The discoveries as to the nature of the bodies of our solar system which the use of the telescope presented to its first inventors, must have been unexpected, and in no small degree astonishing. Yet we may safely assert, that they exhibit no remarkable novelty. The ring of *Saturn* alone can be considered as materially different from the objects constantly before our eyes. In all the other planets we see bodies similar in shape to our earth, analogous (as we have good reason to believe) in internal constitution, revolving in like manner, enlightened by the same principal luminary and by similar satellites, the subjects and the exciters of similar attractions, and possessing at least some similarity in the construction of their surfaces and in the phenomena of their atmospheres, as far as spots and belts enable us to conjecture. Every thing, in fact, leads us to conclude that they are bodies of the same order: that, with specific differences, there is a generic resemblance: that the circumstances of formation, which have bound all in one mechanical system respecting the sun as the principal seat of force, have also impressed upon all one physical system, as testified by the similar arrangement of subordinate bodies, and the probable resemblance of their gaseous as well as their solid parts.

But, when we look into the sidereal world, the analogy of system fails entirely. A star, it is true, may be conceived analogous to our sun: a double star, forming a binary system, though we have nothing here exactly like it, is still not remarkably different in its nature from a single one: but a star, regularly surrounded by dense nebulous matter, an irregular nebula in which one point is brighter than the rest, a nebula in which all idea of a stellar point is lost,—all these present instances of appearance, gradually yet totally different, and entirely dissimilar from every permanent body in our system. The resolvibility of some of these nebulæ, implying the existence of an immense number of stars at a proximity apparently much greater, in proportion to their individual brightness, than the stars which we commonly see, is a very striking phenomenon: but far more striking is the irresolvibility of others, whose magnitude seems to imply comparative nearness, which, nevertheless, defy our telescopes, and whose general appearance seems obviously to contradict the notion of consisting of groups of stars. Among the most remarkable of these I may mention the two most conspicuous—those of *Andromeda* and *Orion*. No one, I think, who has seen these in a telescope of great light,—the one like a lamp shining through a homogeneous fog, the other like a pile of cumuli-clouds tossed together in the same capricious manner in which we see them in our summer-skies,—can persuade himself that these can be any thing but masses of nebulous matter, the causes and the laws of whose arrangement we should vainly endeavour to detect.

In these remarks I have alluded only to the difference between the present appearance of these bodies and that of the planets depending on our sun. We may now, however, consider the matter in another point of view. The phenomena of the solar system impress upon us the notion not only of similarity, but of contem-

poraneity: at least, they seem to inform us that the time which has elapsed since the states of the planets were sensibly different must be immensely greater than the time during which a gradation of formation could have been sensible. But the contemplation of different nebulæ suggests a new idea—the idea of change. In one, we find nebulous matter in the wildest confusion: in another, there are spots in which, apparently, a concentration of the matter has been formed by drawing together the nebula from a large space, and leaving the neighbourhood comparatively dark (an effect exhibited in such various ways, that it is impossible to consider it as an optical illusion, the effect of contrast): in others, we have rings of nebulous matter inclosing a dark space: a more common case is the concentration which, in various degrees, exhibits the various appearances of planetary nebulæ and nebulous stars: and one very curious instance has been pointed out in which the segregation has taken place in a honeycomb form, the lines of the honeycomb being nearly accompanied by lines of stars. But, has Astronomy yet observed any change in these bodies? We cannot say with certainty that it has; yet the notion of change is not the less impressed upon us. To use the powerful illustration of Laplace, we look among them as among the trees of a forest: the change during the interval of a glance is undiscoverable, yet we perceive that there are plants in all different stages: we see that these stages are probably related to each other in the order of time; and we are irresistibly led to the conclusion, that the vegetable world in one case, and the sidereal world in the other, exhibit to us, at one instant, a succession of changes requiring time, which the life of man, or the duration of a solar system, are alone sufficient to trace out in any one instance.

Let it not be thought that the telescopic minuteness of some of these bodies is any argument against the importance of the investigation into their nature. The question as to the annual parallax of any nebula has hardly, perhaps, received sufficient attention: and its practical determination must necessarily be embarrassed with difficulties. This only we can assert, that the parallax of those most frequently observed is not conspicuous, and, probably, is not sensible. If the parallax of the great nebula of *Orion* be no greater than that of the stars most carefully observed, the breadth of that nebula may be fifty or a hundred times as great as the diameter of the earth's orbit. It may, then, well contain a sufficiency of matter for the formation of a sun and a system of planets. With this consideration, the examination of nebulæ acquires a new interest. It is not merely the inspection of a series of natural changes in which we have no greater interest than in the transitions from an egg to a moth, but it is the study of the successive steps by which worlds like that which we inhabit, and that which regulates our motions and our seasons, may have been organised from the most chaotic of all conceivable states. When to this we add, that the combination of relative motion of parts with gradual concentration of mass is sufficient to account generally for the formation of planets and satellites, possessing that remarkable property which is possessed by the

bodies of our system, of revolving all in the same direction, and describing orbits nearly circular, we must acknowledge that the examination of nebulæ, in all their stages, presents not merely a chance, but a highly plausible chance, of forming a distinct theory of cosmogony. And if we admire the genius of the mighty mathematician who first pointed out the simple reasoning by which the transition from nebulous fluid to discrete planets may be shewn to be physically possible and probable, let us at the same time pay our tribute of admiration to the great astronomer whose accurate observations and sagacious reflections gave the first ground for such a theory. Little time has elapsed since the first observation of these sidereal bodies: the observations of the greatest part of them have been made within our lifetimes: the first page in that part of the history of astronomy which relates to these subjects is hardly yet traced. But the history of astronomy may yet be long enough to comprehend a series of visible changes; and the most important element for the value of that particular branch of it will be the fulness and accuracy of the commencement. Happy would it be for other parts of the science, if the first pages of their history were as well traced.

The observation of nebulæ is entirely of modern origin. It does not appear that the largest had even been seen by the ancients: for, though Ptolemy uses the term nebulous (νεφελοειδης), it is applied only to clusters of stars, such, for instance, as that in the neck of *Orion*. The first real discovery of a nebula was that of the great nebula of *Andromeda* by Simon Marius in the year 1612, of which a history is given by Le Gentil in the French *Mémoires* for 1759. The next was that of *Orion*, discovered by Huygens, and described by him in the *Systema Saturnium*, published in 1659. Huygens published a map of this nebula, as good, perhaps, as the light of the telescopes which he used enabled him to draw. The next step made was the publication of a catalogue of six nebulæ, by Halley, in the *Phil. Trans.* No. 347; and the next appears to have been the account of sixteen given by Derham, in the *Phil. Trans.* No. 428. This divine and astronomer seems to have bestowed considerable attention upon the nebulæ. His telescopic means (an 8-feet reflecting telescope) were not contemptible: and he seems to have been fully aware of the importance of considerable optical power in these examinations. His speculations are rather confused. At one time he speaks of the extended nebulous spaces which he observed as "vast areæ or regions of light:" at another time he inclines to believe that some at least of the nebulæ are holes in an opake shell that surrounds the visible system, which holes allow us a sight of the empyreal sphere beyond it: and the authority of theological as well as of astronomical writers is adduced in favour of the reasonableness of such a notion. In another work (his *Astro-Theology*) he has expressed his opinion of the resolvibility of the *Milky Way*, but conceives that its light is more like that of planets than that of suns, and, therefore, that the illumination which reaches our eyes is principally that of the subordinate bodies.

The subject seems to have been left without further notice (excepting only the discovery of the small nebula accompanying the great one in *Andromeda*, by Le Gentil, in 1749), till La Caille published, in the *Mémoires* for 1755, a catalogue of 42 nebulæ observed by himself at the Cape of Good Hope. Le Gentil, in the *Mémoires* for 1759, gave careful descriptions of several nebulæ, with engraved representations, particularly of those of *Andromeda* and *Orion*. He also described the difference of appearance of some depending on the difference of telescopes employed. Messier, in the *Mémoires* for 1771, gave a list of 68 nebulæ, clusters, &c. observed by himself: this is accompanied with a map of the great nebula of *Orion*. This catalogue was copied into the *Connaissance des Temps* for 1783, and again in the volume for 1784, with the addition of 33 nebulæ principally observed by Mechain. The principal defect of this catalogue is, that it is arranged, not in order of R.A. or of N.P.D., but in the order of the times of observation. In other respects it is excellent, as far as the optical means at the command of its author allowed: and there is little doubt that it has contributed, in no small degree, to the formation of the noble catalogue which is more immediately the subject of our notice to-day.

About 1782, Mr. (afterwards Dr. and Sir William) Herschel began his splendid series of observations. His first intention seems to have been to detect parallax by the observation of unconnected double stars (the notion of a binary system being not yet formed), and for this purpose a catalogue of double stars was to be made. In the course of this pursuit, and from perusal of Messier's catalogue, Herschel appears to have been gradually led to devote the greater part of his attention to the examination of nebulæ. The want of optical power was soon manifest, and soon supplied. In the *Phil. Trans.* for 1784 we find the first fruits of the use of a 20-feet reflector: the *Milky Way* was found to consist of stars; some nebulæ appeared resolvible, and Herschel commenced those bold speculations on the construction of the heavens to which every observation made with competent means since that time has given increased probability. To give any account of the succession of papers in which Sir W. Herschel's observations are detailed and his theoretical views explained, would require longer time than can be given on the present occasion. Not fewer than twenty memoirs, on subjects immediately related to this, appear in the *Philosophical Transactions;* the most splendid and most interesting parts, without any exception, of the thirty-seven volumes through which they are distributed. It is almost foreign to my present purpose to remark that, in 1802, the first mention of binary stars is found, and, in 1803 and 1804, their existence established: I shall only add, on this point, that the following up of the observations of double stars, and the using these observations for the investigation of their real and apparent orbits, by Sir John Herschel, must be considered the most remarkable step, in its methods as well as in its results, that geometrical astronomy has made for many years.

In the pursuit of a subject so perfectly novel as the construction

of the heavens, it is not to be wondered at that Sir W. Herschel's views should, with increased power and extended experience, have undergone some change. The most remarkable of these regards the appearance of nebulæ. In 1784, when the use of a large telescope made some nebulæ appear resolvible, he had inclined to the supposition that all were resolvible. In 1811, he acknowledged that his subsequent experience had entirely contradicted this notion. In 1814, he confirmed the last statement: on this occasion he pointed out, more clearly than before, the gradation from nebulæ to stars, on which I have already insisted; and with this paper the theory of nebulous formation may be said to have been established.

In different volumes of the *Phil. Trans.* Sir William Herschel published three catalogues, comprising 2500 nebulæ and clusters. These were observed, for the most part, with the 20-feet telescope; the heavens being regularly swept, according to the system introduced by him, for these objects. To go through a similar work with the 40-feet telescope was wholly impossible. In the volume for 1800, he has computed that fifteen years of assiduous work would be sufficient to examine the whole with a 20-feet telescope, but that six hundred years would be necessary to examine that portion of the sky visible in this latitude with a 40-feet. The separation of the three catalogues which I have mentioned renders them, in some degree, inconvenient for reference.

An extensive catalogue of southern nebulæ, the first, so far as I am aware, since that of La Caille, was furnished by Mr. Dunlop, from the Paramatta observatory. This collection reflects the highest credit on the industry and zeal of its author. The power of the telescopes employed by Mr. Dunlop was not sufficient to render the observations comparable with those of Herschel: but the collection is most valuable as a preliminary catalogue on a large scale, for the use of observers in the same hemisphere who may have at command more powerful instruments.

I now commence the examination of the labours of Sir John Herschel. The subjects of nebulæ and double stars appear to have been considered by him as a hereditary possession, and the familiarity with the instruments necessary for the observations was also hereditary. It is not to be wondered, therefore, that his earliest observations should relate to this subject. One of the first papers in our *Memoirs* is an account of the great nebulæ of *Andromeda* and *Orion*, with an admirable engraving of the latter, and a comparison of its present appearance with the appearances as described by the older observers. The question of change in this nebula had been examined by Sir W. Herschel in the *Phil. Trans.* for 1811. The materials collected by both observers, to whatever conclusion they may lead as to the past variations of the nebula, will undoubtedly fix its present state for comparison with future observations far more accurately than that of any other nebula is known. From the time of making these observations (1825) to the middle of 1833, Sir John Herschel's whole energies were directed to the examination of nebulæ. It is true, that in this time were produced also those

extensive catalogues of double stars which adorn our *Memoirs*, and which are at present the standard collections for such inquiries: in this time, also, were invented, and applied to use, those investigations into the motions of binary systems which I have already characterised as the most remarkable of the age: yet these appear to have been but incidental and subsidiary objects; the leading pursuit was the examination of nebulæ. With what assiduity this was followed may be judged from the circumstance, that little more than half the time calculated as necessary by Sir W. Herschel was employed in the examination of the whole of the visible heavens. The publication of these was deferred till the author was in a state to exhibit a nearly complete catalogue of nebulæ visible in this latitude.

In the contemplation of such a delay, we might be inclined to blame the confidence in the continuation of life and vigour, which could even risk the hazard of leaving such a mass of labour unpublished. But the hazard has passed, and the benefits of the favourable chance are now felt. We have now a single complete catalogue arranged on one uniform system, easy of reference, containing, in immediate connexion, distinct accounts of the impressions received by the observer from different observations, and reduced (as to the coordinates of the place in the heavens) to one epoch. The mention of the latter point reminds me of the method invented by Sir J. Herschel for the reductions, a method analogous to that which he had used for the orbits of double stars, and singularly well adapted to cases in which great, but not extreme, accuracy is required. Indeed, for the observer, of any class, whose business it is to deduce empirical laws from observed irregular phenomena, no paper is more instructive than the description of the methods employed in the reductions of this catalogue. I may add, that, from the testimony of members of your Council, as well as of other persons, there is reason to believe that the places here given possess considerable accuracy.

After an examination so complete as that which had been made by Sir W. Herschel, it could not be expected that very extensive additions would be made with instruments of the same power. Accordingly, it appears that nearly 2000 objects are common to this and to Sir W. Herschel's catalogues. Many peculiarities of these, however, are described which had not been noticed before, and about 500 objects are entirely new. Among the remarkable speculations which Sir J. Herschel has produced, I may mention that founded on the view of binary nebulæ; one of the most seductive hypotheses that has yet been framed.

In conclusion of the work, and forming one of the most important parts of it, are the engraved representations of the most remarkable nebulæ. Let it not be supposed that I am overrating the value of these drawings. The peculiarities which they represent cannot be described by words or by numerical expressions. It would be absurd to attempt to define the place of every point of a nebula, and the intensity of light there, by coordinates of any

kind. These maps contain that which is conspicuous and distinctive to the eye, and that which will enable the eyes of future observers to examine whether secular variation is perceptible. By such representations only can the existence of annual parallax be discovered. They are, in fact, the most distinct and most certain records of the state of a nebula at any given time. Few observers possess the delicacy of hand of Sir John Herschel; yet it were to be wished that his example might be imitated by many, and that careful drawings, the best that circumstances admit of, might frequently be made of the same nebula.

And now, Gentlemen, I trust that I have sufficiently vindicated the judgment of your Council in their decision upon this year's Medal. I trust that your approbation accompanies this act of your executive body, which offers its tribute of respect to the author of the most complete and valuable collection, which has established the beginning of an important science. And if the object of our respect is now far distant—if oceans, and climates, and zones of the earth now separate him from us—shall that circumstance banish from our minds his claims to our regard? shall that diminish the admiration with which we contemplate his past labours? It is in the pursuit of the same science that he is separated from us—it is in the noble effort of completing for the whole heavens what has been effected for the European sky, that he has fixed his habitation for a time in another hemisphere. May he safely and happily return, soon, but not too soon for the completion of his purpose! May he have the satisfaction of hearing the world appeal to his descriptions of the southern as well as the northern heavens, as to the first accurate account on which the knowledge of the yet growing bodies of the sky is to be founded.

(*The President then addressing the Foreign Secretary, continued thus*:—)

Captain Smyth,—Transmit this Medal, in the name of the Royal Astronomical Society, to Sir John Herschel. Assure him that we admire the genius and appreciate the perseverance which have produced the Catalogue of Nebulæ and Clusters of Stars—that we respect the motive which has prompted him to establish himself for a time at a distance from his country—and that we join in the warmest wishes that his residence there may be one of enjoyment and satisfaction, and that his return may be happy and honourable.