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RUTHERFURD, Lewis Morris, astronomer, was born in Morrisania, N. Y., Nov. 25, 1816, son of Robert Walter and Sabina (Morris) Rutherford. His first American ancestor was Walter Rutherford, a paymaster in the British army and later a major in the American Royal regiment; he received the terms of surrender of Fort Niagara and the keys of Montreal when it capitulated. After peace was declared he decided to make his home in this country, purchased land in Hunterton county, N. J. and owned a residence in New York, where he was president of the Agricultural Society, the St. Andrews society and a founder of the Society library. His wife was Mrs. Caroline Alexander Parker, a daughter of the wealthy Alexander family of New York, and their son was John Rutherfurd (q.v.), a lawyer and U. S. senator, who married Helen, daughter of Lewis Morris (q.v.), and became the father of Robert Walter Rutherfurd. As a boy, Lewis Morris Rutherfurd was distinguished for his unusually brilliant mind with a marked capacity for mathematics. At the age of fifteen years, he entered the sophomore class of Williams College, and was graduated with high standing in 1834. Immediately after graduation, he entered upon the study of law in the office of William H. Seward in Auburn, N. Y., and was admitted to the bar in 1837. He was associated in professional practice, first with John Jay, and after his death with Hamilton Fish. His tastes, however, were strongly for scientific pursuits, particularly physics, and this fact led him eventually to abandon the law and to devote his attention to research and experiment. While an undergraduate in college, he had served as assistant to the professor of chemistry, and in this capacity had devised and prepared special apparatus for class lectures. He also reconstructed a telescope from scattered parts found in a lumber room. His abundant means, which increased by his marriage, enabled him to devote his life to professional work, travel, and study. During a sojourn of several years in Europe he studied optics under Prof. Amici, the most distinguished exponent of that science. After his return he built an astronomical observatory in New York, which was the finest and best equipped private institution of its kind in the country. By personal work he constructed an equatorial telescope, and devised original means of adapting it for photographic use; a third lens, placed outside the ordinary object glass, converting the telescope into a photographic instrument. Also he devised and constructed a measuring machine for star plates, arranged to determine the position, angle, and distance from a central star, with which he determined the positions of thirty-one stars in the Pleiades. This was improved in 1868 by using a glass scale, one division of which was equal to ten revolutions of the micrometer screw. Mr. Rutherfurd pursued his photographic work for twenty years, and was the originator and introducer of the photographic method of observation. To him is due the idea of an object-glass for using the chemical rays rather than visual ones. He invented a photographic corrector for adapting an ordinary object-glass to securing sharp definitions upon the sensitive plate. He personally planned the construction of these instruments, and superintended the grinding of the lenses, which were made at his own house, by methods devised by himself. He was the first also to introduce the precautions to protect the sensitive film against distortion, and was the first to devise and construct micrometer apparatus for measuring impressions on the plate. It is stated that he took such pains in the construction of the threads of the screws of his micrometer that he was engaged three years upon a single screw. Mr. Rutherfurd labored at the photographic method of observation for many years without the sympathy or encouragement of astronomers generally, but in 1865 he placed the results of his measurements in the hands of Prof. Gould, who computed and verified them, and presented a memoir embodying the results of his observations to the National Academy of Sciences. Then the value and importance of his labors were recognized and acknowledged. In January, 1863, he published a paper in the "American Journal of Science," which was an attempt at classifying the stars according to their spectra, the first work in this direction since Bunsen and Kirchhoff. In 1864 he presented to the National Academy of Sciences a photograph of the solar spectrum over eleven feet long, which showed three times more lines than any charts previously produced. In the course of his spectrum work Mr. Rutherfurd found, as in his photographic experiments, that his instruments were not sufficiently delicate, and, therefore, with his accustomed ingenuity, devised a ruling machine which was able to work finer gratings than those of Nobert, whose gratings were at that time considered the finest in existence. He succeeded in ruling about 17,000 lines to the inch, an achievement surpassed only by Prof. Rowland. It is with these improved facilities, developed by his own ingenuity, that he was able to achieve such remarkable results, which are all the more creditable because his work was done before the invention of the dry-plate process, so greatly helpful to astronomical research in later years. His photographs of the moon in clearness of detail surpassed all other prints. During the later years of his life Mr. Rutherfurd's health was delicate, and no longer able to endure the confinement of sedentary labor, he was obliged to discontinue active research, which was a sore trial to his energetic spirit. When he realized his inability for further work, he presented his instruments and photographs to Columbia College. His collection of astronomical photographs contains 175 photographs of the sun, 174 of the solar spectrum, 435 of the moon, and 664 of star-clusters. It has been preserved in fireproof vaults. The computation of the measures undertaken by the college authorities was published only a few days before his death, but too late to be verified by him. Prof. Gould says of Mr. Rutherfurd, "we owe to him not merely the first permanent records of the relative positions, at a given moment, of all the celestial objects impressed upon the sensitive plates, but the means and the accomplishment of the conversion of these records into actual numerical data." In 1858 Mr. Rutherfurd was elected a trustee of Columbia College, and became one of its most active and hardworking members. He was one of the original members of the National Academy of Sciences upon its incorporation by act of congress in 1863, and was an associate member of the Royal Astronomical Society. In 1867 he was president of the American Photographical Society, which during his administration became the photographic section of the American Institute, and subsequently served as its first vice-president for many years. He was appointed American delegate to the international meridian conference held in Washington, D. C., 1885, and was one of its most active members, preparing and presenting the resolutions which embodied the results of their labors. In 1887 the French Academy of Sciences elected him a member of the internatio- con-

ference on astronomical photography to be held in Paris, and he was appointed by the president of our National Academy of Sciences its representative to the same conference, but his delicate health compelled him to decline serving. He also received numerous decorations and honors from the learned societies of the world. However, as was said of him by a close associate, "His dislike of ostentation and show was a conspicuous trait of his character. He was never known to wear any one of the many decorations, emblems of rank, or acquirements which had been conferred upon him." His death was the result of a cold taken when on his way to his country home in Florida, and was hastened by the shock caused by the death of his daughter. He died at his country home, Tranquility, May 30, 1892.

BOWDITCH, Nathaniel, mathematician, was born in Salem, Mass., Mar. 26, 1773, son of Habakkuk and Mary (Ingersoll) Bowditch, grandson of Nathaniel and Mary (Turner) Bowditch, and a descendant of William Bowditch, who settled at Salem in 1639. His early education was limited to about three years in a local school, from which he was withdrawn at the early age of ten, to assist his father, who was a cooper. In 1784–85 he studied bookkeeping under Michael Walsh, and was later bound apprentice to the firm of Ropes & Hodges, ship-chandlers and general storekeepers, who having noted his unusual aptitude in mathematics encouraged him to continue study in his leisure hours. Thus he mastered arithmetic and elementary algebra by himself, and meeting a retired sea-captain, he took from him lessons in navigation. In 1790 he began the study of Latin without a teacher, in order to make a study of Newton's "Principia," and afterwards learned to read French in the same way. He did not confine his studies to mathematics, although it was his favorite pursuit. Having no one to direct his reading, he read "Chambers's Cyclopædia" from beginning to end. He was a great admirer of Shakespeare, and was thoroughly acquainted with the Bible. He seems to have had a wonderful facility for acquiring languages, which he mastered for the pleasure of reading their literature. When twenty-two he shipped as clerk in the ship "Henry," and spent about nine years in a seafaring life, during which he made five voyages to the East Indies, Portugal, and Mediterranean ports, serving as supercargo, and afterwards as master. During all this time he devoted every moment to his studies, and it is related of him that, in an engagement with a privateer, when he was called upon for powder, he was found sitting on the powder-keg working out a problem upon a slate. He had a remarkable knowledge of navigation, and made quite a reputation for himself by bringing his ship into Salem harbor in a snow-storm which obscured all landmarks, being guided by his reckoning, which he took from an instant's glimpse of Boker's Island light. He was engaged to correct Morris's work on navigation, but found that it contained so many mistakes that he concluded to make an entirely new one, which resulted in his new "American Practical Navigator," which was published in 1802, and immediately adopted as the standard in this country, and to a large extent in England and France. His fame as a mathematician spread abroad, and Harvard University conferred upon him the degree of M.A., which gave him more pleasure than all his subsequent honors, for it came to him as a surprise, while listening to the college exercises. In 1804 he gave up the sea, and was made president of Essex Fire and Marine Insurance Co., of Salem, Mass., which position he held until 1823, when he was induced to take the position of actuary in the Massachusetts Hospital Life Insurance Co., of Boston, at a salary sufficient to enable him to issue his writings, which lack of means had previously prevented. He was offered a professorship at Harvard College in 1807, one at the University of Virginia in 1818, and one at West Point in 1820, but declined them all, to pursue his favorite work, which he hoped eventually to publish. During his stay in Salem he made charts of the neighboring harbors, and contributed papers on astronomy and kindred subjects to the American Academy. He also contributed many articles to "Rhee's Cyclopædia," and began his greatest work, a translation of Laplace's "Mécanique céleste," which he accompanied with a copious and profound commentary, occupying more than half the whole, explaining obscure portions, giving valuable historical information, and bringing all matters to date. To publish such a work was enormously expensive, but Bowditch refused to issue it by subscription, and devoted his savings to this purpose, he and his family practising for years the most rigid economy. In 1829 the first volume appeared, dedicated to his wife, stating in the preface that, "without her approbation the work would not have been undertaken." The second volume appeared in 1832, the third in 1834, but the fourth was not issued until after his death. The fifth, which was a supplemental volume added by Laplace many years after to the original four, was prepared under the supervision of Prof. Benjamin Peirce. This gigantic effort, on which Dr. Bowditch's fame rests, was the first entire translation of the great original, and was elucidated in a manner which still commands the admiration of men of science. It was said that there were but two or three men in the country at that time able to read and appreciate the original work. Harvard University conferred upon him the degree of LL.D. in 1816, and at his death he was a member of the Royal Societies of London and Edinburgh, the Royal Academies of Palermo and Berlin, the Royal Irish Society, the Royal Astronomical Society of London, and the British Association. During his later years he was a trustee of the Boston Athenæum, president of the American Academy of Arts and Sciences, and a member of the corporation of Harvard University. He was also twice elected to the state executive council of Massachusetts, and held many offices of honor and trust. He was a great lover of poetry, particularly admiring Bryant, considering the "Old Man's Funeral" one of the most beautiful compositions in the English language. Dr. Bowditch's career is one of the most remarkable in American history. Notwithstanding the very limited advantages of education, and his engagement through life in laborious employments for the support of his family, yet by his extraordinary genius, and almost equally extraordinary economy of time, he made great acquisition in learning and science, gained a knowledge of the Latin, Greek, Italian, Spanish, French, Portuguese, and German languages, and made himself the most eminent mathematician and astronomer America has yet produced. He did more for the reputation of his country among men of science abroad than has been done by any other man, except, perhaps, Benjamin Franklin. A eulogy of him was delivered by Prof. Pickering before the American Academy, May 29, 1838, which included an analysis of his scientific publications