his station, to cultivate successfully the researches connected with the antiquities of Ireland, and had earned for himself a high place among those who labour to illustrate her ancient records, or to save from destruction the perishing relics of her former civilization.

Samuel Ferguson, Esq., was elected to the vacant place in the Council; and the Rev. J. H. Todd, D.D., was appointed by the President, under his hand and seal, to succeed the Dean of St. Patrick's in the office of Vice-President.

The Rev. T. R. Robinson, D.D., M.R.I.A., gave the Academy an account of a large reflecting telescope, lately constructed by Lord Oxmantown, and of the processes employed in forming its specula.

After explaining the relative importance of magnifying and illuminating power, Dr. R. proceeded to give a brief sketch of the history of the reflecting telescope, which seemed to have been forgotten for many years after its invention, till it was revived by Hadley. The labours of Short soon gave it celebrity; yet even this artist limited himself in almost every instance to sizes which were not more powerful than the achromatics of his day, and his large instruments appear to have been failures.* It was not till a full century after the publication of Newton's paper, that Sir William Herschel gave this telescope the gigantic development which has crowned him with imperishable fame; and by the construction of telescopes of nineteen

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* A Newtonian of six feet focus, and 9·4 inches aperture, is said by Maskelyne to have shewn the first satellite of Jupiter 13″ longer than a *triple* achromatic of 3·6 inches aperture. The telescope of twelve feet focus, and eighteen inches aperture, now at Oxford, shewed multiple rings of Saturn.

and forty-eight inches aperture, placed regions almost beyond the scope of measurement within the reach of human intellect. But as Short, in a spirit unworthy of his talents, took care that his knowledge should die with himself, and Herschel published nothing of the means to which his success was owing, the construction of a large reflector is still as much as ever a perilous adventure, in which each individual must grope his way. Accordingly, the London opticians themselves do not like to attempt a mirror even of nine inches diameter, and demand a price for it which shews the uncertainty and difficulty of its execution. In Ireland we are more fortunate, for a member of our Academy, Mr. Grubb, finds no difficulty in making them of admirable quality up to this size, or even fifteen inches; but with all his distinguished mechanical talent, he is believed to be doubtful of the possibility of more than doubling this last magnitude in perfect speculum metal.

Under these circumstances, too much praise cannot be given to Lord Oxmantown, who, in the midst of other pursuits, has found leisure for such researches; and by a rare combination of optical science, chemical knowlege, and practical mechanics, has given us the power of overcoming the difficulties which arrested our predecessors, and of carrying to an extent which even Herschel himself did not venture to contemplate, the illuminating power of this telescope, along with a sharpness of definition scarcely inferior to that of the achromatic.

The chief difficulties which are to be overcome in the construction of reflectors, arise from the excessive brittleness of the composition of which specula are made, and from the necessity of giving them figures which shall be free from aberration. The great mirror in the Newtonian form is (if the eyepiece and plane mirror be correct) the conical paraboloid.

It is necessary that speculum metal should possess, in the highest attainable degree, the qualities of whiteness, brilliancy, and resistance to tarnish. Lord Oxmantown has found that these conditions are best satisfied in the *definite* combinations of four equivalents of copper to one of tin; or by weight, 32 and 14·7 nearly. Metals differing from this by a slight excess of either component, are, when first polished, scarcely less brilliant, but are dimmed so rapidly that the lapse of a few days produces a sensible difference. On the other hand, some large specula of the atomic compound have been lying uncovered for years, without material injury to their polish.

But this compound is brittle almost beyond belief; a slight blow, or even the application of partial warmth, will shiver a large mass of it; though harder than steel, its surface is broken up with the utmost facility, and it has a most energetic tendency to crystallize. The common process of the founder fails with it, except for masses of very limited magnitude, as the cast cracks in the mould, and the subsequent difficulties of the annealing are such, that it has been a very general practice to use an alloy lower (containing more copper) than the atomic standard. Even Sir William Herschel was obliged to yield to this necessity. It appears from a letter of Smeaton, (Rees' Cyclopædia, Art. Telescope,) that for his 20 feet mirror of 19 inches aperture, the composition was 32 copper to 12·4 tin; and that for the 40 feet it was even lower. Yet two out of three attempts to cast this huge speculum failed.

Lord Oxmantown at first endeavoured to evade the difficulty, by constructing a speculum in pieces, soldering plates of fine metal to a back of a peculiar brass, ascertained to have the same expansion; and has completed one of thirty-six inches aperture and twenty-seven feet focal length, which performs very well on stars below the fifth magnitude, but above that exhibits a cross formed by the diffraction at the joints; and in unsteady states of the air exhibits the sixteen divisions of the great mirror on the star's disk. By diminishing the number and size of the joints it is found, that these inconveniences can be diminished, so as to be scarcely perceptible; and in all probability this is the process by which the remotest limits of telescopic vision will ultimately be attained. It is, however, not necessary for instruments of even greater dimensions than this, since Lord Oxmantown has succeeded, by a contrivance as simple as ingenious, in casting at the first attempt a *solid* mirror of the same size; and there is no reason to suppose that it will be less effective on a much larger scale.

But however difficult it may be to obtain the rough speculum of large dimensions, it is still more so to give it a proper figure, combined with that brilliant polish which is technically called black, because it reflects no light out of the plane of incidence. In such mirrors as can be wrought by hand, they are worked by short cross strokes on the polisher, and at the same time have a slow rotation relative to it. This might be expected to produce merely a spherical figure; but by varying the length of the stroke, by circular movement, elliptic figure of the polisher, or removing portions of its pitch covering, a parabolic figure is obtained. For sizes above nine inches diameter, the work must be performed by machinery; but in all which Dr. R. has seen, (the most remarkable of which are those of Sir William Herschel* and Mr. Grubb,) the cross stroke is given by a lever moved by hand; and it is supposed that perfect results cannot be obtained but by the *feeling* of the polisher's action. Sir John Herschel is believed to have made important

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* Dr. R. had the good fortune to see this at Slough, in 1830, while at work on a twenty-feet mirror.

additions to his father's apparatus; and it is t › be hoped he will soon redeem his promise (Mem. R. Ast. Soc. vol. vi.) of publishing his improvements.

Lord Oxmantown has in many respects deviated from the usual process. His polisher, of the mirror's diameter, intersected by transverse and circular grooves, into portions not exceeding half an inch of surface, is coated, first, with a thin layer of the common optical pitch, and then with a much harder compound. It is worked *on* the mirror, and counterpoised so that but little of its weight bears; but the want of pressure is compensated by a long and rapid stroke. The mirror revolves slowly in a cistern of water, maintained at a uniform temperature, to prevent the extrication of heat by friction. The polisher moves slowly in the same direction, while it is also impelled with two rectangular movements. The machine is driven by steam, and requires no superintendence, except to supply occasionally a little water to the polisher, and to watch when the polish is complete. By an induction from experiments on mirrors from six to thirty-six inches aperture it was found, that if the magnitudes of the transverse movements be $\frac{1}{3}$ and $\frac{9}{100}$ of the aperture, and their times be to its period of rotation as 1 and 1·8 to 37, the figure will be parabolic: but to combine with this the highest degree of lustre, it is found necessary to apply, towards the close, a solution of soap in liquid ammonia, which seems to exert a specific action.

The certainty of the process is such, that the solid mirror of thirty-six inches aperture, after being scratched all all over its surface with coarse putty, was, in Dr. R.'s presence, perfectly polished in about six hours, and was placed in its tube for examination, without any previous trial as to quality.

Lord Oxmantown has preferred the Newtonian to the Herschelian form, and, in Dr. R.'s opinion, with good reason. In the latter, the inclination of the great mirror to the incident rays must deform the image,* and it is now known, that even with faint objects sharp definition is of high importance. It should, in fact, be a segment of a paraboloid, exterior to the axis; and though a theorem of Sir William Hamilton (Trans. R. Irish Acad., vol. xv. p. 97,) might seem to indicate mechanical means of approximating to the figure, yet Dr. R. fears there would be greater difficulty in applying them than in enlarging the aperture of the Newtonian, so as to make up for the loss of light. Another serious objection is, that in the Herschelian the observer's position at the mouth of the tube, must cause currents of heated air, which will materially interfere with sharpness of definition.

As to the loss of light by the second reflexion, Dr. R. thinks it has been much overrated, and expresses a wish that a careful set of experiments were made on reflexion by plane specula at various incidences, on prisms of total reflexion, and the achromatic prism, proposed as a substitute by Sir David Brewster.

As to the rest of the instrument, it may suffice to say, that it bears a general resemblance to that of Ramage, but that the tube, gallery, and vertical axis of the stand are counterpoised, so that one man can easily work it, notwithstanding its enormous bulk. The specula, when not in use, are preserved from moisture or acid vapours, by connecting their boxes with chambers containing quicklime, which is occasionally renewed. This arrangement, (which also occurred to Dr. R., and has been for several years applied by

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* Any one who has a Newtonian telescope can verify this, by inclining a little the great mirror, so however as not to pass the edge of the plane mirror by the pencil. In Lord O.'s instrument, an inclination of 11′ sensibly injures it; were it Herschelian, the inclination must be 3° 11′.

him to the Armagh reflector,) appears to be very effective in preserving the polish.

In trying the performance of the telescope, Dr. R. had the advantage of the assistance of one of the most celebrated of British astronomers, Sir James South; but they were unfortunate in respect to weather, as the air was unsteady in almost every instance; the moonlight was also powerful on most of the nights when they were using it. After midnight, too, (when large reflectors act best,) the sky, in general, became overcast. The time was from October 29th to November 8th.

Both specula, the divided and the solid, seem exactly parabolic, there being no sensible difference in the focal adjustment of the eyepiece with the whole aperture of thirty-six inches, or one of twelve; in the former case there is more *flutter*, but apparently no difference in definition, and the eyepiece comes to its place of adjustment very sharply.

The solid speculum showed *α* Lyræ round and well defined, with powers up to 1000 inclusive, and at moments even with 1600; but the air was not fit for so high a power on any telescope. Rigel, two hours from the meridian, with 600, was round, the field quite dark, the companion separated by more than a diameter of the star from its light, and so brilliant that it would certainly be visible long before sunset.

ζ Orionis, well defined, with all the powers from 200 to 1000, with the latter a wide black separation between the stars; 32 Orionis and 31 Canis minoris were also well separated.

It is scarcely possible to preserve the necessary sobriety of language, in speaking of the moon's appearance with this instrument, which discovers a multitude of new objects at every point of its surface. Among these may be named a mountainous tract near Ptolemy, every ridge of which is dotted with extremely minute craters, and two black parallel stripes in the bottom of Aristarchus.

The Georgian was the only planet visible; its disc did not show any trace of a ring. As to its satellites, it is difficult to pronounce whether the luminous points seen near it are satellites or stars, without micrometer measures. On October 29, three such points were seen within a few seconds of the planet, which were not visible on November 5; but then two others were to be traced, one of which could not have been overlooked in the first instance, had it been in the same position. If these were satellites, as is not improbable, there would be no *great* difficulty in taking good measurement both of their distance and position.

There could be little doubt of the high illuminating power of such a telescope, yet an example or two may be desirable. Between ε^1 and ε^2 Lyræ, there are two faint stars, which Sir J. Herschel (Phil. Trans. 1824) calls "debilissima," and which seem to have been, at that time, the only set visible in the twenty-feet reflector. These, at the altitude of 18° were visible *without an eye-glass*, and also when the aperture was contracted to twelve inches. With an aperture of eighteen inches, power 600, they and two other stars (seen in Mr. Cooper's achromatic of 13·2 aperture, and the Armagh reflector of 15) are easily seen. With the whole aperture, a fifth is visible, which Dr. R. had not before noticed. Nov. 5th, strong moonlight.

In the nebula of Orion, the fifth star of the trapezium is easily seen with either speculum, even when the aperture is contracted to eighteen inches. The divided speculum will not shew the sixth with the whole aperture, on account of that sort of disintegration of large stars already noticed, but does, in favourable moments, when contracted to eighteen inches. With the solid mirror and whole aperture, it stands out conspicuously under all the powers up to 1000, and even with eighteen inches is not likely to be overlooked.

Comparatively little attention was paid to nebulæ and clusters, from the moonlight, and the superior importance of ascertaining the telescope's defining power. Of the few examined were 13 Messier, in which the central mass of stars was more distinctly separated, and the stars themselves larger than had been anticipated; the great nebula of Orion and that of Andromeda shewed no appearance of resolution, but the small nebula near the latter is clearly resolvable. This is also the case with the ring nebula of Lyra; indeed, Dr. R. thought it was resolved at its minor axis; the fainter nebulous matter which fills it is irregularly distributed, having several stripes or wisps in it, and there are four stars near it, besides the one figured by Sir John Herschel, in his catalogue of nebulæ. It is also worthy of notice, that this nebula, instead of that regular outline which he has there given it, is fringed with appendages, branching out into the surrounding space, like those of 13 Messier, and in particular, having prolongations brighter than the others in the direction of the major axis, longer than the ring's breadth. A still greater difference is found in 1 Messier, described by Sir John Herschel, as "a barely resolvable cluster," and drawn, fig. 81, with a fair elliptic boundary. This telescope, however, shews the stars, as in his figure 89, and some more plainly, while the general outline, besides being irregular and fringed with appendages, has a deep bifurcation to the south.

From these and some other discrepancies, Dr. R. thinks it of great importance that the globular nebulæ and clusters should be all carefully reviewed, as it is chiefly from their supposed regularity that the hypothesis of the condensation of nebulous matter into suns and planets has arisen, an hypothesis which he thinks has, in some instances, been carried to an unwarrantable extent.

On the whole, he is of opinion that this is the most powerful telescope that has ever been constructed. So little has been published respecting the performance of Sir W. Herschel's forty-foot telescope, that it is not easy to institute a comparison with *that,* the only one that can fairly be made to compete with it. But there are two facts on record which lead to the inference that it was deficient in defining power; one, the low power used, which Dr. R. thinks was not above 370; the other, the circumstance that neither the fifth nor sixth stars of the trapezium of the nebula of Orion were shewn by it. As to light, there is no reason to believe that the composition of the forty-foot mirror was as reflective as that of the twenty-foot; and if Dr. R. be correct in the opinion, that the latter* did not shew the fifth star easily, or the sixth at all, and that it only exhibited the "debilissima" and one star near the ring-nebula, then *it* has decidedly less illuminating power than eighteen, perhaps not more than fourteen inches aperture of Lord Oxmantown's mirror, notwithstanding the loss of light in that by the reflexion at the second speculum.

However, any question about this optical pre-eminence is likely soon to be decided, for Lord Oxmantown is about to construct a telescope of unequalled dimensions. He intends it to be six feet aperture, and fifty feet focus, mounted in the meridian, but with a range of about half an hour on each side of it. If he succeeds in giving it the same degree of perfection as that which he has attained in the present instance, which is exceedingly probable, it will be, indeed, a proud achievement; his character is an assurance that it will be devoted, in the most unreserved manner, to the service of astronomy, while the energy that could accomplish

* In its original state, not as improved by the more perfect means latterly employed by Sir John Herschel.

such a triumph, and the liberality that has placed his discoveries in this difficult art within reach of all, may justly be reckoned among the highest distinctions of Ireland.

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A Papal Bulla, found near the Foundation of the Cathedral of Cloyne, (*Clemens PP. IIII.*) Presented by R. J. Graves, M.D.

Fisica di Corpi ponderabili. 2 vols. 8vo. By the Chevalier Amadeo Avogadro. Presented by the Author.

Third Annual Report of the Proceedings of the Botanical Society of Edinburgh. Presented by the Society.

Sixth Report of the Poor Law Commissioners in Ireland. Presented by George Nicholls, Esq.

Ancient Laws and Institutes of England. Presented by the Commissioners of the Public Records of the Kingdom.

A Geological Map of England and Wales. By G. B. Greenough, Esq. Presented by the Geological Society.

Transactions of the Geological Society of London. Vol. V. (1840.) Presented by the Society.

Quarterly Journal of the Statistical Society of London. July, 1840. Presented by the Society.

Address of the General Secretaries of the British Association. Presented by the Authors.

Journal of the Franklin Institute. Vol. XXV. (1840.) Presented by the Institute.