- Journal of Asiatic Society of Bengal. No. 3. 1859. 8vo.—
From the Society.
- Proceedings of the Academy of Natural Sciences of Philadelphia.
 1859. 8vo.—*From the Academy.*
- Extinct Vertebrata from the Judith River, and Great Lignite For-
 mations of Nebraska. By Joseph Leidy, M.D. Philadelphia.
 1859. 4to.—*From the Author.*
- A Memoir on the Extinct Sloth Tribe of North America. By
 Joseph Leidy, M.D. 4to.—*From the Author.*
- The Ancient Fauna of Nebraska. By Joseph Leidy, M.D. 4to.—
From the Author.
- Descriptions of some Remains of Fishes from the Carboniferous and
 Devonian Formations of the United States. By Joseph Leidy,
 M.D. Philadelphia. 1856. 4to.—*From the Author.*
- Journal of the Academy of Natural Sciences of Philadelphia. 1859.
 4to.—*From the Academy.*
- Observations on the Genus Unio. By Isaac Lea, LL.D. Vol.
 VII., Part I. Philadelphia. 4to.—*From the Author.*
- Lever's Year-Book and Railway and Mining Almanac. Manches-
 ter. 1860. 8vo.
- Proceedings of Horticultural Society of London. No. 7. 1859.
 8vo.—*From the Society.*

Monday, 16th January 1860.

LORD NEAVES, V.P., in the Chair.

The following Communications were read:—

1. Suggested Explanation of Messrs Carrington and Hodgson's recently observed Solar Phenomenon. By Professor C. Piazzi Smyth.

The Royal Society of Edinburgh having been the arena wherein Professor W. Thomson first described his calculations and admirable extensions of Mr Waterston's meteoro-dynamic theory of solar light and heat, I beg leave to call the attention of the same learned Society to an apparent instance of confirmation which that theory appears to me to have received, by a phenomenon of very unique character, recently observed in an independent and most satisfactory

manner, by either of two able scientific men—viz., Mr Carrington of the Observatory, Red Hill, and Mr Hodgson at Highgate.

The respective observations of these gentlemen are to be found in the monthly notices of the Royal Astronomical Society for November 1859, and seem quite sufficient to prove, after making all due allowance for the different instrumental methods employed in either case, and the peculiar nature of the subject observed, that on September 1, at about 11 h. 18 m. A.M., Greenwich time, two small telescopic bodies of light, in close proximity, and elongated in the direction of their motion, suddenly burst into view on the surface of the sun, not very far from its central portion, than which they were very much brighter. They moved side by side in arcs nearly parallel with the plane of the ecliptic; first for a time increasing in brightness, and then again gradually fading away, so as to be quite lost in about five minutes after their first appearance. Though apparently on the surface of the sun, yet that appearance was considered to arise from optical projection only, as they did not alter the shape of a group of large black spots, which lay directly in their paths. They must, nevertheless, have been exceedingly close to the surface; and on that supposition, the paths which they described during their period of visibility must, from their angular extent, have measured about 35,000 miles, giving a mean rate of 117 miles per second.

The first remark that we may make on the facts of observation, save that nothing so momentary has ever been witnessed before by astronomers, is, that 117 miles per second constitutes a velocity so exceedingly great, that we can only look to the gravitation influences of the sun for its efficient producing cause. Nevertheless, we are at the same time bound to acknowledge, that the full rate of orbital motion, for a body nearly in contact with the surface of the sun, is rather over 276 miles per second; and the rate of falling to the sun from infinite space, considerably more. Evidently, then, something prevented these bodies of September 1 from moving at their full rate, and produced a retardation in their orbit equal to 159 miles a second, to take Professor W. Thomson's form of the gravitation theory as the more probable.

What that retarding something was, it is not so much to our purpose now to inquire, as long as we can show that it is not altogether a baseless supposition, to assume the existence of any extensive material belonging to the sun, outside his visible, luminous surface.

Now, this is fortunately easy of demonstration, for we have only to point to the red prominences, borders, and clouds, seen stretching to a distance of 60,000 miles sometimes from the edge of the solar orb during solar eclipses ; or to those unmistakable evidences of a large amount of outer absorbent and obstructing atmosphere, indicated by the gradual yellowing and de-photographical properties of the sun's light, with every advance from the centre to the circumference of his disc. (See Teneriffe Report, "Philosophical Transactions" for 1858, p. 487.) Something material, therefore, and forming to all intents and purposes one body with the sun, does exist round about him ; and capable, we cannot but allow, of affording impediment to the motion of any extraneous body, before it actually comes into contact with that intensely bright surface which is vulgarly held to constitute the outside of the sun.

Hence, when we find our solar meteors of September 1 moving at a rate slower by 159 miles a second than they should do according to the laws of gravitation, the simplest assumption that we can make is, that there has been a mechanical retardation to that amount. Let this be granted, and then it necessarily follows from the dynamical theory of heat, that precisely in accordance with the disappearance of motion will be the appearance of heat. And when we further take account of the previous high temperature to which the matter of the meteor (for the two, we are inclined to look on as fragments of one ; unless Bielas' double comet is to be taken as an argument for constant double meteors also) was brought, during the long ages of its circulation around the sun, in an orbit whose mean distance decreased only secularly ; and when we also consider the extraordinary warmth of the region where the observed rapid retardation took place, it will be understood that everything was extremely favourable to the heat produced by conversion of motion, appearing with so intense an expression, as to be accompanied by a most vivid display of light.

Even in the cold external atmosphere of the earth, and with a speed of only 19 miles in a second on the average to be converted, M. Joule has shown that meteors should become intensely white hot ; and Professor Swan has described in the "Proceedings" of this Society, Vol. III., p. 220, a case of one bright enough to be conspicuously seen at noonday.

It is true that, according to Mr Waterston's form of the theory,

and even the first expression of Professor W. Thomson's also, where the sun is fed by lumps of meteoric matter, there is some difficulty in explaining why the occurrence of luminous meteors in the sun is not frequently observed, if remarkably visible in one instance; while, according to the subsequent modification of the latter's view, the generality of meteors must be distilled away into impalpable clouds of finely-divided meteoric matter some time before they actually reach the sun; and neither gentleman had expected that an actual impact would ever be seen by mortal eye.

These objections, however, will be at once, to a great extent, relieved by the very fair assumption of as superior a mass to the September 1st meteor, over the generality of those which fall to the sun, in any and every manner, as men have already recorded of those which have actually fallen to, or have been seen very near, the earth; for while the majority (see the museums of Vienna, St Petersburg, and London) measure only a few inches, with occasional masses of 2 and 3 feet, there was one unusually well observed by many able spectators in Scotland, England, and France, on the 18th August 1783, which was estimated to be more than half a mile in length.

It may indeed be argued that, with this superior size of body, the decrease of the meteor's *radius-vector* in its orbit would have been slower than with smaller lumps revolving in the denser parts of the ethereal medium in the sun's immediate neighbourhood (see "Edinburgh Astronomical Observations," vol. xi. p. 266); and it would therefore have been exposed so much longer to the fiery heat of that region as to be distilled away, equally with the smaller ones, before actually touching the grosser parts of the solar atmosphere.

This argument, even carried to the extreme, does but remove the probability of the phenomenon of September 1st from being a meteor of the W. Thomson character, circulating around the sun, to one of Waterston's, falling to the sun from distant space; and while Professor W. Thomson has most satisfactorily demonstrated that, whatever may be the real character of the greater part of the solar light and heat, *some* of it must be due to meteoric action, so, while we freely concede to him that the majority of meteoric matter falling to the sun is of the planetary or satellite character, we are still entitled, according to his own reasoning on p. 67 of "Transactions of Royal Society of Edinburgh," vol. xxi. part i., as well as

from some of the paths computed by M. Petit, of the Toulouse Observatory, to assume that some meteoric matter arrives from distant space, and falls nearly directly to the sun. In such case, the final rate of its motion being 390 miles per second, there would be small time for much more to be effected, than that that fused crust we so often find on terrestrial meteoric stones should be formed, prior to the commencement of rapid retardation, and before conversion of mechanical energy into heat; followed, doubtless, almost immediately by the breaking up of the matter from explosion and deflagration.

Let us inquire, then, how far the known meteoric mass of 18th August 1783 would suffice to produce the effects observed on September 1st, 1859, had it then fallen to the sun. Professor W. Thomson gives the amount of meteoric matter that would be required, according to Mr Waterston, to produce, by striking the sun, the average solar illumination, as 0·000060 lb. per square foot per second.

For the period of our phenomenon, or 5 minutes, this is ·018 lb. per square foot, and 501·811 lb. per square mile for the same time.

Now the meteor in question, said by Mr Cavalho to have had a diameter of 1070 yards, can hardly have contained less than 15,000,000,000 cubic feet; and if we take for its specific gravity a mean between what has been determined by many measures of earthy meteorites on one hand, and meteoric iron on the other (which comes extremely near the mean density of the earth), then the total weight must have been 5,250,000,000,000 lb. Whence it is evident that there was enough material in that one meteor, properly distributed, to keep a space 5,000,000 square miles of the sun's surface in a state of luminous ignition, twice as intense as that of the ordinary solar disc during all the time of observation; and therefore, by the transparency of flame, to have tripled the brightness of the parts passed over—a phenomenon which, from angular subtense, as well as intensity of light, would be abundantly visible to telescopic observation from our earth.

* To this we may further add another consideration, which would notably increase the quantity of light given out by the same meteor; for in the remarkable investigations which Professor W. Thomson has appended to his paper above quoted, relative to the

* This paragraph added on January 16, 1860.

rotation and the age of the sun, he appears to have assumed, if I read him aright, that all the meteors in the solar neighbourhood are circulating in the same direction as the planets; and it is extremely probable that this is true for the greater number of them. Indeed, the publication in France, since this paper was placed in the hands of your Secretary, of the apparent discovery of a planet interior to Mercury, at considerably less than half his heliocentric distance, and revolving *direct*, might be taken as a remarkable proof of the correctness of the assumption. Nevertheless, we cannot close our eyes to the fact, that the members of the solar system which occasionally come visibly closest to the sun are not planets, but comets, and that, amongst these, retrograde motion is frequent; while of all comets, the one which has made the closest known approach, since the age of exact astronomy, was that of 1843, which was retrograde, and passed only 60,000 miles from the sun's surface. Hence it is by no means an unwarranted supposition for us to make, that an occasional meteor moves *retrograde* also; as, in fact, this one of September 1st appears to have done; and if it should, in such a course, encounter another moving *direct*, in the crowded solar vicinity—a casualty that must become more and more probable with every advance towards the sun—there would be double speeds of motion to be converted into heat; there would be much such a sudden blaze of light as the observers described; and then a rapid descent of both bodies to the sun's surface, through that remaining distance in which they might otherwise have long continued to circulate before their final absorption.

On the whole, then, it appears exceedingly probable that the solar phenomenon of September 1st was a meteor falling to the sun, and giving out the heat of its mechanical energy in accordance with the laws of that dynamical theory of thermotics, first and chiefly in this country brought before the Royal Society of Edinburgh by Professors W. Thomson and Macquorn Rankine. In which case, there is another example added, to several that might be extracted from the history of science, showing that hardly has a true theory been published to the world, before a confirmatory phenomenon, previously quite unexpected, is almost providentially witnessed; and in no case by less prejudiced or more able observers than the gentlemen upon whom we depend in the present instance.