In these equations the independent variables are the time, t, and the coördinates x, y, z.

The components of the active forces are represented by X, Y, Z, which in the most general cases are compounded of the force of gravity, the deflective force of terrestrial rotation and the force of friction; their potential is Φ.

The dependent variables are the following seven quantities:

- u, v, w, the three components of the velocity of the air.
- p, the pressure of the air.
- ρ, the density of the air.
- θ, the absolute temperature of the air.
- r, the moisture (i. e., vapor pressure per sq. cm.) of the air.

These seven dependent variables satisfy the seven equations that are written below. In Scheme I they are given in the classical form that they take when using the C. G. S. system. In Scheme II they are given in the form that they assume when we express the pressure in millimeters mercury, but retain the C. G. S. units for all other quantities.

The equations are as follows: The three hydrodynamic equations (1), (2), (3); the equation (4) of hydrodynamic continuity; the equation (5) of the gaseous condition; the equation (6) for the conservation of energy; the equation (7) that follows from the second law of thermodynamics. Besides the quantity of heat dQ, added to the mass of air under consideration, these two last equations contain two other new quantities, i. e., E, the energy, and S, the entropy, of the mass of air. The fact that these are known functions of the variables p, θ, r, is expressed by the equations (6′) and (7′).

SCHEME I.	SCHEME II.
$\rho\frac{du}{dt}=-\rho\frac{\partial\Phi}{\partial x}-\frac{\partial p}{\partial x}$ ....(1)	$\rho\frac{du}{dt}=-\rho\frac{\partial\Phi}{\partial x}-1.333193\frac{\partial p}{\partial x}$
$\rho\frac{dv}{dt}=-\rho\frac{\partial\Phi}{\partial y}-\frac{\partial p}{\partial y}$ ....(2)	$\rho\frac{dv}{dt}=-\rho\frac{\partial\Phi}{\partial y}-1.333193\frac{\partial p}{\partial y}$
$\rho\frac{dw}{dt}=-\rho\frac{\partial\Phi}{\partial z}-\frac{\partial p}{\partial z}$ ....(3)	$\rho\frac{dw}{dt}=-\rho\frac{\partial\Phi}{\partial z}-1.333193\frac{\partial p}{\partial y}$
$\frac{1}{\rho}\cdot\frac{d\rho}{dt}=\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}$ ......(4)	$\frac{1}{\rho}\cdot\frac{d\rho}{dt}=\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}$
$\frac{p}{\rho}=R\theta$ ....(5)	$1.333193\frac{p}{\rho}=R\theta$
$dQ=dE+pdv$ ....(6)	$dQ=dE+1.333193pdv$
$dS\gtrless 0$..............................(7)	$dS\gtrless 0$
$E=f(p,\theta,r)$......................(6′)	$E=f(1.333193p,\theta,r)$
$S=F(p,\theta,r)$ ....(7′)	$S=F(1.333193p,\theta,r)$

These two systems of equations I and II differ from each other only in that no numerical factor enters the first set, whereas in the second set the numerical factor 1.333193 occurs everywhere in connection with the pressure. It is very evident that this factor causes an increase in the labor of computation. However, this inconvenience is only a small matter. The important objection to this second system of equations consists in the confusion of ideas introduced by this numerical factor. The nature of the confusion is illustrated by the above given example where we have considered the definition of the gradients. But the subject of this confusion is by far not exhausted by this one example; it recurs in innumerable varying forms, with every form of the equation.

It will not be possible to form clear plans for a fruitful coherent systematic development of observational and theoretical meteorology, unless we first consider carefully at every step how the above mentioned confusions are to be put aside or circumvented in the best way possible.

It must not be forgotten that the question here presented has an importance far beyond the limits of meteorology. The C. G. S. system has been planned as a universal system of units, and its universal application can not be prevented in the long run. At the present time we all regret that synoptic meteorology did not, at its very foundation, adopt the unit of pressure of this system. It is easily understood why at the present time and as conditions now exist, the general transfer of all meteorology to the C. G. S. system is delayed. The expenses and inconveniences that accompany the general transfer are very considerable, and the advantages will only be appreciated and become of great importance when the transfer has become really universal. Therefore it may still be proper to await the time when the British Empire and the United States shall have adopted the metric system.

But the conditions in regard to aerology are entirely different. This is a new branch of meteorology that is now in a stage of most rapid development and in which we can not afford to lose the benefit of the C. G. S. system, at least in the theoretical discussion of simultaneous ascensions of kites and balloons. It is of the greatest importance for the rational development of this branch that we allow ourselves the freedom of utilizing the advantages of the universal C. G. S. system.

PROGRESS IN METEOROLOGICAL OPTICS DURING 1912.

By CHRISTIAN JENSEN, Hamburg.

[Translated by C. Abbe, jr., for the MONTHLY WEATHER REVIEW.]

During the year 1912 the occurrence that attracted the greatest attention was the general turbidity of the atmosphere. This unusual condition has shown itself in the low degree of saturation of blue skylight (1), the intense red coloring of the sun when near the horizon, the weakening of s arlight (2), the phenomenon of Bishop's Ring (3), and by other phenomena apparent to the naked eye. The most striking evidence, and of a quantitative character, was afforded by the instrumental measurements of the intensity of insolation and of sky polarization. We shall first review those publications of the year 1912 which deal with this atmospheric turbidity, but it will sometimes be necessary to touch upon studies made during the year 1913 also.

It is generally agreed that the tremendous explosions of the volcano Katmai in Alaska from June 6 to June 9, 1912, produced the exciting cause of that optical disturbance whose principal effects over Europe began on June 20 of that year. But as we have already pointed out (4) the fact must not be overlooked that reports of antecedent optical disturbances at various points, indicate that there was a preexistant condition of general turbidity. Thus the well-known investigator of the zodiacal light, Schmid (5) of Oberhelfenswil, reported that in the second half of May the sun was the center of a peculiar silver-white disk 8° to 10° in diameter; F. Hahn (6) reports that as early as June 8 he noticed the peculiar

[1] From Mitteilungen der Vereinigung von Freunden der Astronomie und kosmischen Physik, Berlin, 1913, pp. 166-183.

appearance of the western sky at a little before sunset, and Addison (7) noticed the remarkable appearance of the heavens at Riga as early as the middle of May. It is specially noteworthy that Eginitis (8) at Athens found the sunshine recorders there indicating a striking drop in intensity at the early date of April 7, followed throughout May by further decrease, after which the intensity increased until the middle of June when it again diminished to the end of the month. E. Barkow (9) reports an atmospherico-optical disturbance observed in the Antarctic, appearing as an unusual twilight. The first record of this twilight was a journal entry of June 15, and the exact time of first appearance of the disturbance can not be given. The general result of all available reports on this turbidity strongly suggests that there were two clearly defined phases in this phenomenon of 1912, and that its cause is to be sought not only in the explosion of Katmai but also in some cosmical cause which was superimposed upon the former from June onward.

The twilight phenomena and Bishop's Ring of the last great disturbance have differed considerably from those that accompanied the explosion of Krakatoa and the West Indian volcanoes, and in consequence new problems have accumulated. So far as Europe is involved, pronounced twilight phenomena began (10) about June 20 and continued for some time. Schmeel (11) reports beautiful colorings as early as June 18 and even on June 11. After this date more or less brilliant twilights occurred at greater or lesser intervals (12), but the experience of former years would have lead us to expect much more frequent brightly colored phenomena. P. Gruner (13), of Bern, has published the results of systematic studies of these and similar phenomena, whence it appears that in Switzerland also the purple glow was very weakly developed throughout the late summer, not regaining its intensity until autumn.

Kimball (14) found a pronounced falling off in the atmospheric transparency at [Mount Weather, Va., 45 miles northwest of] Washington, D. C., from the morning of June 9 to that of June 10. Hand in hand with this went a relatively low degree of skylight polarization (15) for those points in the sky lying in sun's vertical and at 90° solar distance. He also points out the strikingly large daily variations in the degree of polarization and in the atmospheric transparency, as well as anomalous positions of the Babinet point. His first effort was to explain all these anomalies by special local meteorological processes; but when the opacity had endured until the end of August, even though variable in intensity, Kimball felt obliged to modify his views. In a footnote to (14) he presents a table of skylight polarizations and of solar radiation intensities as measured with an Ångström pyrheliometer,[3] and expresses the opinion that the first-mentioned turbidity, except on certain occasions, might also be due to the explosion of the Alaskan volcano. When other things are equal one may say that intensity of insolation increases with the altitude of the sun above the horizon, so that by examining the charred line of a Campbell-Stoke sunshine recorder one may form some idea of the intensity of the sun by noting the time or altitude at which its records begin from day to day. W. Marten (16), A. Stöhr (17), and Eginitis (18) have made such studies. Marten determined the relation between the sunshine recorder and the Ångström pyrheliometer, and then found that even for solar altitudes of 50° to 60° the decrease in the intensity of insolation amounted to about 0.35 gr.-cal. per cm². per hour, the radiation intensity of a normal year being 1.25 to 1.35 gr.-cal. as compared with 0.8 to 1.0 gr.-cal. during the summer of 1912.

Further, Marten pointed out remarkable variations in intensity, which indeed seem to show up in measurements of positions of the neutral points of polarization and call for more thorough investigation. It is evident that one may attempt to explain these variations by supposing corresponding fluctuations in the cause of the turbidity, thus referring them to a general phenomenon, or one may refer them to the effects of local influences. Thus Hildebrandsson (19) would refer a decrease in the turbidity observed at Gothenburg on July 21 to the temporary clarifying of the air by thunderstorm disturbances. But in this connection I would point out that A. Wigand (20) made a balloon ascension on September 28, 1912, whereby he was able to determine that, aside from a vapor veil lying just above the stratus cover and below 1,000 meters, there was 750 meters of intense haze lying at an altitude of 5,000 meters and that up to 9,100 meters there was an increased haze content which reduced the normal visual transparency of the atmosphere. Wigand thinks the haze stratum must have been due to the presence of foreign particles of various sizes, which had gradually settled from altitudes above 10 km. Perhaps these various strata also indicate some relationship with the increasing probability of the two-fold character of the disturbing cause. The extent to which the clouding particles might serve as condensation nuclei for raindrops is closely related to the problem of a meteorological origin of the haze. One is tempted to connect the strikingly heavy precipitation of the second half of 1912 with the loss in atmospheric transparency. So far as I know this was first suggested by Gockel (21), but it seems that it must be abandoned to a certain extent at least. Wigand (22) made a balloon ascension on January 5, 1913, reaching an altitude of 7,000 meters, and observed a considerable weakening of sunlight due to a high haze which yielded an extremely low number of condensation nuclei when examined with an Aitken dust-counter, and hence could not be regarded as a normal mass of vapor.

In August, 1912, Fr. Busch (23) drew attention to a change in the sky light polarization observed by him on July 14, particularly emphasizing the marked increase in the solar distance of the neutral points for positive altitudes of the sun, and the strikingly small solar distance of Arago's point for the sun at −0.5° altitude. At the same time he pointed out the reappearance of Bishop's Ring and the very insignificant development of the purple glow. Unfavorable weather prevented both Busch and myself from securing measurements at the first appearance of this disturbance. The striking decrease in the solar distances of the neutral points for the smaller positive and not too great negative altitudes of the sun, as indicated by the reports from all over the world, Jensen has (23) compared with the strikingly great increase in the zenithal polarization as found by Pickering and Kimball for the greatly disturbed years 1884, 1902, and 1903. Jensen has discussed the cause for these phenomena in another place (24). Referring to these results we would add that, contrary to the experience in undisturbed periods, several series of measurements almost uniformly showed that on interposing a blue or green filter before the polariscope smaller solar distances were found than on using a red filter. The author found these results to be in good agreement with

[3] Marvin pyrheliometers were used at Mount Weather.—Translator.

the naked-eye observations of changes in sky-color due to the haziness, as well as with Dorno's (25) observations, communicated to him by letter, upon the relations between the measured intensities in the different colors of diffuse sky light and of direct sunlight. The latter relation depends upon the ratio of the positive to the negative component of vibration at various points in the sun's vertical. So far as the total brightness is concerned, Dorno found an average decrease in the intensity of the direct insolation, due to the disturbance, while the total radiation (Sun+Sky) showed quite unchanged magnitude. Therefore we must conclude that there was an increase in intensity of the diffuse sky light. The observations of the different colors show that both the direct sunlight and the diffuse sky light have lost decidedly more in the green than in the red, but the difference is most pronounced for the sky light. The ultraviolet solar radiation, as measured with the zinc-ball-photometer, showed specially large decrease (40 per cent as compared with 18 per cent loss in the thermal radiation and 20 per cent in the brightness) but the solar spectrum showed that the composition of the ultraviolet rays remained unchanged, whence Dorno concludes that the disturbance is not to be ascribed to the presence of any substance loaded with absorption lines in this portion of its spectrum.

The second occasion, which drew forth a series of important studies, was the solar eclipse of April 17, 1912. Weber and Borchard (26) made a set of observations of the sun's brilliancy in the red and green spectral regions, using an opal-glass photometer, and they also observed the so-called Ortshelligkeit, i. e., the illumination of an opal-glass plate produced by the light from the whole sky falling upon it. This material was particularly used for checking up Vogel's earlier measurement of the decrease in brilliancy from the center to the limbs of the solar disk. The observations in the red agreed very satisfactorily with those by Vogel; but those in the green show a slight discrepancy which remains to be explained. Werner (27) compared the decreasing brightness of the sun, as measured with a spectro-photometer for wave lengths 443, 514, and 651 $\mu\mu$ by Kron at Potsdam, with calculated values for the brightness of the solar sickle at any given phase of the eclipse and assuming the correctness of Vogel's law for the radial decrease in luminosity of the solar disk. Observation and computation agreed well for the wave length 651 $\mu\mu$, but for longer wave lengths there appeared discrepancies which the author ascribes primarily to the action of the diffuse sky light necessarily present when observing the sun; as stated by Rayleigh's Law, this action of diffuse light is specially pronounced in the regions of the shorter wave lengths as it varies inversely as the fourth power of the wave length. Werner finds no reason for doubting his initial formula, and would also explain a part of these discrepancies by assuming that the atmosphere was more transparent during the first half hour of the eclipse than subsequently; but we can not agree with him in this case. In the first place, the weather notes he himself publishes, wherein it appears that cirrus came over after the maximum phase of the eclipse had passed, seem to testify against such an assumption; in the second place the observations by Elster and Geitel (28), evidently made under similar weather conditions, seem to contradict the assumption. It is true the measurements of the latter observers, made with an electric-light photometer that was fairly sensitive throughout the whole visible spectrum, indicate a probable slight decrease in transparency, but certainly do not show a more rapid increase in the insolation after the middle of the eclipse. The assymetry of the curve of total radiation during the eclipse, observed by Walter and Goos (29) on this occasion as also by Cirera on a former one, is interpreted by Elster and Geitel as showing a certain amount of hazing of the atmosphere within the moon's shadow, hence the direct insolation was weakened to a just barely noticeable degree while the sky illumination was so greatly increased that the total illumination became greater than it had been before the eclipse. This reads as indeed rather plausible, but it is interesting to here recall that Dorno's measurements on the great disturbance of 1912, to be sure a haze of wholly different character, showed that the latter had not caused any change in the total illumination.

Of the various photographs made from balloons during the eclipse those showing the balloon's shadow, as taken by A. Wigand and E. Everling (30) and by M. Seddig (31) are particularly noteworthy. Gimpel's explanation (32) of the sickle-shaped balloon shadow is practically the same as those by Wigand and Everling and by Seddig. Wigand and Everling conceive a point of light at infinity giving a circular shadow upon the plane of projection (the earth's surface) and hence the whole luminous surface (the sickle) giving a multitude of such circles arranged as the geometrically similar inverted image of the sickle. A graphically derived curve of equal shadow densities shows good agreement with the determinations of the distribution of brilliancy.

Werner (27) when estimating the amount of diffuse sky light that gets into measurements of the sun's brightness, employed the values found by Diercks (33) in his study of the brightness of the sky in the vicinity of the sun. One must consult the latter paper to understand what success Diercks had in stopping out all radiation other than that which he wished to measure photometrically from some smallest possible segment of the sky close to the sun, and at the same time determining as accurately as possible the interval between it and the sun's limb. Observations made on some specially clear summer days in 1911, showed uniform decrease in illumination from the sun's limb to a distance of 7½° both to the right and to the left of the same. The normal change was determined analytically with great accuracy by the aid of empirical elliptic equations. Of marked meteorological significance, with reference to further applications of this very exact method, appears to be the well-marked relationship between the above-mentioned segment brilliancy (Flächenhelligkeit) and the Ortshelligkeit minus the direct solar rays, which is an index of the degree of saturation of the blue sky light and of the purity of the air. I should also mention a surprising interruption in the normal course of the decrease in brightness with distance from the sun, a so-called swelling that Diercks describes as a "Hof" about the sun and whose existence could only be demonstrated by the aid of the photometer. The thought is at once suggested that such measurements may in the future furnish a means of detecting weakly defined atmospheric disturbances of both local and general nature.

On Teneriffe, G. Müller (34) and E. Kron have undertaken a very valuable investigation. After the appearance of Abbot and Fowle's recent bolometric determinations of the phototransparency of the atmosphere, Müller had long intended to carry out spectro-photometric measurements of the absorption in order to determine the spectrum distribution of the sun's energy at points without the earth's atmosphere. Pannwitz's expedition to observe the transit of Halley's comet offered Müller a very welcome opportunity. The most important measurements were made with a slightly modified Glan-Vogel spectro-photometer at 1,950 meters (near Pedrogil Pass), and at 3,260 meters (Alta Vista). He succeeded in determining with great accuracy the local transparency for 11 different wave-lengths and in securing the energy curve for the visible portion of the solar spectrum. First, he determined the distribution of brightness of the visible portions of the solar spectrum by means of a standard comparison lamp. In order to compare the distribution of energy in this portion of the spectrum, the distribution of energy for a so-called black body, he had to compare the standard lamp with the artificially blackened black body, and this could not be done until after his return from Teneriffe. It was constantly borne in mind that the incandescent standard lamp might undergo changes during the period the expedition lasted, and the greatest care was exercised in all measurements and computations. Finally Müller employed Wien's shift law and Planck's radiation equation in an effort to determine the absolute temperature of the sun's surface by means of the extra-atmospheric energy distribution of the solar spectrum. He found the values 6,283° and 6,332°, respectively, by the two methods, values which agree satisfactorily with those recently found by Kurlbaum from observations made in upper Egypt. It is noteworthy that in general the coefficient of transparency varies directly with the wave-length, but that every curve showed a slight bend in the central region of the spectrum, a phenomenon which Schuster had already pointed out as characteristic of Abbot's values. Since the air above the Teneriffe stations is abnormally dry, this interruption in the otherwise uniform decrease in transparency with decreasing wave-length can not be explained as due to selective absorption by water vapor. Besides, as Müller points out, Abbot's latest measurements on Mount Whitney, though not known to Müller at the time, seem to show that the selective absorption between 560 and 580 $\mu\mu$, which is still clearly marked in the measurements at Alta Vista, seems to have disappeared at the summit altitude of 4,420 meters.

During the past year K. Bergwitz (35) made balloon ascensions to determine the atmospheric coefficient of transparency for blue-violet rays, using the newest Elster-Geitel cells. In these cells the light falls upon a negatively charged, photosensitive layer in the high-vacuum chamber and thereby sets free electrons which make the vacuum conductive. This conductivity may be measured by means of appropriate devices, and it is found that the strength of current due to the individual wave-lengths is proportional to the intensity of the incident light. In the present case the cell was fitted with a sheet of Jensen blue glass to limit the region of wave lengths, and the current was measured by means of a Kadelbach and Randhagen box galvanometer. The well-known Lambert-Bouguer formula was tested by measurements at different altitudes of the sun, with a very satisfactory agreement between observed and computed values. Bergwitz found the coefficient 0.47 for blue-violet rays, a value differing slightly from that determined by Schünemann in Wolfenbüttel a few days earlier. However, Bergwitz showed that the sign of the discrepancy was the one to be expected under the plausible assumption that blue-violet rays are more strongly absorbed in the lower than in the higher layers of the atmosphere. As was pointed out in our review for 1911 (36), this coefficient enables us to compute the number of molecules in a unit volume of a given gas. Dember (37) therefore endeavored to secure the Loschmidt numbers, i. e., number of molecules in 1 cm^3. of gas at 0° and 760 mm., by means of a transparency coefficient also determined by an Elster-Geitel cell. To do this one must determine the Rayleigh relation between the intensity of the incident light, the intensity of the ray transmitted by a definite atmospheric layer, the thickness of that layer, the wave-length of the incident light, the index of refraction of the scattering particles, and their number per cm^3. Homogeneous light must be used because the effect of the larger particles increases as the sun's altitude decreases, and to secure this Dember combined a spectrometer with an Elster-Geitel photometer in which the Uviol-glass cell was replaced by an alkali cell fitted with quartz covers to transmit the shorter wave lengths. The magnitude of the photoelectric effect was measured by means of a unifilar-electrometer. His measurements of August 24, 1912, made on the Signalkuppe (4,560 m.) of the Monte Rosa massiv, gave a mean coefficient of 0.4 (0.54 for blue-violet, 0.32 for ultraviolet), corresponding to the Loschmidt number $n = 1.25 \times 10^{19}$. The author explains the difference between this value for n and that found by Millikan (2.7×10^{19}) in his investigations of unit charges, by the effects of water vapor, of ozone, and of minute snow crystals. He has here lost sight of the fact that, although he describes August 24 as being a perfectly clear day in a period of otherwise quite unfavorable weather, the general haziness of the atmosphere had already been long since markedly effective in the Alps. However, these measurements encourage us to hope that the extremely sensitive photoelectric photometer will find further application in such investigations.

We should mention here the daily noonday radiation measurements carried out in 1911 by G. Raymond (38), who measured the photoelectric effects by means of an accurately described zinc amalgam receiver. He determined the time required by the insolation to dissipate a definite and uniform negative charge. The sensitive surface was not exposed perpendicular to the sun's rays, but was always kept in a horizontal position, so that the observed values had first to be reduced to those for perpendicular incidence. We have not been able to understand from the paper cited whether Raymond attempted to exclude and how far he succeeded in excluding the effects of diffuse sky light. Dorno's work, "Studie über Licht und Luft des Hochgebirges" (39), so far as it treats optical conditions, is concerned with measurements both of solar radiation intensities and of the radiation from the whole sky (sun + remaining sky). An article by him (40) in 1912 points out that by using the better known meteorological elements his measurements at Davos may be extrapolated to cover all other similarly situated localities in the Alps. He finds that a physically adequate idea of the photometric and atmospheric climate of large regions might be secured by carrying out at a few other places the supplementary work which he carefully describes. Finally he presents positive accurate suggestions for selecting the points at which definitely described radiation observations are to supplement those in atmospheric electricity.

Humphreys' (41) interesting investigations into the so-called "earth light" have a purely theoretical significance. Some years ago Yntema came to the conclusion that the light of the nocturnal sky, disregarding that due to direct starlight, was referable in part only to atmospheric diffusion or scattering while the by no means small remaining portion was to be referred to a kind of permanent aurora. It is rather notable that in his observations made at sea-level he found that the increase in brightness from zenith to horizon was by no means constant either from night to night nor even throughout the same night. Abbot made a corresponding study on the summit of Mount Whitney (4,400 m.) and obtained essentially the same results as those of Yntema. Humphreys concludes from this that the "earth light" is some general phenomenon of the upper levels of the atmosphere. He objects to Yntema's view that it is of auroral character by pointing out that there is no evidence that the phenomenon is relatively stronger in those regions where the aurora is particularly well marked. On the other hand, he points out in detail how it would be possible for a bombardment by meteoric dust, moving at an average rate of 42 km. per second through the atmosphere, to produce a general luminescence of the atmosphere due both to the high temperature resulting from the compression of gases and to an ionisation similar to that resulting from bombardment by α-rays. It is evident that, in view of the necessary absorption, the meteoric particles must penetrate to a considerable distance within the outer more tenuous layers of the atmosphere in order to produce a sufficiently pronounced luminescence, consequently Humphreys finds that a direct variation of brightness with zenith-distance is in good accord with his theory. He further tests the same by computing the consumption of energy required to produce the observed brightness, and reaches the result that previous estimates of the amount and velocity of precipitated meteoric material would provide more than enough material to produce the observed effect.

Personally the reviewer is specially pleased to record very satisfactory advances in the field of atmospheric polarization. Plassmann (42) has given us a beautiful contribution in which he determined with tireless and most painstaking care, the exact times and positions of the Arago and Babinet points for both evening and morning hours from March 26, 1910, to October 18, 1911, employing a Jensen pendulum-quadrant. Except for a few series made at Oberkirchen an der Lenne (450—460 m. alt.) his observations relate to Münster. As Plassmann himself says, he presents this abundant material just as it comes from the observations, and leaves its application to meteorologists. Many results may be expected when this rich material has been worked up. Plassmann generally combines 5 individual observations—sometimes 3, 4, or 6—and computes the sun's mean altitude for the pentad, the solar and antisolar distances for the neutral points. Then he combines each ten mean solar distances according to decreasing solar altitudes, and computes the final mean solar distances for each solar altitude. In this work he has used all the series of observations, including some that are obviously much influenced by clouds. In the nature of the case, the time intervals between the individual values which have been combined into pentads may sometimes be quite considerable, so that Busch (43) is quite justified in referring the absence of a regular march in Plassmann's final values to this fact in part. As a matter of fact it appears that when he computed the values by a method explained below, and omitted a specially disturbing series, the jumps in values disappeared. These computations showed a minimum solar distance for the Arago point with the sun at $-1.5°$; the distance of the Babinet point increased from a small positive up to the maximum negative solar altitude without showing a maximum at sunrise or sunset, thus agreeing with Jensen's measurements for the first half of 1909. The method introduced by Busch and adopted by us as well as by many other observers, is to combine all observations made for sun's altitudes $n.9°$ to $n°$ and refer them to sun's altitude $n.5°$, and observations $-n.1°$ to $-(n+1)°$ are referred to sun's altitude $-n.5°$; for example, under the altitude 3.5° are grouped those from 3.9° to 3.0°, and under $-2.5°$ are grouped those from $-2.1°$ to $-3.0°$. Disregarding the minutiæ of the curve, this method has shown itself a very practical one and in view of the increasing scope of these observations it is to be earnestly hoped that the method may find general adoption for the sake of uniformity. Plassmann makes some very interesting remarks about the residual interference fringes sometimes seen after closing his evening observations, when all the uncolored bands seem to cross the field of view without interruption. This phenomenon was so distinctly pronounced that Plassmann could project the subjective and objective images against the sky, where the positions of identifiable stars enabled him to determine equality in width of the two sets of images. Plassmann (44) communicates some of the measurements of solar distances in another place also, where he particularly contributes an elegant, easily comprehended guide to observations on the neutral points, specially adapted to the needs of the navigator who is less familar with the phenomena. The neutral zones of water surfaces for low positions of the sun discovered by Jensen (45) have been discussed in connection with the neutral points of the sky.

My review for the preceding year noticed Platania's first observations in Catania. Fortunately he has continued to zealously observe the neutral points (46). A comparison of the mean values from his observations for 1910 and 1911 with the corresponding ones obtained by Busch shows the solar distance of these points was generally somewhat less during 1911 than 1910 in Catania as well as in Arnsberg. We will not here consider the degree of influence possibly exerted by the strikingly clear skies of the summer of 1911. Platania concludes, from the slight difference between the means for Arnsberg and for Catania, that local conditions have but slight influence on the solar distances when observations are made under perfectly clear skies. But in view of the emphasis laid by so many observers upon the relation between local conditions and skylight polarization, his conclusion must be regarded as rather venturesome.

As pointed out last year, a consideration of the turning points in the regular march, and the jumps in the march of the neutral points led Süring to the conclusion that there is here an influence such as that of strata-boundaries at definite atmospheric levels. Humphreys (47) has tested the possibility of the existence of such boundaries as Süring assumed for his explanation, and finds that dust layers are actually to be expected at the levels of 1, 4, and 11 km. as given by Süring. The lowest layer would consist of relatively heavy dense dust carried by surface winds; the second layer of lighter, less dense particles and resulting from vertical currents; and the third layer, the least dense, is referred to action of cyclonic currents. Finally Jensen (48) points out that a study of the recent computations of observations by himself and many others, is far from affording any grounds for doubting the relation pointed out by Busch in 1893, existing between the sunspot period and the secular variation in the solar distances of the neutral points.

This seems the best place to introduce a notice of Heim's (49) elegant little book presenting lectures before the Alpine Club, although it is a remarkable and regrettable fact that he does not touch at all upon the interesting and important polarization phenomena. In this work he comments inspiringly and beautifully on the peculiarities of the atmospheric colorings, their causes, the so-called blue and the yellow distances [die sogenannte blaue und die gelbe Ferne], the color of the sky and the stars, the colors and duration of twilight and of Alpenglow. In considering the zodiacal light Heim relies principally on the later observations by Schmid. Noctilucent clouds and Bishop's Ring are briefly considered, and summary treatment is also accorded both solar and lunar halos and coronas, mirages, etc. He dwells lovingly upon the causes for the peculiarities in the air colorings, setting forth in detail how the air appears as a blue veil when it is projected against a weakly illuminated background, or acts as a red-yellow glass when projected against a strongly illuminated surface that may or may not be self-luminous. He discusses atmospheric perspective, the yellow and the blue distances, and shows how combinations of the two effects may produce a great variety of tones. His somewhat original train of thought can not be considered in detail here. Twilight and allied phenomena are treated at length, and many colored plates show the gradual changes in the illumination of the Glärnisch with its sky background, seen from the Zurichberg as the sun sinks from +4° to −4°. This and another splendid series of color plates from the brush of the author, increase the pleasure which this little book, popular in the best sense of that word, gives to the reader. Full of enthusiasm for nature's beauties, few readers will regret purchasing it.

We now come to a series of publications in meteorological optics during 1912, most of which are of special scientific significance, but as nearly all of them treat subjects of purely meteorological interest we must be content with a brief survey of their content. Many readers already know that Forel solved the problem of the Fata Morgana over the Lake of Geneva. He was able to demonstrate that the phenomenon occurs at the point of transition from refraction over relatively warm water to refraction over relatively cold water, that is between two regions of opposite refractive conditions. A later more detailed memoir (**50**) shows that there is by no means a slow gradual change from the one type of refraction to the other, but that the rapid transformation of the unstable into the stable atmospheric equilibrium seems to be precisely the deciding factor in bringing about the phenomenon.

A series of papers by Richarz (**51**) and Stuchtey (**52**) deal with the broader aspects of the Brocken specter. Richarz gives an explanation for the bright fringes on the shadow of the balloon car, which have been much commented on of late, that is of general application for all the forms of the so-called Brocken specter. His explanation is equivalent to saying that it is only when the line of sight coincides with the direction of the incident solar ray reflected by a cloud droplet that other drops do not interrupt the reflected ray. Thus there is a maximum intensity of the total light reflected by a cloud surface, along that direction which coincides with that of the incident ray-bundle, independently of the positions of the cloud surface with reference to the direction of the incident rays. He points out, further, that if his explanation is correct, then the intensity-maximum about the car's shadow must be visible at times when lack of uniformity in size of the fog particles would prevent the formation of refraction rings. Richarz broadens his theory to include numerous cases where certain intensity-maxima have been seen without refraction phenomena, and treats conditions where needles, foliage, straws, etc., play the rôle of the fog particles. Stuchtey considers observations by himself and others which are explained by Richarz's amplified theory, and finally discusses experiments imitating a car shadow falling upon a wheat field, using a system of many parallel threads and an arc lamp 8 meters distant therefrom. In this way, and at Richarz's suggestion, he has verified experimentally the latter's theory.

Wigand and Schwab (**53**) object to Wegener's explanation of the pseudhelion as due to reflection from the horizontal basal planes of floating ice tablets; and point out that in their own observations the ice crystals had the spicular form whence it follows that the pseudhelion may be due also to reflection from horizontal prismatic faces.

Simpson (**54**) reports observations by himself in the Antarctic which seem to clearly demonstrate the presence in the atmosphere of liquid water at much lower temperatures than is generally supposed possible, and this leads him to doubt that ice spicules can cause the more intensive refraction phenomena of the colored coronas which are usually explained in part by their aid. Simpson points out in support of this view that the halos produced by cirrus are usually the very ones showing the most brilliant colors. He shows, however, by more careful investigation of the process, that the first assumption of a helter-skelter arrangement of the ice spicules would produce an impure mixture of colors which could not give more than a weak suggestion of color to the cloud. He points out that a quantity of spicules are always floating in a position that brings their longer axes horizontal which would produce an effect contradictory to our experience, that the halos are more brilliant above and below than they are on either side the luminary. On the other hand, if water drops are the refracting elements, then high cirrus are the most favorable prerequisites for the production of specially brilliant halos, in so far as the absence of various sized dust particles and of vortex motions is specially favorable to the wide-spread formation of very small drops of uniform diameter. Interesting as this question is for meteorology, we can not do more than mention Simpson's very interesting section devoted to iridescent clouds, which he also explains by the aid of refracting water droplets.

Unfortunately I have not space sufficient to properly notice Möbius's (**55**) very valuable work on the theory of the rainbow, based upon Kirchhoff's strict conception of the Huyghens-Fresnel principle. Filehne's (**56**) work on the apparent form of the heavens, using relative numbers obtained by Reimann's method for the apparent diameter of the sun between altitudes 0° and 55°, finds the sky to have the shape of a half-ellipsoid of rotation whose major axis is the diameter of the horizon and one-half minor axis is the distance to the zenith. The latter element is subject to slight corrections resulting from the depression of the horizon.

In conclusion comes a work by Charles-Gallisot. The phenomenon of twinkling is very important in estimating the order of brilliancy of the stars, therefore our author investigated scintillation photometrically, using an artificial light of different colors to determine the influence of brightness, duration of light emission, and the frequency of the individual flashes upon the observed brilliancy. He finds, from the work of various observers, that the effect of scintillation upon estimates of brilliancy, is to increase the intensity of the blue ray as compared with the red ray, directly as the photometric strength of the luminous body. He believes to have found the same to be true in the case of star-brilliancy observations, and that his preliminary results throw some light on G. Müller's (**57**) photometric investigations which showed that the increasing photoabsorption as stars approach the horizon affects the blue stars less than it does the red stars.

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