and kindest of human beings—qualities well attested even by her features and conversation, but expressed still more in all the habits of her domestic and social life. Her modesty and humility were as remarkable as those talents which they concealed from common observation. . . . Scotland," he justly adds, "is proud of having produced a Crichton. She may be proud, also, in having given birthplace to Mary Somerville."

R. A. P.

NATHANIEL BEARDMORE was the second son of Joshua and Marianne Dorothea Beardmore, and was born at Nottingham on the 19th of March, 1816. His father, an independent gentleman, shortly afterwards removed to London and then to Chudleigh, in Devonshire. Here he was educated, and at the age of sixteen was sent to Plymouth to study with Mr. George Wightwick, architect, for six months, and was then articled to Mr. James Meadows Rendel, civil engineer, for five years. At this time he evinced much interest in the study of practical astronomy, and the construction of a Newtonian telescope became a great feat of ambition with him. A brother engineer who shared to some extent in the same pursuits remembers well the perseverance that he displayed, and in the matter of specula his was superlative. The metal, the moulds, the melting and mixing were of course essential, so also the grinding and polishing. Failures were numerous, and many a night were these operations carried on until morning hours with crucibles on a kitchen grate. The landlord of his lodgings being pressed into the service with a pair of bellows, the unflagging movement of which was absolutely necessary to obtain the melting point for the amateur, whose zeal became shared if not comprehended by the veteran of seventy years. Of course experience brought knowledge, and it was found that regulus of antimony was not absolutely essential to a reflecting surface. A telescope was, however, produced, though probably the experience got in the process was the only result of value. Soon after the expiration of his pupilage he entered into partnership with Mr. Rendel, but the connexion terminated in 1848. For the first few years of his professional life Mr. Beardmore resided principally at Plymouth. In 1843 he removed to London, and in 1856 took a private residence at Broxbourne, in Hertfordshire, retaining offices in London. In the earlier part of his career he was engaged in various questions connected with engineering, but of late years he confined his attention almost entirely to the practice of hydraulic engineering, and had attained the position of one of the first hydraulic engineers of the day. Under his direction the *régime* of the River Lea was entirely remodelled; and at the time of his death he was engineer to the Public Works Loan Commissioners, the River Thames Conservancy Board, the Essex Sewers Commissioners, besides being consulted in all the more important questions of drainage

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