

THE ECLIPSE OF THE SUN.

KIÖ ISLAND, BRAS HAVN,
Thursday, August 6, 1896.

BEFORE I attempt to give an account of what we have done here and of the local conditions generally, it may be well to state what, in my opinion at all events, is the most important work to be done at eclipses in the present state of our knowledge.

In looking back along the eclipse records, say till 1870, it is not a little surprising to note how the attack has varied in the importance attributed to certain of the inquiries; and how often it has happened that the chief scientific result secured at any eclipse was hardly dreamt of by the organisers of the expeditions. But when there has been this notable divergence between anticipation and actual result, the work done has proved of the greatest advantage to science. I shall not be sorry, therefore, if the following anticipations fail to include the most important advances made during the coming eclipse.

In the first place I think the records already obtained by large scale prismatic cameras have shown to everybody that these instruments are the most important ones we can employ on an eclipsed sun. They not only give us a complete chemical record, on a scale hitherto undreamt of, but they give us the positions and forms of the prominences far better than they have ever been obtained before. Nor is this all, they enable us to study under new conditions some of the conclusions arrived at in previous eclipses, and give us a means of inquiring into the possible origins of some of the phenomena already recorded by slit spectroscopes.

It is now more than a quarter of a century since bright lines were recorded in the spectrum of the dark moon. There could, of course, never have been any doubt that this was due to chromospheric glare in our atmosphere; but the moment this was conceded, the more difficult it became to determine the exact height of the solar envelopes, for if there was glare over the dark moon, how high might it not extend over the prominences?

Now one of the important points about the prismatic camera is that it is quite impossible for it to treat such a general glare as this in the same way it does any local illumination; as a result of this property any effect due to general glare which *can* be recorded by a slit spectroscope *cannot* be recorded by the prismatic camera, and so, roughly speaking, a comparison of the two records may be safely trusted to eliminate the effects of such glare.

It will be generally recognised that this is an important service to render; but there is another which, from the chemical point of view, is more important still—it enables us to localise the origins of the various radiations which build up the spectrum of the sun's surroundings, whether they be high or low.

For the first time in 1893 the corona was photographed as a ring by means of the prismatic camera in "1474" light, and apparently associated with it were other rings in the ultra-violet. The 1474 ring was best shown in the Brazilian photographs taken by Mr. Shackleton, but the others in the series taken by Mr. Fowler in West Africa. Now we find that the brightness of these coronal rings seems to depend upon proximity to the equator, and is entirely independent of the prominences. That the true spectrum of the corona will be eventually thus discerned is unquestioned, and the sooner it is done the better. This part of the attack this year has been greatly strengthened, and not only have we here prismatic cameras of 6 and 9 inches aperture, but I have equipped Mr. Shackleton with a powerful instrument for his observations in Novaya Zemlya, whither he has gone in the expedition rendered possible by the public spirit of Sir George Baden-Powell.

The large scale prismatic camera was, as I have said, introduced in 1893—that is, only three years ago. The results obtained in that year represent, therefore, only

the experimental stage; at the critical moments of the eclipse—that is, at the beginning and end of totality—only snap-shots were taken. This time what is termed a dropping-plate is introduced in the programme of the 9-inch. That will be exposed, while gradually falling, from ten seconds before the end of totality to fifteen seconds after, in the hopes of catching the so-called "flash" which is supposed to represent the "reversing layer." To my mind, the reversing layer is dead and buried already, but may the fates be propitious on the 9th, and enable us to place a wreath on its tomb.

So much then, briefly, for the prismatic cameras and the pre-eminent importance of their use. I next come to another point, to investigate which an important instrument has already been set up.

In organising the work for the eclipse of 1871, stress was laid on the importance of obtaining a photograph of *all* the light radiated earthwards during an eclipse, to supplement the work of the slit spectroscopes which had to do with the light radiated by *special parts* of the solar surroundings.

This work is a thousand times more important now that the spectrum of the prominences is so clearly separated from that of the corona by the prismatic cameras, because it enables us to make a flank attack, so to speak, on the corona spectrum.

The integrating spectroscope to be used on the 9th consists of a 4-inch Taylor lens of long focus as collimator directed to the sun's place during totality in a way I will state further on; then come two prisms of 60° of dense flint, and lastly a camera of 19 inches focus. The light reflected from a dark cloud gives an exquisitely sharp and well-dispersed solar spectrum in 40 seconds. During totality a plate will be exposed for 60 seconds.

Now in this instrument, simply pointed to the sun's place, the light from the greatest area will give the brightest lines. We may therefore expect the coronal lines to be well visible; and since the prismatic cameras are certain to give us a complete record of the chromosphere and prominence spectrum, a simple subtraction will bring us face to face with the spectrum of the upper reaches of the solar atmosphere.

I next come to another matter, on which it is necessary to lay great stress. It is well known that Prof. Newcomb, in 1878, introduced into eclipse work the use of a disc, behind which the brighter lower layers of the sun's atmosphere, apparently surrounding the dark moon, were hid during the totality. The object of this is, of course, to shield the eye, and an additional precaution is to blindfold the observer till totality has well commenced.

Armed in this way, Prof. Newcomb was enabled to see long luminous extensions equalling in length several diameters of the dark moon along the sun's equator. Now since such long streamers had never been seen before, it has been imagined that they indicate a special form of corona visible at the period of minimum sun-spot activity, for it was at very nearly this period that the eclipse of 1878 occurred.

But it may well be that the appearance may be due to the method employed, and that such an equatorial extension may be always there if only we can see it, and the greater the solar activity the more difficult is it to see it ordinarily, because this greater activity is always accompanied by a brighter lower corona.

Prof. Newcomb, I believe, used a disc of such a size that the brighter lower corona some 3' above the dark moon was covered. I hope to repeat this observation, and to extend it by using several discs, one or more of which will cut off 5'.

Finally, I have a few words to say on the various features of the corona independently of the large extensions, which can best be specially dealt with by the disc observers.

Let us get photographic representations of this by all means; indeed amateurs are sure to provide them; but my own opinion is that a large telescope suited for obtaining such photographs would be much better employed with a prism in front of it.

I have no photographic telescope available, so I am forced to rely on drawings, which experience shows are better than photographs for feeble extensions. It is the fashion to ridicule these drawings, and I am free to confess that often there has been no resemblance between such drawings taken at the same place; still, all the eclipses I have seen have had coronas of very different forms; and further, the special features I recorded during the eclipse of 1878 were confirmed by the photographs.

On my way to Kiö, therefore, I determined to make an experiment, by the kind help of several of my shipmates on the Orient liner *Garonne*, to see how much the uncertainty of the result depended upon the absence

1871, a year of sun-spot maximum, were fresh in my mind, and fortunately the eclipse of 1878 occurred at the period of minimum. The difference was marked in every way, and I said so. For a time the statement was disputed, nay, ridiculed, but I think everybody accepts it now. The conclusion was further intensified during the eclipse of 1886, which also took place near a minimum. In that year the eclipse happened in the morning, the observation place was Green Island in the West Indies in the middle of the rainy season, and the only thing I saw was first a cloud which formed and began to obscure the sun soon after the first contact, and grew till after totality; and next, some patches of sky away from the cloud-eclipsed eclipse. These patches swarmed with stars as on a darkish night; full moonlight was never suggested.

The sun now occupies a position in the constellation Leo, such that besides planets many stars of the first, second, third, and fourth magnitudes are conveniently situated for observation. It is obvious then that we have here, if it be properly utilised, a method of photometry easily applied, and I propose if possible to utilise it, since where doubt exists the more methods of observation we employ the better.

Such, then, are some of the points to which I attach the first order of importance. I next pass on to deal with the station selected for the observations.

The longer totality and higher sun in Japan seemed to make a station in that country most desirable, but a careful inquiry into the weather conditions showed the hopelessness of any attempt there. I was then driven to Norway, and although it was true that the totality here was short, it had to be borne in mind that a short totality in the case of a prismatic camera is really more advantageous than a long one, for the reason that the rings are more

complete; the longer the totality the shorter the arc impressed on each photographic plate.

Since Dr. Common and many others had determined to observe on the north side of the Varanger Fjord, it seemed a duty to go to the south side, where the weather chances were bound to be about the same. In this case, however, a man-of-war was necessary as a base. This was a matter of utmost congratulation, for I knew how surely help could be depended upon, even in extending the area of observations.

Thanks to the intervention of the Royal Society, H.M.S. *Volage*, commanded by Captain King Hall, was ultimately detached for this duty, and my story will be very badly told if I fail to show what a debt of gratitude science owes to him and his ship's company for what they have done to secure such a record of an eclipse as has never been attempted before at a single station, and I may add that the gratitude will be none the less even if the eclipse is as efficiently clouded out as it was ten years ago.

On July 23 H.M.S. *Volage*, coming from Iceland with



FIG. 1.—The landing of the Exploring Party.

of special training, and to what extent it could be eliminated.

With this object in view, by means of a capital magic lantern which we had fortunately on board, I threw on the screen about a dozen photographs and drawings, coloured and otherwise, of various eclipses observed since 1869, describing the main points to be noted at the sun's poles, equator, &c. Finally, I threw a previously unseen corona on the screen, marking the time—I took 105 seconds—as during an eclipse.

It was amply proved that after a rehearsal or two such as this all the drawings were wonderfully similar.

This new bit of experience therefore showed that when made under good conditions such drawings become of the utmost value.

The enormous difference between the shape and brilliancy of the corona at the periods of maximum and minimum sun-spot activity was one of the revelations—the *unanticipated* revelations—of the eclipse of 1878. In that year the appearances of the corona in

most of the instruments on board, picked up at Hammerfest Mr. A. Fowler and Dr. W. J. Lockyer, who had been sent forward to erect and adjust them.

On the evening of the 24th the *Volage* arrived some seven miles south of Vadsö, and proceeded to land a party of explorers to find a suitable site for the encampment on the south side of the Varanger Fjord, which had been determined on, and also to make a survey of Bras Havn in order to find the most convenient anchorage.

After sending the party on shore, the *Volage* proceeded to Vadsö to communicate with the Governor (the Norwegian Government had already given permission to camp) as to the local weather conditions. The landing party, which consisted of Lieut. Martin and Sub.-Lieut. Beal, Mr. Fowler and Dr. W. Lockyer, and several blue-jackets, together with Lord Graham, who had volunteered to help, proceeded to the shore in the steam cutter, having in tow the sailing cutter and the dingy, and provided with the necessary coal, water and provisions for two days. During the three-quarters of an hour steaming from the ship they encountered a sharp squall, which would have saturated everybody if it had not been for the invaluable sou'-westers and oilskins; and it is well here to note that if one goes to the north of Norway, these should always be found in the kit together with a pair of sea-boots.

The party landed, however, safely on a small island on the eastern shore of Bras Havn, and commenced immediately to put up tents. By eleven o'clock p.m., local time, all preparations were finished. The evening turned out so beautiful that a chat round the camp fire and a drop of grog were indulged in before turning in.

The first morning on this island was not by any means cheerful, rain was coming down in torrents, and the wind whistled round the tents in a most unwelcome manner. It was decided that the survey of the bay should be taken in hand first, so Lieut. Martin, Sub.-Lieut. Beal, and Lord Graham started off in the steam cutter and commenced operations. The weather did not improve, but rather the reverse; the survey, however, made good progress notwithstanding the unfavourable conditions, but all hope was given up of finding on that day a site for the observatory on the island near by.

Sunday morning was of a different type, and work was commenced at an early hour. Mr. Fowler and Dr. W. Lockyer were landed on Kiö Island while the survey was being finished. The island of Kiö lies nearly north of Bras Havn, at a distance of about a mile and a quarter. The island itself is small, and consists of gneiss mottoned and polished to a wonderful degree, the surface putting on the appearance of snow in many places. The rock is covered here and there with peat. At the first glance it seemed that a suitable site for the observatory was out of the question, but on examination a very fair spot was selected which appeared to improve the more acquaintance was made with it. To economise time the sites for the concrete pillars were settled upon, and pits were dug in the peat to sound for the solid rock.

With the evening came the *Volage* from Vadsö, and her arrival was gladly hailed by the whole surveying party, as provisions had run rather short, and peat water was not regarded as a luxury. The return of the ship meant that work could now be begun in earnest, so plans were laid for an early start on the morrow. Fortunately the day proved fine, and a good start was made at putting up the large 6-inch hut. This is the time when a warship at one's back makes everything easy. The gunner turned bricklayer for the occasion, and commenced, with the help of a couple of bluejackets, mixing and setting up concrete pillars for the 6-inch and siderostat. The ship's carpenters, with their assistants, went to work with zeal with the erection of huts. Others were employed in fetching from the beach sand and stones, which were required for the concrete pillars.

Levelling the camp occupied also the time of another half-a-dozen bluejackets. At the close of the day's work the appearance of the spot had entirely changed, and the Lapps who came and watched the work seemed to be very much astonished at the alterations taking place on

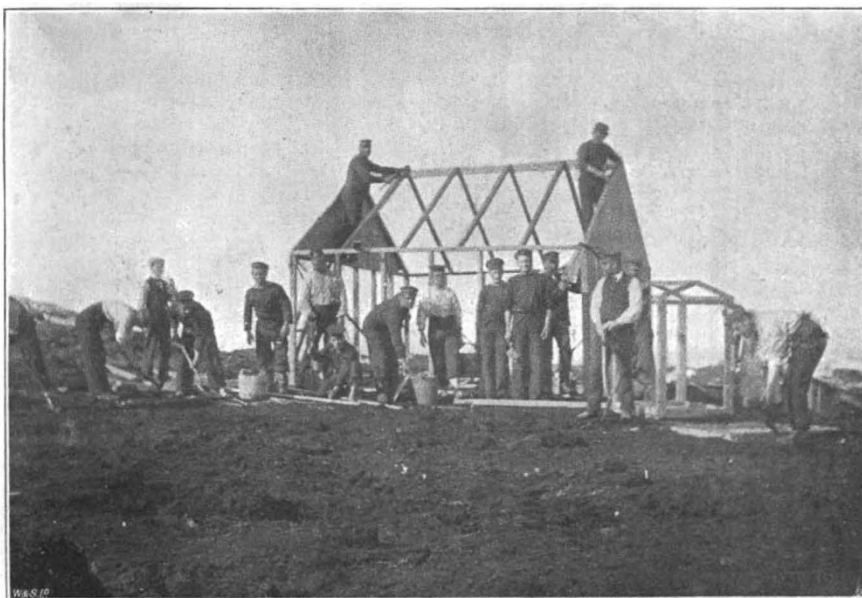


FIG. 2.—The erection of the Huts.

their island. They were, however, very friendly, and seemed to be only too pleased to help in any way they could; their assistance, however, was not required, as sufficient was at hand.

The following day, which proved fine, saw even greater progress; for besides erecting the 6-inch prismatic camera and siderostat, a party of bluejackets was employed in carrying stones from the beach to place on the peat covering the floor of the camp. This was done in sailor fashion, and at the word of command "stone camp," the small path leading upwards to the camp was lined with bluejackets, and buckets, full and empty, were passing up and down respectively. The scene was an interesting one to watch, and, after two hours' work, a geologist might have found a genuine raised beach.

Bad weather, however, now set in, so work was restricted for the next two days mostly inside the huts. The integrating spectroscope was put together, photographic dark slides were blackleaded to run more easily in the grooves of the cameras, and two more tents were put up to protect the 9-inch prismatic camera and integrator from the weather. The latter was composed of ship's

materials, a sail being used for the covering; the tent served its purpose well, and withstood, like the others, a heavy blow from the east.

The two wet days were followed by two very fine ones, and great advance was made.

The foregoing account will give an idea of the kind of work done up to the end of August, the day of my arrival at Kiö. It was impossible for me to join the advanced party, so I subsequently proceeded direct to Kiö in the Orient liner *Garonne*. After a delightful voyage through the most wonderful of the Norwegian fjords under perfect travelling conditions, Captain Veale was good enough to slightly alter his course so as to drop me on the day named at a point about two miles north of the island, where I was met by the boats of H.M.S. *Volage*, which soon transferred the rest of the instruments and myself to the Eclipse camp.

It will have been gathered that when I arrived at Kiö,

the services of other volunteers would be of any help to us. I replied that there was so much to be done that I thought I could usefully occupy all possible volunteers if the detail of duty on board left any time for instruction and training. I was at once taken at my word, and was requested to give, in lecture form, in the fore-castle that evening a statement of what was required, and why it was useful to try to do it. This was done by the help of the magic lantern, which had been kindly lent me by the *Garonne*, the deck being darkened by sails laid over booms. After it was over the Captain called for volunteers. Many at once responded to the call, and, to make a long story short, I may say that at present the number of volunteers, including officers and men, is over 70.

The first thing to be done next morning with this wealth of help was to set to and compose a programme of eclipse work beyond all precedent.

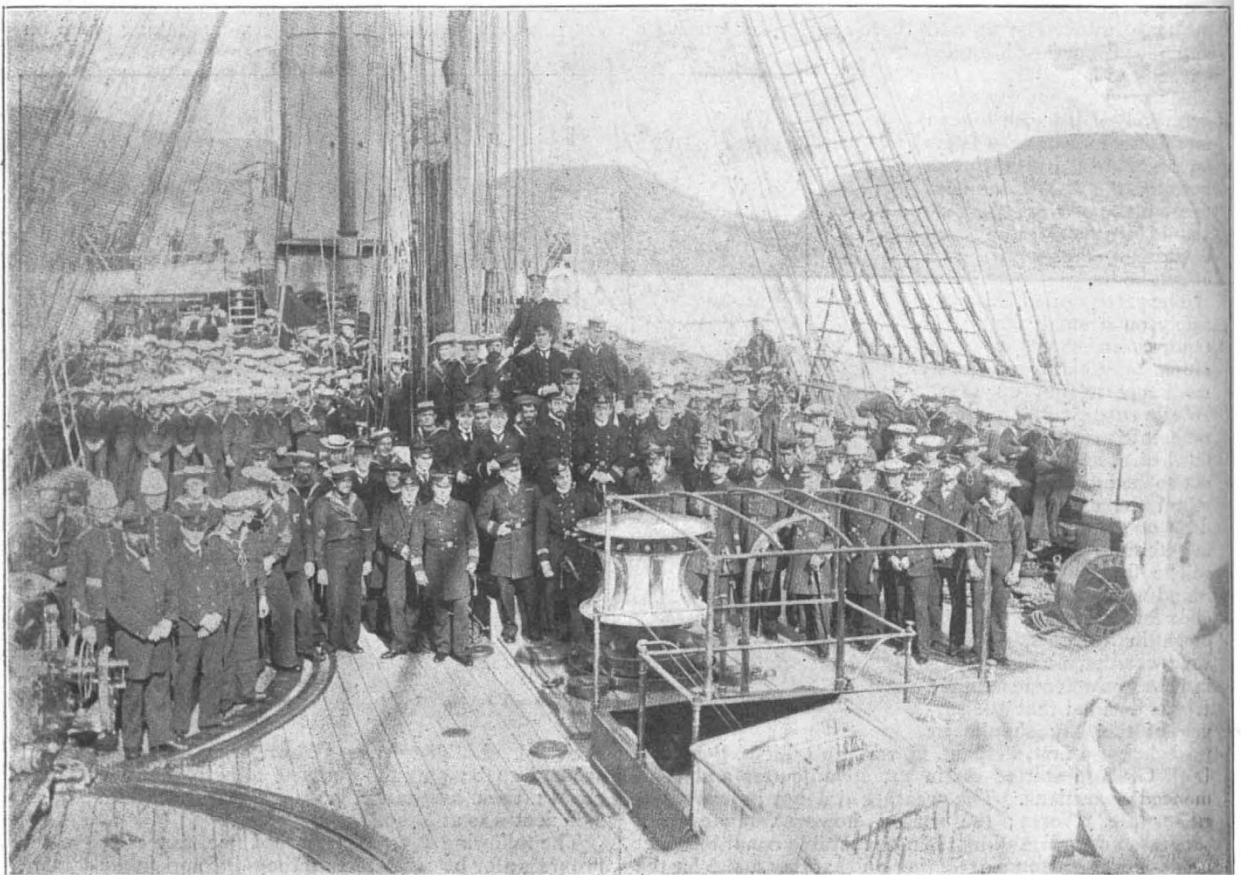


FIG. 3.—The Volunteers.

all the fixed instruments brought out had been erected and adjusted as far as possible. I put in this qualification because, of course, all star observations were out of the question, as the sun at midnight was only 4° below the horizon.

Furthermore, profiting by the good will and keenness to assist on the part of the officers, full complements of assistants had been secured for the various manœuvres requisite to obtain the greatest amount of results in the restricted time covered by the totality.

But Captain King Hall was not satisfied with this contribution to our endeavours. He inquired whether

It was at once determined to form groups to sketch the corona, to note the stars visible during totality, to note the changes of colour of the landscape, discrimination being made between cloud, sky, and land and sea surfaces; to erect several discs cutting off the lower corona to different heights; and the swoop of the shadow of the moon was not neglected.

Further, as I had brought small polariscopes, prisms, and slit spectrosopes with me, other groups evidently had to be formed to use these instruments.

Two things then obviously had to be done at once—to select the artists and to start some spectroscopic demon-

Very many inquiries were made at the various stopping-places in the north of Norway concerning the chances of fine weather in the neighbourhood of Vadsö. The English Consul at Hammerfest, where H.M. *Volage* picked up Mr. Fowler and Dr. W. Lockyer, informed them that the question of clear or foggy weather depended almost entirely on the direction of the wind. An east wind at Vadsö meant foggy weather, a west wind fine; the reverse was the case at Hammerfest. It was also mentioned that the south side of the Varanger Fjord seemed to be more free from fogs than the northern shore. The news seemed very encouraging, since it was proposed from the beginning to settle on the southern side. It was also made manifest that it would be unwise to select an elevated spot, since clouds and mists often were seen hanging about at 100 feet and over, while the lower levels remained clear. The experience, gathered from the first few days spent on the southern shore, did not, however, bear out very exactly the Hammerfest information. The 24th and 25th were both miserably wet days, and yet the wind was blowing hard the whole time from the north-west. The following two days were very fine and hot, the wind coming from the eastward. But the view as to the necessity of a low elevation has been quite justified by what has taken place here.

When mists were prevalent, Kiö has always been better off than the surrounding country. The hills to the south-east and south-west have often been wrapped in mists, while the eastern horizon at the camp has been as clear as a bell. So far we have only experienced one fog.

The weather so far has seemed to have a two-day period, two fine days following wet days. The 29th and 30th were wet and windy days, while the two following ones were moderately fine. On the s.s. *Garonne* I had an opportunity of consulting two pilots well acquainted with the Veranger fjord, and both informed me that the characteristic feature of the weather was that the mornings were fine and the sky was overcast later. This has so far in the main proved accurate. The eastward horizon (we have a sea horizon) has been nearly always clear in the earlier part of the morning, *i.e.* about six a.m., while towards six p.m. it was invariably cloudy. This gives us good encouragement, and make our chances of fine weather at the time of the eclipse very hopeful. And it may be stated, further, that the chances are that even if the eclipse morning proves misty, our place of observation will be the best available, and only clouds will prevent a successful issue.

J. NORMAN LOCKYER.

(To be continued.)

NOTES.

SIR GEORGE BADEN-POWELL did science a very important service when he conveyed a small party of observers to Novaya Zemlya to record the characteristics of the eclipse of August 9. Mr. Norman Lockyer points out in the *Times* that, thanks to this timely aid, the failures in Norway and Japan are much less disastrous than they otherwise would have been. He has received a code telegram from Mr. Shackleton, one of his assistants who accompanied Sir G. Baden-Powell, stating that results just short of the best possible have been obtained. The programme of work arranged for Novaya Zemlya included a series of twenty-two photographs with the prismatic camera (that is, a long photographic camera with two large prisms of 60° in front of the lens). The exposures were to begin thirty seconds before totality, and were to end shortly after it. They varied from snap-shots to forty seconds. The times of exposures were arranged to secure specially the spectrum of the corona. Besides this work, to which the highest value is attached, three photographs of the corona were to be obtained with a long focus telescope of 4-inch aperture. It is a matter of congratulation

that these instruments have been utilised, and as Dr. Stone, who also accompanied the party, was probably equally successful in making observations, we may say that the eclipse has been saved from entire failure, so far as British astronomers are concerned, by Sir G. Baden-Powell's assistance. As to Russian observers, a Reuter telegram from St. Petersburg, August 20, says:—"The Russian astronomical expedition, which was sent to the north of Finland to observe the solar eclipse, telegraphs from Tornea that, owing to the magnificent weather which prevailed at the time, ten good photographs of the corona were obtained by means of three different apparatus. The Hydrographical Department has received a telegram from General Baron Maidelicheff, of the Saghalian astronomical expedition. The message, which was despatched from Cape Notoro, the south-western extremity of Saghalian, states that the observation of the eclipse was fairly successful, and that, although the sky was cloudy, two photographs of the corona were obtained. Some magnetic variations were noticed during the eclipse."

At the moment of going to press, the following details have been received from Mr. Shackleton, with reference to his observations at Novaya Zemlya:—"I obtained about eight photos during totality. The most successful are those at the beginning of the eclipse, also at the end and the long exposure near mid-totality. The two photos near the beginning of totality are very interesting: the one nearest the time of the beginning of totality shows, I think without doubt, as many bright lines as there are in the Fraunhofer spectrum with the same instrument, so in all probability we have succeeded in photographing the 'reversing layer.' The plate at the end of totality also shows a great many lines, but not as many as at the beginning; probably they are the same as those photographed by Mr. Fowler in the metallic prominences of 1893—certainly most of them are. The long exposure near mid-totality gives a good ring at 1474 K, and also one near K (3969 Å), and several other fainter ones. The spectra are not so extensive in ultra-violet lines as those of 1893, probably because of the cloudy state of the sky. The corona-photos have also come out very well." We propose to refer more fully to the Novaya Zemlya observations in an article in our next issue.

THE Royal Society was represented at the funeral of Sir John Millais, on Thursday last, by Dr. Michael Foster and Sir Joseph Fayrer. Among other scientific bodies, which honoured art in the person of the late President, were the Society of Antiquaries, the Royal Astronomical Society, the Linnean, Chemical, and Geological Societies, the British Museum, the Royal Geographical Society, the Institution of Civil Engineers, the Colleges of Physicians and Surgeons, and the Royal Institution of British Architects.

THE success of Sir Martin Conway's expedition to Spitzbergen was noted in our issue of August 6. A Reuter's telegram from Tromsö, dated August 21, states that the whole party had arrived there on their way home. Mr. Garwood and Mr. Trevor-Battye had left the main party in Spitzbergen in order to explore Horn Sund, and they succeeded in reaching and ascending Hornsund Tind, a "marble mountain" in the middle of Southern Spitzbergen, which has hitherto only been seen from the sea. They studied the geology and glacier systems of the surrounding country, and encountered serious difficulties on account of the boisterous weather. By no means the least daring part of their journey was the return from Spitzbergen to Norway in a small steam launch of less than twelve tons, necessarily a much less seaworthy craft than a sailing boat of the same size.

A REUTER telegram states that the Danish cruiser *Ingolf* returned to Copenhagen on Thursday last from a long voyage,