capital specimens of photographic work. One showed a hall of pillars like the aisle of some noble cathedral, the capitals of the columns being lost in darkness. Another depicted a placid lake, with stalactite above meeting stalagmite below, both being reflected in the mirror-like surface of the water. Another picture showed the curious, blanket-like form in many folds which stalagmitic masses will sometimes assume. Altogether, the scenes depicted were so remarkable and out of the common that we needed no more persuasion to pay our shilling for the "open sesame" to this place of marvels. But where was the hall of columns which we saw in the photograph? Here it was, a little cabin of a place a couple of feet high—a hole in the rock, in fact, where these columns were done in miniature. Where the lake? Here it was in another corner, holding about as much water as a sponge bath, and covering about the same area as that useful domestic appliance. The whole thing was a miniature of what we had expected—genuine enough, no doubt, but increased from pigmy size to gigantic proportions by deceptive photography.

THE PORTRAITURE OF THE SUN.*

BY JAMES MEW.

IN a pamphlet published some ten years ago by Mr. A. Davanne, vice-president of the French Photographic Society, it was asserted that at the Kew Observatory, during the space of some dozen years, more than two thousand photographs of the sun had been produced, giving the elements necessary for the verification of the number, position, and dimensions of the spots and faculæ, or bright streaks of diverse form on the solar surface, especially near the edge of the disc. These faculæ seem to have grown larger since the time of Sir John Herschel. Davanne speaks of some of them extending to forty thousand miles in length and to four thousand in breadth. The spots, first noticed, probably, by Fabricius in 1611, led to the discovery of the sun's rotation by Galileo. They are of irregular form, size, and position; black, surrounded by a striated penumbra, presenting to some the appearance of the edges of a thatched roof. About these spots, of which the discovery has also been ascribed, like that of most other things, to the Chinese, an interesting and early notice may be found in *La Rosa Ursina*, published in 1626.

In the study of the sun's surface, the photographic method has a great advantage in the strength and permanency of its recording picture, and the consequent power of perusing it at leisure. The disadvantage is that great foe of astronomical observation, atmospheric undulation, which renders the sun's image tremulous and confused, except at occasional moments. By taking a large number of photographs and selecting the best, this difficulty may be in some measure obviated. Janssen has taken pictures of the sun up to fifteen inches in diameter. In these the coarsely mottled corrugated surface of the photosphere is shown with much distinctness. Those luminous masses representing rice grains, or nodules, or oblong willow leaves, or blunt arrow heads, or feathers of a duck's wing, or trapeziums with rounded corners, or "things" two or three or even five times as long as they are broad, according to the imagination of the observer, are shown by these photographs to be of different sizes and splendour, which may arise from their different depths, or from bodies analogous to atmospheric clouds. This shape is commonly elliptic, but is subject to considerable variations. They tend, says Janssen, to sphericity, but are deformed more or less by gaseous currents.

Professor Rowland tells us that the spectra of all known elements—with the exception of a few gaseous, and some too rare to be yet obtained—have been photographed in connection with the solar spectrum, and that the greater part of the lines in these photographs has been identified, and the substance producing them noted. He has also presented us with a rough table of some two score solar elements, among which attention may be called to silicon, vanadium, scandium, yttrium, zirconium, glucinum, germanium, and erbium as possibly new. Arranged according to intensity, calcium occupies the first place in these sun elements, and potassium the last. Potassium is also the last if they be arranged after the number of lines in the spectrum, but the first is iron. Ruthenium, tungsten, with some half-dozen others, are classified as doubtful elements. Antimony, boron, gold, rubidium, thallium, and praseodymium, with some ten more, are said to be absent from the spectrum, while bromine, fluorine, holmium, thulium, terbium, &c., are substances not yet tried. "On the whole," says Professor Rowland, "were the earth heated to the temperature of the sun, its spectrum would probably resemble that of the sun very closely." But its inhabitants would, under such circumstances, cease to be interested in spectrum analysis.

Another proof of the scientific value of photography is in the establishment, through its assistance, of the fact that the glory of the sun, called the corona, circling sphery fire like the crown of soft, silvery light set about the heads of their saints by the artists of old, noticed as far back as the time of Kepler, and attended by its tongues or protuberances of rosy flame, is not any result of a lunar atmosphere, or a terrestrial phenomenon owing to the passage of the rays of this, our bright particular star in the galaxy through our earthly air, but a real and true appendage of the sun.

During the solar eclipse of August, 1869, the first piece of adminicular evidence touching the sun's corona came from the dark walls of the camera. Of the corona as well as the chromosphere, or chromatosphere, or sierra, the telescope ordinarily shows nothing. This is visible only during total eclipses or by aid of the spectroscope.

The photographs of the eclipse of July, 1878, show that the corona is not a mass of milky light, as it commonly appears through small telescopes, but has a hairy structure. Its outer limit is very irregular, resembling long tufts of flax. The *Bureau des Longitudes* of 1884 contains a photograph, neither retouched nor enlarged, of the corona during the eclipse of May, 1883, by M. Janssen. The picture was taken with a lens eight inches in diameter; the exposure lasted five minutes. The photograph shows a more extended corona than was visible in the telescope.

In August, 1887, photographs were taken in Russia and Japan, with plates of the same make, and probably of the same emulsion, with the same exposures, and developed by the same operator. In the next total eclipse visible in England, in the extreme north, just after sunrise, in 2290, the majority of our readers will feel comparatively faint interest.

* Concluded from page 482.