to the existence of the downward current in cyclones, it renders M. Faye perfectly helpless when he contemplates an anticyclone. In the presence of such a formidable foe he is completely disarmed. Here, just where a downward current would come in really useful, he finds he has *used it all up*. All he can say, therefore, is that they have nothing cyclonic about them, which is quite true.

M. Faye concludes by drawing up a list of questions which relate to the phenomena exhibited by cyclones, tornadoes, and waterspouts, and which he considers yet unsolved. Some, doubtless, still await a more complete explanation, but we think the list might be considerably curtailed if M. Faye would descend, if possible, in one of his favourite eddies, and meet the *aspiring* meteorologist half-way. Atmospheric phenomena seldom present themselves in the form of purely mechanical problems. If, as M. Faye says, the question "is not one which can be treated by actual methods of rational mechanics on which everyone can agree," we are equally confident that it is one whose solution cannot be attempted without the aid of rational physics, or without reference to the facts already established by observation.

E. DOUGLAS ARCHIBALD.

THE VISITATION OF THE ROYAL OBSERVATORY.

THE Report of the Astronomer-Royal to the Board of Visitors of the Royal Observatory was read at the annual visitation on June 2.

One of the first points touched on in the Report is the threatened railway invasion of the Observatory.

The subject of approaching railways has again, after a lapse of many years, engaged our serious attention. Early in March notice was received from the Home Office of a proposal to carry a railway (in extension of the authorized Bexley Heath Railway) in a tunnel across Blackheath, the nearest point being 840 yards from the Observatory. As there was reason to believe that this railway might injuriously affect the Observatory, preliminary observations of the effect produced by trains on the existing Greenwich and Maze Hill Railway were at once commenced, the observations being made on six nights with the transit-circle, and the disturbance in the image of the wires, as seen by reflection from the trough of mercury, being noted. It resulted from these experiments that trains on this railway caused great disturbance during their passage, not only on the section between Greenwich and Maze Hill, the nearest point of which is 570 yards from the transit-circle, but also on the line beyond Greenwich on the London side and beyond Maze Hill on the Woolwich side. The distances of the Greenwich and Maze Hill stations from the Observatory are about 970 and 670 yards respectively. There was also evidence of disturbance caused presumably by trains on the Lewisham, Blackheath, and Charlton line, at a distance of about a mile from the Observatory, but we could only infer the times of passage of these trains from the published time-tables.

In order to establish conclusively the connection between definite disturbances and trains, arrangements were made to note the times of arrival and departure of trains on the Greenwich line and at Blackheath, facilities for doing this having been courteously given by Mr. Myles Fenton, the Manager of the South-Eastern Railway. Observations were made on this plan on five nights, one observer being stationed at the transit-circle to record all disturbances of the reflected image, while another observer travelling up and down the Greenwich line, and a third observer at Blackheath, noted the times of arrival at and departure from the stations. It was found that the disturbance was very great during the passage of trains between Greenwich and Maze Hill, the reflected image being invisible while the train was in the tunnel, at a minimum distance of 570 yards, and that there was considerable disturbance during the passage of trains through the Blackheath-Charlton tunnel, at a distance of a mile, the reflected image becoming occasionally invisible. As the tunnel of the proposed railway would be similar in character to this, but at half the distance, it was concluded that it would cause so great a disturbance as to make delicate observations impossible. On my notifying this to the Admiralty, the Bill was opposed on the part of the Government, and as a consequence of this the clauses authorizing the construction of the railway across Blackheath were abandoned.

I may here mention that the extension of the London, Chatham, and Dover Railway from Blackheath Hill to Greenwich, which was authorized in 1881, is now in course of construction. I hope that, though the terminus of this line is distant only 620 yards from the Observatory, the tremor from trains will not have sufficient time to produce the full accumulated effect in the short interval between Blackheath Hill station and the terminus. But if at any future time a further extension of this line should be proposed, the question would require very careful consideration in the interests of the Royal Observatory.

The following statement shows the number of observations made with the transit-circle in the period of 356 days ending May 10, 1888 :—

Transits, the separate limbs being counted as separate observations	5304
Determinations of collimation error	294
Determinations of level error	351
Circle observations	5067
Determinations of nadir point (included in the number of circle observations)	331
Reflection-observations of stars (similarly included) ...	503

About 350 transits (included in the above number) have been observed with the reversion-prism, to determine personality depending on the direction of motion.

The very bad weather in the first four months of this year has seriously affected the number of observations with the transit-circle.

The total number of observations made with the altazimuth is as follows, the observations having been as usual restricted to the first and last quarters in each lunation, except during the winter, when, in the absence of suitable objects for equatorial observations, the moon was observed throughout the lunation.

Azimuths of the moon and stars	354
Azimuths of the azimuth mark	114
Azimuths of the collimating mark	116
Zenith distances of the moon and stars	209
Zenith distances of the collimating mark.....	116

In consequence of the building operations for the extension of the computing-rooms the collimating mark was dismounted on November 9, and the view of the azimuth mark has been obstructed by the new building from the beginning of December. Since then the collimation and azimuth errors have been determined entirely by observations of high and low stars. It is proposed, when the work on the new building is completed, to select two azimuth marks, one distant and the other sufficiently near to be seen in the foggy weather of the winter months. For distinct vision of the latter a lens of very long focus would be required, and it would thus be available strictly as a collimating mark.

All will regret to hear that no progress has been made since the date of the last Report in the construction of the new 28-inch refractor, owing to difficulty in obtaining the crown disk. The flint disk made by Messrs. Chance seems to be satisfactory, but up to the present neither that firm nor M. Feil's successor has succeeded in making a crown disk.

Attempts have been made to show if anything is gained in sidereal photography by using curved plates. For this purpose a 4-inch photographic object-glass by Dallmeyer, belonging to one of the photoheliographs, was mounted at the end of June in a light wooden tube, and firmly attached to the side of the telescope tube and parallel to it, to carry out experiments on the extent of field available on plane and curved plates respectively, the latter being moulded by Messrs. Chance to a radius of 22 inches, corresponding to the curvature of the field, if the circle of least confusion be taken for the image. We read :—

Forty-one photographs have been taken of the Pleiades and other objects with different exposures and in different parts of the plate, 13 of these being on curved plates. In these experiments the Sheepshanks refractor was used as directing telescope, the image of a star being kept on its cross-wires during the exposure of a plate by means of the slow motions. The plates measure 6 inches × 6 inches, representing $5\frac{3}{4}^\circ \times 5\frac{3}{4}^\circ$, and it is found that on the flat plates the star images are sensibly circular to a distance of nearly 2° from the centre of the field, while micrometric measures of these plates show that for some distance beyond this limit the relative places of stars can still be measured with an accuracy exceeding that of meridian observations, and with no sensible systematic error depending on magnitude or duration of exposure. Comparison of the results on flat and curved plates respectively indicates that the advantages of using the latter are doubtful. As the Dallmeyer object-glass is peculiar in having the flint outside, it was reversed in the cell in the course of the experiments, and some photographs were taken with it in this position, the flint being inside. It appeared on comparing the results that a somewhat better field is obtained with the flint outside. A photographic object-glass of 6 inches aperture and 6 feet focal length, made by Sir H. Grubb for experiment, was mounted at the end of April in place of the 4-inch object-glass, and some trial photographs of stars have been taken with it.

Special arrangements were made for observing occultations during the total eclipse of the moon on January 28, observers being stationed at nine instruments, but clouds covered the moon almost continuously during totality. Various devices were adopted with a view to facilitating the observation in rapid succession of the faint stars occulted during the eclipse. In the case of two instruments the eye-piece was mounted excentrically at the distance of the radius of the moon's image from the axis, so that without disturbing the position of the telescope any point of the limb could be brought into the centre of the field. For setting the position-circles rapidly in the dark, cardboard circles with notches at important points or with the figures indicated with luminous paint, were found very useful.

The spectroscopic observations of motions of stars in the line of sight have been continued. The recent observations of Algol confirm the previous results indicating orbital motion, but further observations are required to establish the fact. At the request of Mr. Lockyer, the spectra of α Orionis, α Herculis, γ Cassiopeiæ, and β Lyræ have been examined on several occasions.

That the daily record of the solar surface is gradually getting more complete is clearly shown by what happened in the year 1887, in which Greenwich photographs are available on 188 days; photographs from India or Mauritius filled up the gaps in the series on 173 days, thus making a total of 361 days out of 365 on which photographs have been measured in this year.

The sun has been free from spots on 106 days in the year 1887, and the areas of both spots and faculæ have diminished since the date of the last Report. With the exception of a fine group seen during three rotations in May, June, and July, and of three other groups, one in July and two in December, all of these being in the southern hemisphere, there has been a complete absence of conspicuous spots. The entire spotted area has rarely amounted to 1/2000 of the sun's visible hemisphere, and the mean is less than one-sixth of that recorded in 1883, being intermediate between those for the years 1875 and 1876.

In view of the diminution of the current work as the minimum of sunspots approaches, the further discussion of the results of former years has been commenced, and arrangements have been made through the Solar Physics Committee to complete the Greenwich results as far as practicable by the measurement of photographs taken elsewhere, particularly at Ely and Cambridge, U.S. From the beginning of 1882 the photographic record is practically complete, the measurement of Indian photographs to fill up gaps in the Greenwich series having been undertaken from December 22, 1881. The further discussion of results has, therefore, been commenced from that date, and the projected areas of spots (uncorrected for foreshortening) have been formed to May 29, 1885, and from the beginning of 1886 to the end of 1887. The ledgers in which the areas and positions of the spots of a group are collected and the mean area and position of the group, deduced for each day and for the whole period of visibility, have been formed for 1886 and 1887, and their completion for the years 1882 to 1885 will now be taken in hand. Two new forms have been prepared to exhibit the distribution of spotted area on each day for every degree of latitude and for every 10° of longitude, mean results being taken for each rotation and for each year.

With regard to magnetic observations we read that the only important change is the substitution, since October last, of a wooden bar loaded with lead, of the same size and weight as the declination-magnet, for the brass bar hitherto used for determination of the torsion of the suspending skein, a very weak trace of magnetism having been detected in the brass bar.

The earth-current observations have been attended with some difficulties. We read:—

The earth-current wires, which were damaged by the snowstorm of 1886 December 26, were not completely repaired till August 1887, when it was found that the earth-plate at Angerstein Wharf had been stolen, another earth-plate being then supplied. A renewal of the earth-current wires concurrently with the telegraph wires on this portion of the South-Eastern Railway was arranged, in concert with Mr. Leonard, but this has not been carried out owing to a rise in the price of copper. Five measures of resistance of the earth-current wires have been made since the last Report, but the results are not satisfactory, owing presumably to the bad condition of the wires. On the line from Angerstein Wharf to Ladywell, 7½ miles in length, the measures of resistance range from 220 to 285 ohms, and on the Blackheath to North Kent East Junction line, 5 miles long, the measures range from 230 to 262 ohms. Under these circumstances it seems hopeless to attempt to express the measures of ordinates on the earth-current sheets in terms of the electrical units until the conditions of the circuits have been improved. A further difficulty arises in discussing the small diurnal inequality on the earth-current registers in consequence of the circumstance (to which attention was first drawn by Mr. A. J. S. Adams, of the Post Office Telegraphs) that there is a slight dislocation in the Angerstein Wharf to Ladywell trace shortly after sunset with sudden return to the original position shortly before sunrise, representing an increased current from Ladywell to Angerstein Wharf, or a diminished potential at Angerstein Wharf during the night hours. Possibly this may be connected with the electric lighting in the vicinity of the earth plate. It appears to have commenced in 1883, becoming more pronounced in 1884.

The following are the principal results for the magnetic elements for 1887:—

Approximate mean declination . .	17° 47 W.
Mean horizontal force . .	3·9419 (in British units) 1·8175 (in Metric units)
Mean dip	67° 25′ 45″ (by 9-inch needles) 67 26 20 (by 6-inch needles) 67 27 13 (by 3-inch needles)

In the year 1887 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 mean daily motion of the air in 1887 was 275 miles, being 9 miles below the average of the preceding twenty years. The greatest daily motion was 829 miles on March 23; and the least, 59 miles on November 16. The only recorded pressure exceeding 20 pounds on the square foot was 20·5 pounds on April 6.

During the year 1887, Osler's anemometer showed an excess of about 17 revolutions of the vane in the positive direction N., E., S., W., N., excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded during 1887 by Campbell's sunshine instrument (Prof. Stokes's improved pattern) was 1401, which is about 190 hours above the average of the preceding ten years. The aggregate number of hours during which the sun was above the horizon was 4454, so that the mean proportion of sunshine for the year was 0·315, constant sunshine being represented by 1.

The rainfall in 1887 was 19·9 inches, being 4·8 inches below the average of the preceding forty-six years.

There has been no failure in the automatic drop of the Greenwich time-ball, but on four days the ball was not raised on account of the violence of the wind.

The automatic drop of the Deal time-ball failed on six days owing to interruption of the telegraphic connections, and on two days high wind prevented the raising of the ball. There has been no case of failure of the 1 p m. signal to the Post Office Telegraphs.

There have been twenty-three failures in the automatic signals from the Westminster clock since the date of the last report. The error of the clock was insensible on 25 per cent. of the days of observation, 1s. on 38 per cent., 2s. on 20 per cent., 3s. on 15 per cent., and 4s. on 2 per cent.

Provision has been made in the estimates for the expense of a re-determination of the difference of longitude between Greenwich and Paris, and correspondence has been carried on with the French authorities on the subject. The regretted death of General Perrier occurred before any definite plan had been settled; but his successor, M. le Commandant Bassot, has taken the matter up warmly in concert with Admiral Mouchez, and the French Bureau des Longitudes has approved the scheme, which is to include a determination of the longitude of Dunkirk. Three French delegates (M. Lœwy, M. Bassot, and M. Defforges) propose to visit Greenwich very shortly to settle the details of the plan of operations which it is intended to carry out in the autumn. In preparation for the work, Mr. Turner and Mr. Lewis have observed for practice, by eye and ear, a number of galvanometer signals sent by another observer and automatically registered on a chronograph, five sets of ten signals having been recorded on each of seven days.

The Report concludes as follows:—

In my last Report it was suggested that the instrumental equipment of the Observatory should be supplemented by a photographic refractor of 13 inches aperture (equatorially mounted) to enable Greenwich, as the National Observatory, to take its share in the scheme for forming a photographic map of the heavens, and for thus extending our knowledge of the places of the fixed stars. Consequent on the resolution of the Board of Visitors at the last visitation, I brought this question of the insufficiency of our instruments for the present wants of astronomy to the notice of the Admiralty and of the Chancellor of the Exchequer, and the matter is still under the consideration of the Government. If the Royal Observatory is to take part in this work of carrying out one of the principal objects for which the Astronomer-Royal was appointed, it appears to be essential that a decision should be arrived at without delay, in view of the circumstance that thirteen Observatories (including those of Melbourne and Sydney in our own colonies) have already ordered their instruments, which are to be completed by the end of the present year.

Allusion was made in the last Report to the increased demands made on the Observatory in recent years both by the scientific and the general public, and in view of the consequent development of work it now becomes necessary to review the position of the establishment, which was constituted many years ago, when the conditions were very different. In order to understand the difficulty of the present situation it is necessary to bear in mind the following facts:—In 1835 there were five assistants (excluding the chief assistant), having no computers to superintend, no extraneous work beyond the care of a relatively small number of chronometers for the Navy, no magnetic and meteorological observations, no altazimuth observations, no spectroscopic and photographic observations. At the present time there are eight assistants (excluding the chief assistant) having fifteen computers to superintend, and of this staff two assistants are absorbed by the magnetic and meteorological branch, one by the altazimuth, and two by the spectroscopic and photographic branch, leaving only three assistants to do the astronomical work, which in 1835 required five assistants, and in addition to perform all the extraneous duties which the Astronomer-Royal has felt it desirable to undertake in the public interest.

Under these circumstances it becomes a matter for serious consideration whether, unless adequate provision be made for the primary objects of the Observatory, extraneous work, such as the supply of time-signals, may not have to be dropped. The service of hourly time-signals throws considerable work on myself and the staff of the Observatory, and, as it is purely voluntary, it appears to me that a condition of its maintenance must be that arrangements shall be made to enable the proper work of the Observatory to be carried on and suitably developed.

INDUSTRIAL TRAINING.

AT a meeting held at the Mansion House on Friday last, in support of the scheme for establishing Polytechnic Institutes in South London, an able and interesting speech was delivered by Lord Salisbury. Having pointed out that of late years much had been done for primary education, he went on to show that a sound system of secondary education for the great mass of the people was not less necessary. Secondary education, as we know it at present, had been established for the benefit of classes who in the main had not to work for their living. Plainly, therefore, it was not adapted to the needs of the working classes. "What we have now to do," he continued, "is to provide an education which will develop for each man the faculties that Nature has given him in such a manner that he may be as active, profitable, and prosperous a member of the community as possible." Lord Salisbury then passed in review the efforts which have been made in London to meet the demand for technical instruction, and concluded as follows:—

"I have only one more word to say, just to call your attention to another aspect of this case and to commend it to your efforts. We live in a time when men multiply fast, but apparently the means of supporting them do not multiply as rapidly; when there is vehement competition and occasionally intervals of deep depression. And if you should look more closely, you will find that one cause at least of this phenomenon is that man, as the mere owner of muscle, is being edged out by another and more powerful competitor. Merely as an agent of physical force, as the possessor of the power of labour, the steam-engine is a competitor which drives him easily out of the market. And more and more the mere unskilled labour is being made unnecessary by the development of the forces which mechanical science has discovered. And as the world goes on, you must expect this tendency to increase. You must expect mechanical force to become more varied and more powerful and more cheap, and the competition with human arms and limbs to become more hopeless. But there is one region where the machine can never follow the human being, and that is in the exercise of thought. In skill, in cultivated mind, in the power to adapt the processes of thought to the laws of Nature, in all that we call 'skilled labour' of the highest kind, in that man must always have a monopoly, and need fear no encroachment from the competition of the steam-engine. It is to the development of his powers in that respect that the increase in the means of subsistence and the opening of new paths of self-support must be found. On all of us, in whatever position we are, is pressing, as one of the most anxious subjects of public care, the discovery of methods