and acts by suction to draw in fresh air at the stations; but on a four-track road the passage of one train can do nothing more than produce a certain amount of eddying in the atmosphere and certainly can have no general effect of renewing the whole body of air in the tunnel. At the same time it must be remembered that the problem of air renewal is simplified by the fact that the subway lies very close to the surface, and not, as do the London tubes, 60 or 80 feet below it. The use of electric traction will, of course, preclude any such state of things as revealed by the 89.4 per cent of carbonic acid gas that was found in the steam-operated tunnel of the Metropolitan Railway, London.

LORD KELVIN—ENGLAND'S GREATEST LIVING SCIENTIST.

Although a Scotchman by descent, Lord Kelvin was born in Belfast, in 1824. His father, Dr. James Thomson, was a well-known mathematician in his day, who filled the chair of mathematics both at the Royal Belfast Academical Institution and at the University of Glasgow. From his father the present Lord Kelvin clearly imbibed that taste for mathematics which marks all his scientific investigations. Together with his brother, Thomson studied at Glasgow College. From Glasgow he went to St. Peter's College, Cambridge, graduating in 1845. That his main work at Cambridge was mathematical goes without saying.

Even before his Glasgow student days came to an end, William Thomson's original work in science had begun. His first mathematical papers, written before he entered Cambridge, discussed the Fourier mathematics, then but little known. In 1842, when but seventeen years of age, he published a paper on "The Uniform Motion of Heat in Homogeneous Solid Bodies and Its Connection with the Mathematical Theory of Electricity." Even in that early paper he points out the analogy between certain problems in the conduction of heat and in the mathematical theory of electricity and magnetism; and he shows how to make use of solutions of the one set of problems in order to arrive at important conclusions with regard to the other. The papers which we have mentioned were followed by a treatise on "The Linear Motion of Heat," which contained principles later so powerfully applied to the question of "geological time."

Owing to the very limited amount of space at our disposal it is impossible even to mention the many papers with which Thomson enriched the literature of pure physics. In the early forties electricity was passing through a transition stage. The discoveries of Faraday had opened up an unsuspected field. The function of the dielectric had been discovered and traced out; and the doctrine of lines of force had been expounded. Thenceforth action at a distance, so far as electricity and magnetism were concerned, was a notion of the past—an hypothesis utterly untenable and incapable of representing the facts of the case. Thomson eagerly grasped this truth; and using the new discoveries as the basis of his mathematical investigations, gave to them a mathematical form, which rendered them of practical service to later electricians.

Thomson's early investigations were soon translated into the language of "the potential;" and the connection was established between these results and the theories of energy, with which Joule was just then concerning himself. Thus it was that Thomson, at the early age of twenty-one, become the exponent of doctrines, the full value of which can scarcely be said to have been appreciated until he had reached his fortieth year. In 1867, the word "potential," which is now one of the stock terms familiar to every electrical student, was unknown, except to a few advanced mathematicians.

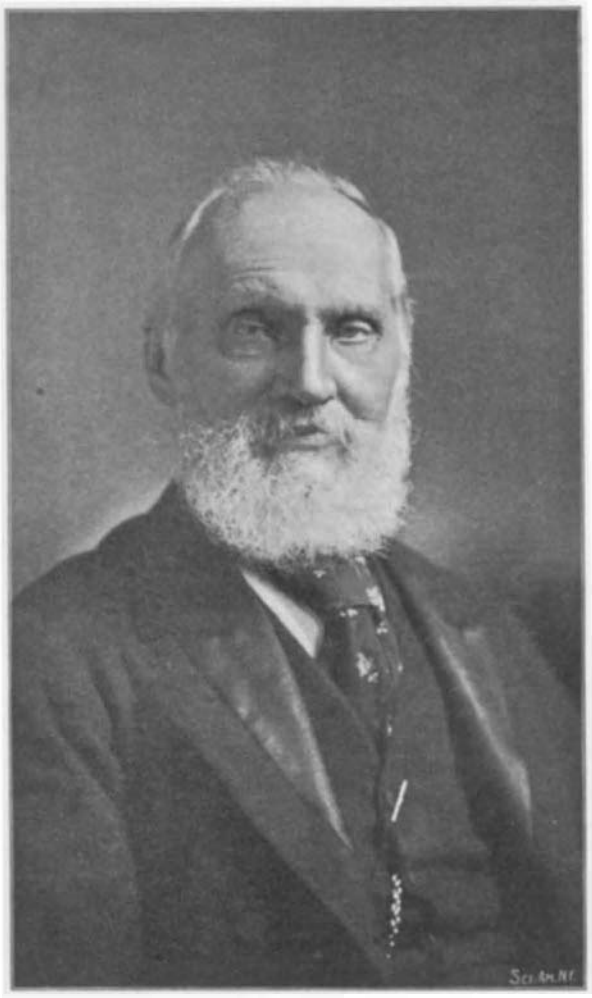
At twenty-two Thomson was elected Professor of Natural Philosophy in the University of Glasgow—a chair which he has filled with honor and distinction up to the present time.

As we have already seen, even in his student days, Thomson had been attracted to the dynamical theory of heat. He was one of the first to appreciate the importance of the work of Joule. One of his earliest papers on thermo-dynamics shows how the theory of Carnot may be adapted to the modern doctrine of heat. Thomson's papers on the subject of thermo-dynamics constitute one of the most valuable and most remarkable contributions made to modern physical science. In 1852 the principle of the dissipation of energy was announced, in connection with which experimental determinations were undertaken both by Joule and Thomson. More than one joint paper of rare value was contributed by these two life-long friends.

In 1855 and 1856, the problem of ocean telegraphy was placed before scientific men for solution. Thomson ardently threw himself into the work and gave to the world the first practical solution. Only a brief account of this, his most important practical work, can here be given.

Following the experiments of Faraday, Thomson had investigated mathematically the retardation of signals, and had formulated the law of squares, now so familiar in telegraphy. When the possibility of laying down a cable across the Atlantic was discussed, he pointed out that a conductor 2,000 miles long, unless of unprecedentedly large cross section, might prove a commercial failure, on account of the slowness of the transmission of signals. The warnings of Thomson were not heeded. It was only when the 1858 cable was completed that the full force of his contention was appreciated. When Whitehouse, Thomson's rival, failed to make good his promises of transmitting messages at a fair rate of speed, Thomson was sent for by the directors of the company, and asked to provide an instrument that would satisfy the conditions necessary for its success.

Experimenting with the reflection of the image of a candle thrown from his concave eye-glass on a sheet of white paper in a fairly lighted room, Thomson judged that the flame of a paraffine lamp reflected from a silvered mirror would give an image bright enough for the convenient reading of telegraphic signals. Such was the germ of the mirror-galvanometer. Mirrors and instruments were soon made; and in 1858 the mirror-galvanometer was successfully applied to the cable. The instrument is the first of Thomson's many inventions. With characteristic generosity he had intended to abandon the instrument to the public, but was finally induced by the company to take out patents. The fruit of his labors in developing the



LORD KELVIN, LL.D., F.R.S., ETC.

sounding machine and the mariner's compass he was also willing to leave unprotected. Sounding by piano wire was offered to the Admiralty, as well as the compass; but he found in each case that the only way of securing public attention to inventions was to patent them and work the patents.

In 1867 the siphon-recorder was invented and patented by Thomson. Three years later it was used on ocean telegraph cables. Up to the present time the mirror-galvanometer and the siphon-recorder are the only instruments by which signals are read on very long submarine lines.

For five or six years he devoted himself to electrical problems of transcendent difficulty. Almost every department of electricity bears the impress of his work. That a scientist of his attainments should have received honors from every country in the world is but a small acknowledgment of the valuable work he has done in modern science. He succeeded Sir George Gabriel Stokes as president of the Royal Society in 1890, and was created first Lord Kelvin in 1892. He is a Fellow of almost every scientific society of note throughout the world, bears degrees conferred upon him by half the universities of Europe, and has received numerous medals for his eminent inventions and discoveries. The present is not Lord Kelvin's first visit to this country. In 1876 he was a judge at the Centennial Exhibition. In 1884 he visited America to attend the Montreal meeting of the British Association. In 1897, the date of his last visit, he attended another meeting of the British Association held at Toronto.

THE HEAVENS IN MAY.

BY HENRY NORRIS RUSSELL, PH.D.

In concluding our description of the zodiacal light last month, we referred to the fact that, under favorable conditions, it can be seen to extend entirely across the sky as a very faint band of light which, in the region that lies opposite the sun, brightens into a faint spot of light.

This spot is commonly known by the German name Gegenschein—a *glow* in the sky.

The Gegenschein is one of the faintest objects known; yet it is easier of observation than has often been supposed.

The observer should glance rapidly across the sky from the zenith to the horizon. A few such sweeping glances will probably convince him that there is a region some distance above the horizon where the background of the sky is sensibly brighter than in the regions above or below it. This region lies at present in the constellations of Virgo and Libra. He should now repeat the process, sweeping the sky from right to left, along the brighter region previously noticed, when he will probably see that a certain region is brighter than those to the right or left of it. It can best be studied by glancing across it from one side to the other, rather than by looking directly at it.

The position of its center among the neighboring stars may now be estimated, and if this position, when looked for on a star map, lies near the ecliptic, and about 180 deg. from the sun's place on it for the day of observation, the observer may be sure that he has seen the Gegenschein.

THE HEAVENS.

At 9 P. M. on May 15 Cygnus is rising in the northeast. Above it, on the right, is Lyra, and Hercules is farther on in the same direction. The brilliant Arcturus high up on the southeast of the zenith, marks the position of Bootes, and the little circlet of corona lies between it and Hercules. The intertwined constellations of Ophiuchus and Serpens fill the large area below them, while the red Antares, low in the southeast, shows that Scorpio is rising there.

Virgo lies south of the zenith, its brightest star, Spica, being nearly on the meridian. Libra lies between Virgo and Scorpio. Leo is southwest of the zenith, and Hydra stretches its ungainly length below it. Canis Minor, Gemini and Auriga are near the western and northwestern horizon.

Ursa Major is above the pole on the left, and Draco on the right, while Cassiopeia and Cepheus are below the pole, near the northern horizon.

THE PLANETS.

Mercury is evening star throughout the month. At first he is too near the sun to be seen, but later on he is remarkably well placed for observation. His distance from the sun is greatest on the 28th, when he sets two hours and twenty minutes later than the sun. He can therefore be well seen in the northwest, much less involved in the twilight than usual.

Venus is conspicuous as a morning star, rising about two hours and a half before the sun.

Mars is also a morning star, but is still too near the sun to be observed.

Jupiter is morning star in Capricornus. On the 6th he is in quadrature with the sun, and is due south at 6 A. M.

Saturn is morning star in Sagittarius and is due south at 4 A. M. in the middle of the month.

Uranus is in Ophiuchus, coming to the meridan at 1:40 A. M. on the 15th. Neptune is in Gemini, too near the sun to be seen.

THE MOON.

New moon occurs on the afternoon of the 7th, first quarter on the morning of the 14th, full moon on that of the 22d, and last quarter on that of the 30th.

The moon is nearest us on the 8th, and farthest away on the 23d.

She is in conjunction with Venus on the 4th, Mars on the 7th, Mercury on the 8th, Neptune on the 10th, Uranus on the 23d, Saturn on the 27th, and Jupiter on the 28th. On the 19th there occurs an occultation of the bright star Spica, in Virgo. As seen from Washington, the star disappears behind the moon's dark limb at 1:48 A. M., and reappears at the other side of the moon 47 minutes later. This interval will be longer for places north of Washington, and shorter for those south of it.

On May 7 there occurs a partial eclipse of the sun. As it is visible only in New Zealand and the Pacific Ocean south and east of it, it is of little importance to us.

Princeton, N. J., April 19, 1902.

Captain Morse, Chief Signal Officer of the Department of California, has received orders from the War Department to open negotiations for the installation of a system of wireless telegraphy between army stations in Alaska.