PREPARATIONS NOW BEING MADE IN SYDNEY OBSERVATORY FOR THE PHOTOGRAPHIC CHART OF THE HEAVENS.

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[With Plate xi.]

[Read before the Royal Society of N.S. Wales, July 1, 1891.]

Last year I exhibited various photographs of stars and nebulae taken with a portrait camera lens having a focal length of thirty-two inches, now I am able to shew you some of the same objects photographed with the new star camera of one hundred and thirty-five inches focal length. One could hardly realize the extraordinary difference between the two without seeing it. I am also able to shew you the result of taking a star cluster with an enlarging lens which makes the equivalent focal length of the star camera five hundred and sixty-four inches or forty-seven feet. The success of this addition to the star camera is very gratifying, because it shews how much may be added to our knowledge of star clusters by this method of direct enlargement. I find it is much better to enlarge the star pictures in the camera direct than after they are taken, because there are always blemishes in the surface used for the photograph which get enlarged with the picture. The first photograph of Kappa Crucis did not cover a space of one-tenth of an inch square, the star camera makes it eighteen times larger and the enlarging lens three hundred and twenty-four times larger. Where extreme accuracy for measurement is required, as in these cases, the photograph may be again magnified fifty times under the microscope, and the smaller picture will bear no greater power, because it is the imperfections in the surface that carries the image, that limit the magnifying power that can be used.

The photograph obtained with the enlarging lens on the star camera speaks volumes for the stability and accurate motion of
the telescope, which under such a magnifying power gives perfectly sharp star discs. The clearness of these star discs, many of them representing coloured stars, enables us to see distinctly the effect of different colours on the size of the star discs. There are two conspicuous stars, a red, and a blue, the red star to the eye is fully a magnitude brighter than the blue, Herschel called it 9th magnitude, and the blue one 10th magnitude, the red one in the photograph appears of the 11th magnitude or two magnitudes less, and the blue one appears of 9th or one magnitude greater, in other words, the difference in colour as estimated by the eye and the photograph, makes a difference of three magnitudes in the stars.

As I have just stated the photographs exhibited here last year were made with a six inch Dalmeyer Portrait-lens. My object now is to bring before you the state of preparedness of the Star Camera for the work of charting the heavens, as well as some examples of the actual work, plates taken of the dimensions and under the conditions of the plates which will be used for the chart, and only differing from them in that the réseau or grating of lines, though ruled and made by the same machine as those that are to be used, has not been tested in Europe, as all must be before they are accepted. These are in fact experimental plates.

The réseau I have, was courteously sent to me by Admiral Mouchez, the Director of the Paris Observatory—as an untested sample. The process of testing those to be used being a tedious one, it will take some time before the approved ones are available, but for our present purpose the one I have answers admirably. It consists of a piece of plate glass with a thick coating of silver from solution on one side, on this silver, two sets of lines at right angles have been ruled with a sharp point, which has cut the silver through, the lines are about two-tenths of an inch apart, which is equal to five minutes of arc, and each line is numbered.

The réseau is placed face upward in a box, the exact counterpart of the plate holder in the telescope, upon it is then placed a sensitive plate, and the box is closed and put in front of the
object glass of the Star Camera. A small electric lamp of two and a-half candles is then put in the focal point of the Star Camera, and the rays from it pass out from the object glass parallel, and falling on the réseau are all stopped by the silver, except those which fall on the lines and figures, and these pass through on to the sensitive plate and mark it. A number of plates are so treated one after the other and stored ready for use in dark boxes. They are all carefully numbered on the glass, and exposed in the Star Camera in order of the numbers. The plates measure $6\frac{1}{2} \times 6\frac{1}{4}$ inches, and the part actually exposed $6 \times 6$ inch; of this space $4\cdot7 \times 4\cdot7$ inch is the portion which is finally used, that is $2^\circ \times 2^\circ$. Of the margin, rather more than half inch serves as overlap on the plates, and the stars on this can be compared for verification in each adjoining pair of plates. When the plate is developed after exposure, the lines or grating as well as the stars appear.

So far everything is simple and mechanical, but the resolutions of the Conference require, that one set of plates shall have on them all stars to the 11th magnitude, and the other set all stars to the 14th magnitude, and the difficulty in an everchanging atmosphere, and with plates which differ in sensitiveness, is to give the exposure necessary to secure these results.

The Astronomer Royal of England as Chairman of the Committee appointed to deal with these and other kindred questions, has been making experiments on a fairly good night in London. He has come to the conclusion that two minutes will be enough in such weather for stars of 11th magnitude, and thirty minutes enough for stars of 14th magnitude, and that these times must be varied to suit the weather, that is increased if the weather is bad. I am able to shew you three plates, one exposed thirty seconds, another two minutes, and the third thirty minutes, on the well known star cluster Kappa Crucis. You will see that thirty seconds is enough to get images of stars to the 9th magnitude, and that two minutes gives images of stars to the 11th magnitude, and takes in also some of 12th and one of 13th magnitudes.
The plate exposed for thirty minutes is however not so satisfactory, for it should according to the rule, show with defined discs stars of the 14th magnitude of Argelander’s scale. In Herschel’s monograph on this cluster he has eleven stars of 14th and four of 15th magnitude, of Argelander’s scale, of these eight are invisible, six are visible but not measurable, and only one is “measurable,” and some stars of even the 12th and 13th magnitudes that are not measurable. The plates were exposed one after the other, on a night that seemed to be uniform, and when the two minutes plate was a success the thirty minutes one ought also to have been. I give the result of this experiment to shew one serious difficulty that besets the work; at first sight the foregoing results look like a failure of the method, but I find that these faint stars in Herschel’s list are either much fainter than he took them for, or they are coloured stars. This was proved by taking a photograph of the same object and giving three hours exposure. Even then most of the stars referred to above are far too faint to measure, although they can be seen plainly enough in nearly every instance, and the photograph, hurriedly examined to see if the faint stars were on it, is found to contain at least twenty more faint stars which Herschel did not see. This example will serve to show you better than any statement, the difficulty to be met in following the adopted rule, viz., if two minutes exposure records stars of the 11th magnitude, then thirty to thirty-five minutes should record those of 14th, for here in the case of a well known cluster, with every star recorded by careful observers, it is found that the rule fails, and the question arises, did Herschel over-estimate the magnitude of these stars, or are they coloured. Over nearly the whole surface of the sky we have no record of stars below the 9th magnitude, and therefore no means of finding whether the photographs will really record what is desired, that is stars of 14th magnitude. It is obvious therefore, that more experiments will have to be made upon well known clusters to determine the time necessary for the purpose of making certain of 14th magnitude stars. When that is done however, we shall have
(in the photographs) a vast number of stars appearing as of the 14th magnitude, which the eye cannot see through the telescope, just as I found in Kappa Crucis. The longer exposure given in order to secure visible 14th magnitude stars, resulted in recording a large number of stars photographically of 14th magnitude, but wholly invisible through the telescope. At the recent meeting of the Committee, it was decided on the evidence given by Dr. Scheiner, to extend the time of exposure for 14th magnitude stars to forty minutes, and it is reasonable to expect, since all are interested and working at this difficulty, that it will soon be solved, and times of exposure in different states of the atmosphere agreed upon. At present there seems to be no possibility of dealing with the colour difficulty which is a serious one, as I have already pointed out. Great differences are found also in the sensitive plates, we have tried Swan's, Wratten and Wainwright, Field Dodgson's star plates, M. A. Seed plates (American), and Ilford plates; and so far as I have gone, the Ilford plates are certainly the best for our purpose.

In my photographs of the Great Magellan Cloud taken with the portrait camera, which I exhibited at the November meeting, the stars owing to their countless numbers appear as blurred masses, and the great and remarkable nebula 30 Doradus is only a white spot. With the Star Camera the picture is enlarged eighteen times, and the stars are separated and brought out sharply defined, while the nebula 30 Doradus is revealed in its wonderful complexity, and shewn to be much more extensive than Herschel made it with his great reflector, so that quite a new light is brought out by the Star Camera, and is thrown on the structure of this object.

There is one thing about this nebula which is very suggestive, some of its loops are round, and all its features seem to be laid out, as if in a plane at right angles, or nearly so to the line of sight; there are no decided elliptical forms, which so commonly appear in nebulae, owing to their circular forms being oblique to the line of sight, and therefore projected into ellipses. If we look at the main
features of Nubecula Major we see that the curves are nearly circles, both those in the main body of it, and in the several star clusters and nebule; further if we examine them very closely we find that they are all slightly elongated in the same way; or in other words the major axes of these ellipses are parallel or nearly so; they all in fact seem to lie in a plane nearly at right angles to the line of sight. Now just as the sun with his attendant planets, the planets with their moons, and especially Saturn with his rings, shew us that there has been a tendency, as theory would also lead us to expect, to arrange the matter, that is revolving about them in a plane common to all, and as is also evidently the case with spiral nebuleæ, the matter is arranged in a plane of which the diameter is enormously greater than the thickness, so I think we may safely assume, that the Nubecula Major is a great spiral structure of which we see the greatest diameter, and that its thickness, measured through in the line of sight is comparatively small; further in addition to the central spiral there are two nebuleæ, and at least three clusters of stars arranged as spirals, having one character in common with the main one, that is, they are nearly circular, and these are all arranged in space, so that they appear to us, in the same or parallel planes, and near together. It may, I think, be safely assumed that all these are parts of the grandest spiral structure that we know, and that they are all in one plane, because if they are not in the same plane, then, being optically close together and in parallel planes they must be arranged one after the other in a long vista which happens to be in our line of sight; that is, a series of great spirals, one behind the other, at different distances towards infinity, and all revolving as if on a common or parallel axes; a conclusion which is highly improbable, and impossible to receive when the simple and more rational alternative of their being all in the same plane is available, which also accords with what we see in other systems. If we assume that all are in the same plane, we can imagine what we should see if transported to some star near the centre. All round us would be an infinity of stars, which on closer inspection, would
seem more crowded in a great plane, and in the same plane we should see certainly two, and probably many nebulae, projected into straight lines, because looked at in the plane in which they revolve; in some directions the stars would appear thinner than in others, because in those, the photograph shews us they do not extend so far into space, and in others owing to the dark spaces in the great spiral, we would see through into the infinity beyond.

If you look at the photograph and assume as I have done above, that the whole universe of stars is spread out in the plane of the photograph, you will notice that there would be no difficulty in finding positions from which the observer would see through some of the comparatively dark places as well as other directions in which countless multitudes of stars of all magnitudes would meet the gaze. In fact, his vision would be much the same as ours, in one plane in the heavens, that of our universe, we see an inconceivable wealth of stars, the Milky-Way, with here and there dark spaces, coal sacks—so called—due to the dark rifts such as those above referred to, and turning our eyes gradually away from that plane the number of stars decreases, although they are still abundant.

Now, although even amongst the infinitude of the heavens, we cannot find two star-clusters, or two nebulae alike, we can still find classes, which have many points in common, and I think we have reasonable ground for supposing, that we have presented to us in the Nubecula Major, a universe similar to that in which we are, and that instead of seeing it from within, where it is impossible to make out its form, we are here—with the aid of telescopes, and the still more powerful Star Camera—able to see just such a universe, to trace out a rational explanation of the many puzzling features of the stars, and Milky-Way around us, and to see how such a universe may be arranged.

In reference to another well-known southern object, “the nebula about Eta Argus,” it will be remembered that last session I exhibited a photograph of it with three hours exposure, stating that it had not been exposed long enough. On April 9th, 1891,
I obtained a clear night, and an exposure of eight hours—again with the short camera—which brings out a host of stars and shows the Milky-Way with a brilliance it has never been seen to have before, at the same time the nebula, is more distinctly shewn and larger. After a series of trials, I have succeeded in getting several fine photographs of this object with the Star Camera, which make it eighteen times larger than the one I used last year. I have however been unable to get a continuous exposure of eight hours with this camera, still in Plate 77, taken March 18th 1891, with five hours forty-three minutes exposure on a fine clear night, and in others taken about the same time, we have a marvellous revelation of the details of light and shade presented to us in this object, which have never been seen before in any photograph, or by any telescope.

Something like the appearance would be produced, if one took a number of tufts of long-fibred wool, and dropped them one after the other on to a black cloth; as they fell and rolled over one another, they would arrange themselves in curves and lines, through which as one looked down at them, the dark cloth would here and there be seen through tangled wreaths of wool; and in others the cloth would be wholly hidden by the mass of such lines and curves, which would nevertheless be sufficiently distinct to shew how the mass of white was made up; but no description could correctly convey the wonderful detail which the photograph reveals; the general form of this object is the same as in drawings, and in the photographs exhibited last session, but there are certain new features which may be indicated. In the first place, there is evidence here that the nebula is much more extended and the spiral structure more decided, and it can be traced even to the details of the fainter branches. Secondly, the nebula covers a much larger area than that of Orion. Thirdly it proves conclusively that a conspicuous part of the nebula which Herschel drew and described in 1838 has entirely disappeared. I pointed this out in 1872, but as I then used a telescope inferior in power to Herschel's, its invisibility to me, was not proof that it was gone. Now the
Star-Camera is vastly more powerful than Herschel's telescope, how much may be judged from the fact, that in one small space where he could see only one star, the Camera shows ten, and in another place examined by Herschel with equal care, and said to contain four stars, the Camera shews twenty. There can then be no doubt, that in this case a bright nebulous mass, has entirely disappeared in thirty-four years, and it is significant that the part where this nebula was, is now replaced by a dark round spot. I have photographed the object many times with both Cameras, and the dark spot is always there, can it be that in the thirty-four years 1838 to 1872 one of the supposed dark clouds of space has drifted in between us and the nebula. It cannot be a solid body, because the stars are there, but a slight misty body would hide the nebula and not affect the stars very much.

It would be tedious to attempt to describe all that the photograph reveals, especially in the central part of the nebula, but I may say, that while the eye aided by the best telescopes, sees the nebula of fairly uniform brightness, interrupted by certain well-known darker spaces, and especially by that which Herschel called the Lemniscate, this photograph shews a most complex structure, with a great variety of light and shade; and just as in the case of the Theta Orionis, the nebula with its vast folds is shewn to extend farther from the centre, with each increase in the time of exposure, so I find with that about Eta Argus. The southern nebula is however very much more difficult to photograph, and I think it must have some tinge of colour in it, probably yellow, for a photograph of Orion with one hour's exposure is more dense than one of Eta Argus with six hours exposure.

Taken as a whole, the nebula about Eta Argus covers a much larger space than that about Orion, even in these photographs in which the southern nebula, although longer exposed, is comparatively under exposed; while that of Orion is much over exposed.

I have also brought two photographs of the Moon to show you, they were taken on 19th and 28th of May last. As you are all aware,
it is extremely rare to get a night in which there is absolutely no motion, or what is called twinkle in the stars, or in other words, when the Earth's atmosphere is not disturbed by currents of air of unequal temperature. Now until we get such a night and a suitable Moon, it will be impossible to get a perfect photograph of the Moon, for any motion in the air, such as that referred to above, has the effect of enlarging every point of light. A star image for instance may in this way be made two or three times its normal size, and if the stars are close together they are run into one blotch. So on the Moon, all the little details are enlarged and mixed up, so that they cannot be seen; but these photographs are very good and show some features of the Moon's surface which I have never seen in any others, for instance the undulations on the surface of the lunar plains, the equivalent of what on the earth we should call hills and valleys, as opposed to mountains.

SOME FOLK-SONGS AND MYTHS FROM SAMOA.

Translated by the Rev. G. Pratt.

With Introductions and Notes by John Fraser, LL.D.

[Read before the Royal Society of N.S. Wales, July 1, 1891.]

V.—Sa‘u-mani and Le Fe‘e—A ‘Tala.

How their friendship was broken.

INTRODUCTION.—On the road that leads from Taʻu to Falea-sao, in the Samoan islands of Manu‘a, there is now a large menhir or ‘standing stone,’ and thereon hangs this tale. There is nothing remarkable or even interesting in the tale; it only shows that the same causes and modes of story-making have operated in Samoa as in the rest of the world; some uncommon appearance or object in nature excites attention and wonder; imagination comes in and invents a simple but supernatural

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