this observation alone it would seem extremely probable that when a comet enters our system for the first time it simply means that a swarm of meteorites in that part of space through which the sun was passing at the time began to feel the sun's attraction, and ultimately became a member of our system, and also that when we see the appearance which we call a nebula in space, since its spectrum is the same as the spectrum of a comet, the nebula is simply a swarm of meteorites if it be true that a comet is a swarm of meteorites.

These nebulous masses, visible in all parts of the heavens, but in some parts of the heavens very much more numerously than in others, were very early observed and imagined to be very different in nature from the so-called fixed stars.

Ptolemy was the first to point out, when he was making his map of the stars that there were certain "cloudy" stars of which he gave 5 on his map, and Tycho Brahé, whose work was done before the invention of the telescope, although he did not notice any bodies which we now class as nebulæ, was firmly convinced that that nebulous luminosity, which we call the Milky Way, was something entirely different in its nature from the stars. He imagined it to be what he called an ethereal essence, a sort of fire mist, so that when in his time, in the year 1572, a new star appeared, he supposed it to be a considerable agglomeration of this ethereal fluid. Galileo was able to show that the Milky Way, the "ethereal substance" of Tycho, was only an appearance due to enormous numbers of stars lying in the same visual ray, the stars of which the Milky Way is composed can indeed be seen with very small optical power. It was not till 1612, a few years after the introduction of the telescope, that we got the first real definition of a body which we now call a nebula.

The first observation we owe to Simon Marius, who stated that some of the bodies visible exactly resembled the appearance produced by the flame of a candle seen through horn. It was not till 1656 that the nebula in Orion was discovered, although now to the trained eye it is very easily visible, so that it seems rather wonderful that it was not discovered before. In 1714, in England, attention began to by paid to these bodies, but it was not until the time of Sir Wm. Herschel that the most magnificent revelations were made. He was the first to construct very large telescopes, the function of very large telescopes being to collect light, so that objects which appear to the eye as excessively dim may be brought into full visibility.

After not only Sir Wm. Herschel but his son, Sir John Herschel, had accumulated vast stores of facts, Lord Rosse took up the story, and made a telescope very much more powerful than any which had been employed by the Herschels. His telescope has a light-grasping power compared with the eye of 130,000. One of the results of Lord Rosse's work to which we need here refer is the idea that in a great many bodies which had been classed as nebulæ this enormous increase of optical power suggested that we were only dealing with very distant clusters of stars.

Lord Rosse was able to get the suggestion of "resolvability" in so many bodies which had been classed as nebulæ by Sir Wm. Herschel and others, that gradually the idea came to be held that the most nebulous nebula, if we could get sufficient optical power to bear upon it, would be broken up into stars, just as certainly as the Milky Way had been.

This would mean that the nebulæ were simply clusters of stars so infinitely remote from our ken that even with the power of Lord Rosse's instrument they put on the appearance of an ethereal essence.

This was the general opinion in 1864, in the early days of spectrum analysis, when Dr. Huggins turned his spectroscope one night to one of the planetary nebulæ. At first he thought that something had gone wrong in the apparatus because he could only see a bright line instead of the usual sort of spectrum obtained from a star. The spectroscope, however, was doing its level best, and the cause, the anomaly, was really that the nebula gave out monochromatic light.

In some cases another line was seen, stated to be due to hydrogen. It now appears that the dispersion employed was so small that the discoverer had no right to allocate any line, so that it is fortunate that other observers have since shown that there is another hydrogen line visible.

Dr. Huggins came to the conclusion that the first line was very nearly, if not exactly, in the position of the chief line seen in the spectrum of nitrogen, and the suggestion was therefore made that these nebulæ were masses of nitrogen and hydrogen gases mixed, or, if not nitrogen, some constituent of nitrogen mixed with hydrogen. That result made the idea of Lord Rosse concerning the possibility of the resolvability of nebulæ into stars untenable. We had to consider from that time that the light of the nebulæ came from a gas, and hence it was held that the nebulæ were masses of gas.

Another explanation of the origin of the green line has already been given. If we study the spectrum of magnesium we find a very bright fluting with its less refrangible edge absolutely in the position of the green line with the dispersion generally employed; in nebulæ and in comets the same line appears, if, as I said before, Dr. Huggins's observations are to be relied upon.

We are therefore justified in holding the view that nebulæ, like the comets, consist of meteorites.

J. NORMAN LOCKYER.

(To be continued.)

THE ANNUAL VISITATION OF THE GREENWICH OBSERVATORY.

THE Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory, Greenwich, was received at the annual visitation on Saturday last, June 1.

As regards buildings, it is noted that the new 18-foot dome is completed, together with the photographic dark rooms, in preparation for work with the 13-inch photographic equatorial which is to be erected this year. As regards transit-circle observations, we read:—

"The regular subjects of observation with the transit-circle are the sun, moon, planets, and fundamental stars, with other stars from a working catalogue, which includes all the stars in Groombridge's Catalogue and in the Harvard Photometry not observed since 1867, and a selection from Piazzi's Catalogue. Ten close circumpolar stars taken from the *Connaissance des Temps*, or from M. Lœwy's list of stars for longitude determinations, have been observed regularly, in addition to the four standard azimuth stars. The observation of these close circumpolars has been much facilitated by the adoption (since 1889 January 1) of the method used by the officers of the French Service Géographique, which consists in making a number of bisections of the star with the R.A. micrometer during its transit, the exact time for each bisection being recorded on the chronograph. The Annual Catalogue of stars observed in 1888 contains about 1820 stars.

"Special attention has been given to the observation of the minor planet Iris and comparison stars in connection with the determination of its parallax at the late favourable opposition, eighteen observations of the planet and 113 of twenty-eight comparison stars having been made last autumn."

As regards computations, the transits have been completely reduced so as to exhibit mean Right Ascension 1889 January 1, and also the circle observations to exhibit mean North Polar distance for the same period. Two determinations of the astronomical flexure of the transit-circle telescope have been made since the last Report, the resulting values being 0″·08 and 0″·52. It has been found that the correction for discordance between reflection and direct observations of stars was erroneously applied in 1887, and hence the results for colatitude and for position of the ecliptic are also erroneous. The correct values are now given, with those recently found for 1888.

The ecliptic investigations from 1877 to 1886 have been revised to reduce the results to the same system of flexure, R—D correction, refraction and colatitude; so the computations for the ten-year Catalogue, containing 40,000 observations of 4059 stars, are now practically complete.

It has been found that the mean error of the moon's tabular place (computed from Hansen's lunar tables with Newcomb's corrections) is + 0·090s. in R.A., and + 1″·21 in longitude, as deduced from seventy-four meridian observations in 1888. The mean error in tabular N.P.D. is − 1″·19, indicating that the mean of the observed N.P.D.'s is too great. A number of altazimuth observations has been made and reduced to April 8, so as to exhibit errors of moon's tabular R.A., N.P.D., longitude, and E.N.P.D.

The object-glass for the new 28-inch refractor is now being worked, and, as it is to be of a special form, equally suitable for photographic and eye observations, an experimental object-glass is being mounted on the Sheepshanks equatorial for trial. A number of photographs of stars have been taken with the experimental 6-inch object-glass, supplied as a preliminary to the construction of the 13-inch, which is to take part in the construction of the photographic map of the heavens. Only inconclusive results have, however, as yet been obtained. The spectroscopic work has mainly consisted of observations of motion of stars in line of sight. We read:—

"For determination of motions of approach or recession of stars, 236 measures have been made of the displacement of the F line in the spectra of 38 stars, and 18 of the *b* line in the spectra of 8 stars, besides 5 of the *b* line in the spectrum of Saturn's ring, and comparisons with the spectra of the moon, Venus, the sun, or the sky, as a check on the general accuracy of the results. Observations of Algol on three nights during the past year confirm the previous results indicating orbital motion, but further evidence is required to establish the fact. The spectra of γ Cassiopeiæ, *o* Ceti, β Lyræ, P Cygni, R Cygni, and β Pegasi, have been examined on several occasions, and Comet *e* 1888 has been spectroscopically observed on one night, the spectrum being chiefly continuous. The spectroscopic observations of all kinds are completely reduced."

Photographs of the sun have been taken 182 days in the year ending on May 10, 1889. Indian and Mauritius sun photographs have been received from the Solar Physics Committee as far as 1888 December 31 and December 9 respectively, and it is noted that, by means of photographs from these two places supplementing the Greenwich series, the daily photographic record of the sun's surface is practically complete since the beginning of 1882. For earlier years 118 photographs of the sun taken at Harvard College, Cambridge, U.S.A., between 1874 December 9 and 1875 December 31, and ten photographs taken at Ely, between January 1 and February 25, 1874, have been received from the Solar Physics Committee.

The photographs of the sun for 1888 show that it has been free from spots on 155 days in the year 1888, the longest spotless periods being February 4 to 17, May 24 to June 8, and October 5 to 25. The mean spotted area in 1888 was half that of the preceding year, and corresponded closely to that for 1877, so that the minimum may be expected to occur during the present year. The mean distance of spots from the equator has also diminished to 7°·38 in 1888, being very little larger than it was in 1878, just before the last minimum, and this is a further indication that the sun-spot minimum is close at hand. The faculæ in 1888 show a diminution in correspondence with that of sun-spots, their area for 1888 being intermediate between those for 1876 and 1877.

Continuous observations of the changes in the three magnetic elements of declination, horizontal force, and vertical force have been photographically recorded.

The following are the principal results for the magnetic elements for 1888:—

Approximate mean declination	17° 40′ W.
Mean horizontal force ...	3·9480 (in British units).
	1·8204 (in Metric units).
Mean dip	67° 24′ 26″ (by 9-inch needles).
	67° 25′ 33″ (by 6-inch needles).
	67° 26′ 16″ (by 3-inch needles).

In the year 1888 there were only three days of great magnetic disturbance, but there were also about twenty other days of lesser disturbance, for which tracings of the photographic curves will be published, as well as tracings of the registers on four typical quiet days.

The meteorological results are as follows:—

"The mean temperature of the year 1888 was 47°·7, being 1°·6 below the average of the preceding forty-seven years. The highest air temperature in the shade was 87°·7 on August 10, and the lowest 18°·4 on February 2. The mean monthly temperature in 1888 was below the average in all months excepting May, November, and December. In March, April, July, and October it was below the average by 3°·6, 3°·6, 4°·4, and 3°·9 respectively, and in November it was 4°·0 above the average.

"The mean daily motion of the air in 1888 was 296 miles, being 12 miles above the average of the preceding twenty-one years. The greatest daily motion was 790 miles on March 11, and the least 57 miles on December 31. The only recorded pressures exceeding 20 lbs. on the square foot were 31 lbs. on March 11, and 21 lbs. on August 28.

"During the year 1888 Osler's anemometer showed an excess of about nineteen revolutions of the vane in the positive direction north, east, south, west, north, excluding the turnings which are evidently accidental.

"The number of hours of bright sunshine recorded during 1888 by the Campbell-Stokes sunshine instrument was 1068, which is about 250 hours below the average of the preceding eleven years, after making allowance for difference of the indications with the Campbell and Campbell-Stokes instruments respectively, and it is 333 hours below that of 1887 recorded with the same instrument. The aggregate number of hours during which the sun was above the horizon was 4465, so that the mean proportion of sunshine for the year was 0·239, constant sunshine being represented by 1. A comparison has been made of the records of the Campbell and Campbell-Stokes instruments for the twelve months from 1886 June 1 to 1887 May 31, with the result that the former registered 1256 hours of bright sunshine, while the latter registered 1364. It would appear, therefore, that the indications of the former instrument require to be multiplied by the factor 1·086 to make them comparable with those of the latter.

"The rainfall in 1888 was 27·5 inches, being 2·9 inches above the average of the preceding forty-seven years."

The average daily number of chronometers and deck watches being rated is 212, and the total number received up to May 10, 1889, was 668. The Astronomer-Royal notes that in future the duration of the trial of deck watches will be increased from twelve to sixteen weeks, viz. six weeks in the ordinary temperature of the room, four weeks in the oven (temperature 80° to 85°), and finally six weeks in the room.

The Report concluded with a note on the re-determination of the difference of longitude between Greenwich and Paris:—

"Observations were made in four groups of three nights each (or the equivalent in half nights). An English and a French observer were stationed at each end, each with a separate instrument and chronograph, and the pairs of observers were interchanged twice, to eliminate any change in the personal equations during the progress of the work. The pairs of English and French instruments were similar, and the signals as well as the star transits were recorded on similar chronographs. On a full night each observer recorded about forty star transits, reversing his instrument three times, and exchanged signals twice (near the beginning and end of the evening) with his compatriot at the other end of the line, and once with the other observer. At Greenwich the transits were referred to the sidereal standard clock, and comparisons with the large Greenwich chronograph enable the ordinary determinations of clock-error with the transit-circle to be utilized as well as those specially made with the portable transits. With this object transits of clock stars with the transit-circle were usually taken by four observers on each night during the longitude operations. The actual stations were the Front Court of the Royal Observatory and the Observatory of the Service Géographique de l'Armée at Paris, the position of which reference to the Paris Observatory has been accurately determined. Commandants Bassot and Defforges were the French observers, and Mr. Turner and Mr. Lewis the English. The observations lasted from September 23 to November 15, and 18 nights of observation at both stations are available, the two English observers having observed at Greenwich 653 transits of clock stars and 165 of azimuth stars, and at Paris 778 transits of clock stars and 165 of azimuth stars. All of these, as well as the signals exchanged, have been read out from the chronograph registers and the reductions are far advanced. Subsidiary investigations of the value of a revolution of micrometer screw, of intervals of wires, of form of pivots, and of errors of the axis-level have consumed much time, the last-named having been a long and tedious discussion."

The difference in longitude between Greenwich and Dunkerque will be determined this month, and Commandant Defforges also proposes to determine the latitude between these two places.

THE EARTHQUAKE.

ON the evening of Thursday, May 30, a considerable seismic disturbance was noticed over the English Channel and in the neighbouring districts. Its area cannot yet be precisely determined. It seems to have been felt most strongly in the Channel Islands, but it was also very distinctly noticed over wide districts in the south of England and the north of France. We bring together various facts relating to the earthquake, some of which have been communicated to us by correspondents.