patch which it produces even across a sheet of metal on a screen of barium platino-cyanide, the instantaneous discharge of an electrified body brought near to the substance, and the sparks passing when radium is brought within a few centimetres of the spark gap. The magnetic deflection of the rays could, of course, not be made evident to such a large audience. But the original negatives could be projected, and they showed the curvilinear propagation of the rays in a magnetic field.

The new bodies constantly project matter endowed with a great velocity. Neighbouring bodies are impregnated with it, and become radio-active in turn. These particles attach themselves, not only to objects, but to persons as well, so that M. Curie will be condemned for some time to abandon every kind of electrostatic research. No electrometer remains charged in his neighbourhood, and it is certain that if radium had only been as plentiful as gold, static electricity would never have been discovered.

In the same domain, important generalisations have been made, such as the theory of dispersion in metals, founded by M. Drude upon the electron theory, of which the author gave an account to the section.

The sixth section, under the presidency of M. Mascart, occupied itself with cosmical physics. Terrestrial magnetism should undoubtedly have formed part of the work of this section, but the Meteorological Congress which will shortly meet intends to make that the principal object of its studies, and it was evidently necessary to leave it aside.

Yet the work of this section was very fruitful. Here, naturally, observation still holds a predominant place, as in the work of the Swiss physicists, with M. Hagenbach at their head, on glaciers; and the detailed study of oscillations of lakes by MM. Sarasin and Forel, who brought their results before the Congress.

In the department of atmospheric electricity, a very good account was given by M. F. Exner, and Mr. Paulsen gave an account of the Danish expedition to Iceland for the study of the aurora. The evaluation of the solar constant by M. Crova, according to recent researches, and a very ingenious theory of suns-pots established by M. Birkeland after troublesome calculations, were heard with much interest. Finally, M. C. Dufour showed how, without the help of any laboratory apparatus, the approximate brightness of the stars could be determined.

It had seemed useful to collect in a seventh section some works relating to biology. In the absence of M. d'Arsonval, this section, presided over by M. Charpentier, did a great deal of good work, and justified the idea of the organisers of the Congress. The application of physical and mathematical methods to the transmission of energy in organisms, to which M. Broca has devoted attention for a considerable time, and the curious retina phenomena studied by M. Charpentier, gave this section a vast field of discussion. Finally, the new theory of accommodation established by M. Tscherning received the sanction of a very largely attended meeting, while M. Hénocque spoke of the spectroscopic methods used in biology.

The proceedings of the Congress were not confined to sectional work and general meetings. A visit to the laboratories of the Sorbonne and the Ecole Polytechnique showed many experiments in progress, installed by the professors of these establishments or their provincial and foreign colleagues. These could only be properly appreciated by observing them closely and in small groups.

Shall I speak of the reception in the Jardin de l'Elysée, whither the President of the Republic invited several Congresses to witness a theatrical performance? Or of the charming *soirée* for which Prince Roland Bonaparte had placed at the disposal of the organisers his vast and magnificent library for a number of interesting experiments? This *soirée*, which will leave in the minds of all who were present the most agreeable memories, would itself deserve a lengthy description. But I cannot conclude this already lengthy article without saying how much the French physicists have been touched by the sympathetic action of the foreign secretaries of the Congress, who deposited a magnificent crown on the modest tomb of the great Fresnel, of which the Société Francaise de Physique has constituted itself the guardian. A moving speech by M. Warburg, and a warm expression of thanks by M. Cornu, president both of the Congress and of the Society, referring in a few words to the life of that great physicist, ended this first Congress, where so many new thoughts have been born, and so many friendships made or consolidated.

CH. ED. GUILLAUME.

ORIENTATION OF THE FIELD OF VIEW OF THE SIDEROSTAT AND COELOSTAT.

OBSERVERS who have practical acquaintance with the siderostat and heliostat are familiar with the fact that while the reflected image of a star may be kept stationary, the images of surrounding stars have a rotation around it; while if the sun is the object viewed in the mirror, the image will rotate about the axial ray. It is on account of this rotation of the field that neither the siderostat nor the heliostat can be used with a fixed telescope for celestial photography, except for objects which can be photographed with short exposures.

Certain unexpected peculiarities of this motion have recently led Prof. Cornu to investigate the general laws governing the rotation of the field in both instruments (*Comptes rendus*, vol. cxxx. No. 9, 1900; *Bulletin Astronomique*, February 1900). Some of the results at which he has arrived are of great interest, and we believe attention has not been previously drawn to them, although they could have doubtless been derived from Orbinsky's formula for the orientation of the field (" Die totale Sonnenfinsternisse am 9 Aug. 1896"), or from other formulæ which have been employed by observers as occasion required.

Prof. Cornu first discusses the general question of the orientation of the field, irrespective of the mechanical means of retaining the reflected image in a fixed position. In Fig. 1, NESW represents the horizon, Z the zenith, P the pole, PD the hour circle of the star D, and D′ the point of the horizon towards which the rays are reflected. PN is equal to the latitude of the

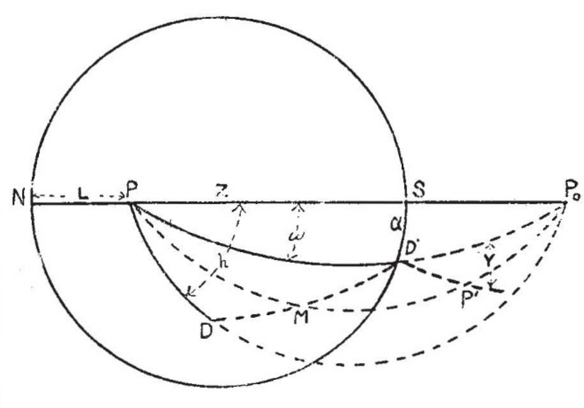


FIG. 1.—Orientation of field of siderostat.

place, = L; PD is the polar distance of the star, $= \delta$; SPD is the hour angle of the star, $= h$. For the purposes of calculation the point D′ is defined by its polar distance $PD' = \rho$, and by the angle $SPD' = \omega$ which the plane PD′ makes with the meridian; ρ and ω can be determined in terms of the azimuth of D′ ($= SD' = \alpha$, reckoned positive towards the west) and the latitude, by solving the right-angled triangle PSD′, in which $PS = 180° - L$; thus

$$\cos \rho = \cos \alpha \cos L; \ \tan \omega = \frac{\tan \alpha}{\sin L}.$$

The normal to the mirror must always bisect the arc DD′ of a great circle, at M, so that the position of the reflected ray from any part of the sphere can be easily determined. Thus the image of P is at P′ in the continuation of the hour circle PM, MP′ being equal to PM. To determine the orientation of the field, it is most convenient to ascertain the direction, after reflection, of the point P, since it is a fixed point on the sphere. Taking the plane of $PD'P_0$ as the reference plane, and its trace on the sphere as a fixed direction, the orientation of the reflected pole is conveniently defined by the angle $P_0D'P' = Y$, which can be readily calculated, as also D′P′, the distance of the reflected pole from the centre of the field.

Applying this in the first place to the siderostat, where the reflected rays are south or nearly so, and the angle α consequently small, Prof. Cornu obtains the following results :—

(1) The reflected image of the pole describes a circle round the centre of the field, with a radius equal to the polar distance of the star observed.

(2) Since the angle Y is equal to the supplement of the angles at the base of the triangle PDD′, P being the apex, the orientation of the reflected pole (that is, the direction of the north point of the field) is given by the equation

$$\tan \tfrac{1}{2} Y = \frac{\cos \frac{1}{2} (\rho + \delta)}{\cos \frac{1}{2} (\rho - \delta)} \tan \tfrac{1}{2} (h - \omega)^1$$

The law of rotation readily follows. The interval from the passage of the star over the hour circle PD′ being expressed by t, with a day as the unit of time, $h - \omega = 2\pi t$, and the equation becomes

$$\tan \tfrac{1}{2} Y = K \tan \tfrac{1}{2} 2\pi t.$$

$$\text{where } K = \frac{\cos \frac{1}{2} (\rho + \delta)}{\cos \frac{1}{2} (\rho - \delta)}$$

Hence :—(*a*) The rotation of the field has the same period as the diurnal motion.

(*b*) The motion is continuous and in the same direction, direct or inverse according to the sign of K.

(*c*) The plane of reference is a plane of symmetry, since the angle Y has equal values of contrary sign at equidistant intervals of time from passage across the reference plane.

Prof. Cornu illustrates the rotation by a diagram similar to those in Fig. 2.

(3) The angular velocity of rotation at the epoch t is given by

$$\frac{dY}{dt} = 2\pi \frac{K}{\cos^2 \pi t + K^2 \sin^2 \pi t}.$$

(6) When the reflected ray is in a horizontal and southerly direction, as is usually the case, $\omega = 0$, and $\rho = \pi - L$, so that the formula for orientation becomes

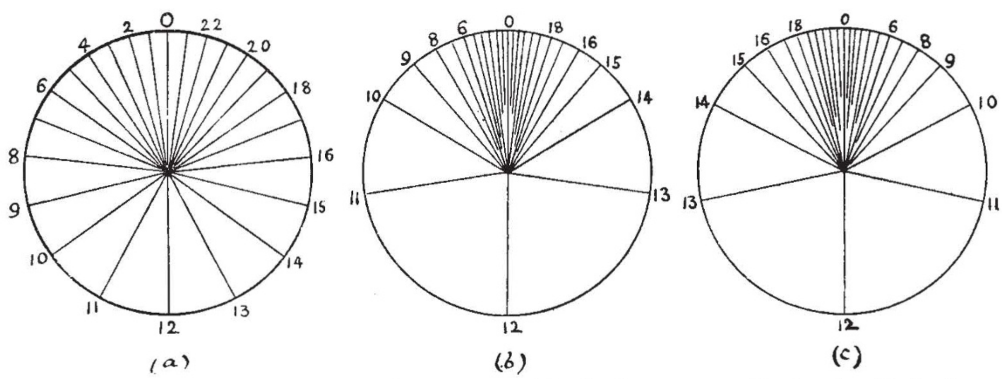
$$\tan \tfrac{1}{2} Y = K \tan \tfrac{1}{2} h$$

where

$$K = \frac{\sin \frac{1}{2} (L - \delta)}{\sin \frac{1}{2} (L + \delta)}.$$

It readily follows that there is no rotation of the field in this case when the polar distance of the star observed is equal to the latitude of the place of observation ; the rotation is clockwise if the polar distance be less than the latitude, and contrary if greater. Fig. 2 illustrates the varying conditions of rotation in the latitude of London (*a*) for the position of the sun at the winter solstice, (*b*) for the position of the sun at the summer solstice, and (*c*) for a star which passes through the zenith. In each case the numbers are placed to represent the position angles of the north point of the field at corresponding hour angles.

In the case of the heliostat, where the rays are reflected in a northerly direction, a similar method of computation is adopted by Prof. Cornu ; but as the instrument is so little used in work of precision, it is unnecessary to give the details. The important result is that the field of view under ordinary conditions has an angular velocity of rotation greater than that of the diurnal motion.



Sun at winter solstice, London. Sun at summer solstice, London. Star through zenith, London.

FIG. 2.—Illustrating rotation of field of siderostat.

The denominator is always positive, so that the velocity has always the same sign as K ; its value varies from $2\pi K$ (when $t = 0$) to $\frac{2\pi}{K}$ (when $t = \frac{1}{2}$), and is equal to the diurnal motion when the conditions make the denominator equal to K. The velocity varies so slowly for small values of t, that it may be sufficient to regard it as constant and equal to $2\pi K$. Since the northern meridian passage cannot be observed with the siderostat, the value $\frac{2\pi}{K}$ is not observable.

(4) The apparent motion of the field, as seen in the mirror, will evidently be in the same direction as the apparent motion of D′P′ seen from outside the sphere, and it will not be reversed by an astronomical telescope. When the polar distance of the star observed is less than the supplement of the polar distance of the reflected ray, the apparent direction of rotation of the field of a siderostat is clockwise ; it is in the contrary direction if the polar distance of the star is greater than this supplement.

(5) When $\cos \frac{1}{2}(\rho + \delta) = 0$, we have $K = 0$, and $Y = 0$ for all values of t. Hence there is no rotation of the field when the polar distance of the star observed is equal to the supplement of the polar distance of the direction of the reflected ray.

In this case, $\rho + \delta = 180°$, and PM $= 90°$, so that the mirror is parallel to the earth's axis, and the instrument thus behaves like a cœlostat.

[1] This gives the angle reckoned from the direction D P. To obtain the inclination to a vertical line passing through the mirror, it would be necessary to calculate the angle PD′Z.

A knowledge of the orientation of the field as reflected by a mirror is so frequently required that it may be useful to refer briefly to other ways of treating the problem.

Orbinsky proceeds much in the same manner as Prof. Cornu, but considers the more general case in which the reflected rays are neither in the meridian nor horizontal. The position of the normal is midway between the direction of the star and that of the reflected ray, on a great circle, so that the direction of the reflected ray from any other point of the celestial sphere can at once be determined.

In this way the position of the zenith point of the field (vertex) is derived with respect to the vertical circle in the plane of the reflected ray. A calculation of the angle between the vertex and the north point is then all that is required to give the direction of the north point of the field with respect to a vertical line through it.

Another method of representing the orientation was adopted by Mr. Shackleton in connection with the eclipse of 1896. This can be applied to a reflection in any direction, but it will suffice to indicate its application to a siderostat with the reflected ray in the meridian. Using Prof. Cornu's notation so far as possible, in Fig. 3 NESW is the horizon, NPS the meridian, P the pole, D the star, M the mirror, MS the direction of the reflected ray from D, and SDN the trace of the plane of reflection. Representing the direct field by *anb*, *n* is the north point. The field of the mirror appears behind the mirror as *a′n′b′*, *a′b′* remaining in the plane of reflection, and *b′*N*n′* being equal to *b*D*n*. Since N*v* is a vertical line through the field of the mirror, and *v*N*a′* = DSP, it is evident that *v*N*n′* = 180° − (PSD + PDS).

vNn' thus corresponds with the angle Y in Prof. Cornu's formula, and its value is derived by precisely the same formula.

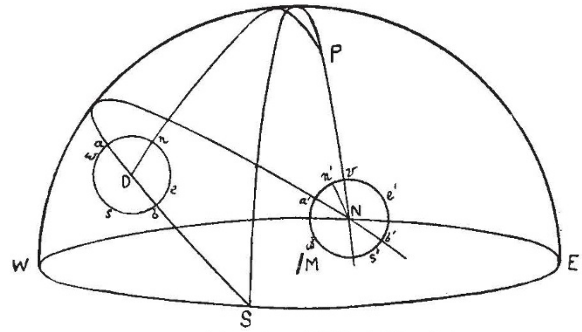


FIG. 3.—Orientation of field of siderostat.

The orientation of the field of a cœlostat is very readily derived. In this instrument the mirror turns on a polar axis in its own plane, so that the normal is always on the equator, and the polar distance of the reflected ray is always equal to the supplement of the polar distance of the star. Thus, in Fig. 4, PD′ is the supplement of PD. The reflection of the hour circle through the star, PD, will coincide in direction with that through the reflected ray, PD′, so that n will become n', and it only remains to determine the angle PD′Z to ascertain the position of the north point with regard to a vertical line through the field of the mirror. If we suppose the rays to be reflected in a horizontal direction, in the triangle PZD, PZ = the co-latitude, ZD′ = 90° and PD′ = 180° – PD, so that the required angle can be at once derived. In this case it is convenient to know the azimuth of the reflected ray, that is, PZD′; and the simplest solution is to calculate this angle first by the formula

$$\cos \text{PZD}' = \cos (180° - \text{PD}) \sec L.$$

The required angle is then derived from the formula

$$\sin \text{PD}'\text{Z} = \sin \text{PZD}' \cos L \operatorname{cosec} (180° - \text{PD}).$$

The position of the north point having been determined, the remaining points can at once be placed, noting that the east and west points are reversed as compared with the direct view in the sky.

It is important to note that although there is no rotation of the field so long as the telescope remains in one position, the whole field is turned when the telescope is set in a different direction. Thus, if the telescope is directed west for observations of the morning sun, the orientation of the field will be different when the telescope is pointed in an easterly direction for observations of the sun in the afternoon; in the former case the north point lies to the right of the vertical, and in the latter case to the left.

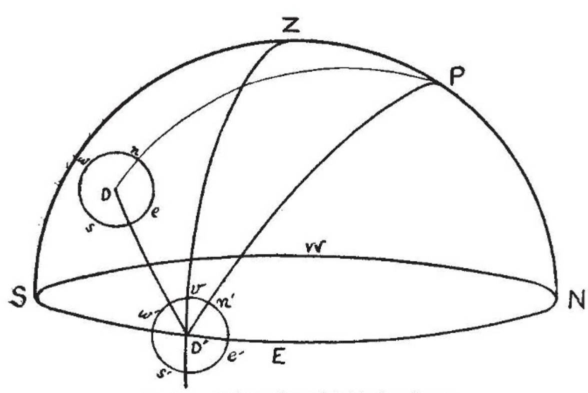


FIG. 4.—Orientation of field of cœlostat.

Other investigations relating to the cœlostat, including the determination of the best position for the telescope under given conditions, have been made by Prof. H. H. Turner (*Monthly Notices R.A.S.*, vol. lvi. p. 408).

As the cœlostat has not yet come into very general use, it may be of interest to add a few remarks as to the arrangements which have been made by Sir Norman Lockyer at the Solar Physics Observatory for utilising this instrument in a permanent observatory (Fig. 5). On account of the varying declinations of the heavenly bodies, the position of the observing telescope must admit of corresponding changes, either in inclination or azimuth, or both. When special instruments, such as the spectro-heliograph, are to be used with the cœlostat, as at the Solar Physics Observatory, motion in azimuth is the only motion permissible, and this is provided for by fixing the receiving instrument on a platform which runs on circular rails, with the cœlostat at the centre. The platform carrying the telescope or spectroscope is covered with a travelling hut, the roof of which is inclined so as not to obstruct the mirror. The cœlostat itself is provided with a hut, which is removed to the north when the instrument is in use; this is shown to the left in the illustration.

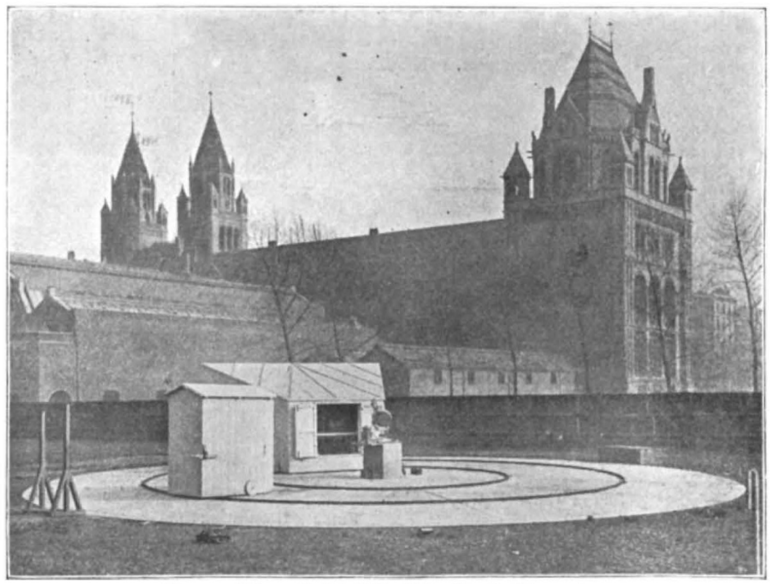


FIG. 5.—The cœlostat of the Solar Physics Observatory.

A. FOWLER.

THE ANNIVERSARY MEETING OF THE REALE ACCADEMIA DEI LINCEI.

A MELANCHOLY interest attaches to the anniversary meeting of that ancient scientific society, the Reale Accademia dei Lincei, held in June, from the fact that the society was then mourning the loss of its distinguished president, Prof. Beltrami, and has since been plunged into deeper mourning by the untimely and unexpected loss of its patron, King Humbert, who with Queen Margherita had for many years taken part in these yearly meetings. It is, moreover, largely due to the munificence of the late King of Italy that the society is enabled to further the advancement of science by the award of prizes for theses dealing with some subject of scientific research.

From the presidential report of Prof. Mesadaglia, we learn that the society's losses have included, besides Beltrami, the names of Capasso, De Simoni, Ferrara, Nestore and Tommasi-Crudeli among the ordinary members, and, of foreign members, Bertrand, Bunsen, Janet and Liais. The *Atti*, or "Proceedings" contain for the year 147 papers, in addition to which several