about 1:62, which is very close to Thiessen's value with the photometer pointed toward the full moon, the zenith distance of the latter being about 66°. According to Russell [47] the illumination of the moon in its first or last quarter is about one-tenth of the full-moon illumination.

From papers by Fabry [48] and Yntema [49] it appears that the total starlight of a hemisphere is somewhat in excess of 1,000 stars of the first magnitude, or about 1/250th of the brightness of the full moon.

From the above data Table 5 has been constructed.

TABLE 5.—*Relative illumination intensities.*

| Source of illumination. | Intensity. | Ratio to zenithal full moon. |
|---|---|---|
| | *Foot-candles.* | |
| Zenithal sun | 9,600.0 | 465,000.0 |
| Sky at sunset | 33.00 | 1,650.0 |
| Sky at end of civil twilight | 0.40 | 20.0 |
| Zenithal full moon | 0.02 | 1.0 |
| Quarter moon | 0.002 | 0.1 |
| Starlight | 0.00008 | 0.004 |

From Table 5 and figure 1 it appears that the twilight illumination exceeds the illumination from the zenithal full moon until the sun's center is about 8° 40′ below the horizon. As this is an illumination intensity of some interest, the time after sunset or before sunrise when the center of the sun will be 8° 40′ below the horizon is given in Table 6 for certain latitudes at the time of the equinoxes and the solstices.

TABLE 6.—*Time after sunset, or before sunrise, during which the twilight intensity exceeds zenithal full-moonlight.*

| Latitude. | Winter solstice. | Equinoxes. | Summer solstice. | Latitude. | Winter solstice. | Equinoxes. | Summer solstice. |
|---|---|---|---|---|---|---|---|
| ° | *H. m.* | *H. m.* | *H. m.* | ° | *H. m.* | *H. m.* | *H. m.* |
| 0 | 0 35 | 0 31 | 0 35 | 38 | 0 44 | 0 40 | 0 49 |
| 10 | 0 35 | 0 32 | 0 35 | 40 | 0 46 | 0 41 | 0 51 |
| 20 | 0 36 | 0 33 | 0 37 | 42 | 0 48 | 0 42 | 0 54 |
| 25 | 0 38 | 0 35 | 0 39 | 44 | 0 50 | 0 44 | 0 57 |
| 30 | 0 40 | 0 36 | 0 42 | 46 | 0 52 | 0 45 | 1 00 |
| 32 | 0 41 | 0 37 | 0 43 | 48 | 0 54 | 0 47 | 1 05 |
| 34 | 0 42 | 0 38 | 0 45 | 50 | 0 57 | 0 49 | 1 11 |
| 36 | 0 43 | 0 39 | 0 47 | | | | |

## SUMMARY.

1. A review of the literature indicates that from an early date *astronomical* twilight has been considered to end in the evening and begin in the morning when the true position of the sun's center is 18° below the horizon. At this time stars of the sixth magnitude are visible near the zenith, and generally there is no trace on the horizon of the twilight glow.

2. It also appears that *civil* twilight ends in the evening and begins in the morning when the true position of the sun's center is 6° below the horizon. At this time stars and planets of the first magnitude are just visible. In the evening the first purple light has just disappeared, and darkness compels the suspension of out-door work unless artificial lighting is provided. In the morning the first purple light is beginning to be visible, and the illumination is sufficient for the resumption of out-door occupations.

3. Some confusion has arisen in the computation of tables of the duration of both astronomical and civil twilight, due to the fact that in some instances the time of sunrise or sunset has been considered to be that instant when the *center* of the sun is on the true horizon; in others, when its center *appears* to be on the true horizon; and in still others when the *upper limb* of the sun appears to coincide with the true horizon. In the United States this latter is regarded as defining the time of sunrise and sunset.

4. In the tables here presented the duration of astronomical twilight is the interval between sunrise or sunset, according to this latter definition, and the instant the true position of the sun's center is 18° below the horizon. Likewise, the duration of civil twilight is the interval from sunrise or sunset to the instant the true position of the sun's center is 6° below the horizon.

5. At the instant of sunrise or sunset the illumination is about 1,650 times as intense as that from the zenithal full moon; at the end of civil twilight it is about 20 times as intense; with the sun 8° 40′ below the horizon it about equals zenithal full moon illumination; while at the end of astronomical twilight, in the absence of the moon, it is only about 0.004 as intense.

The above refer to average clear sky conditions. The twilight will be more intense in a dry climate than in a moist one, will be greatly reduced by smoke or haze, and may be almost completely obliterated by a dense cloud layer. On the other hand, the intensity may be increased by the presence of ice crystals in the atmosphere, especially if they are at a considerable elevation above the place of observation.

I wish to acknowledge my indebtedness to the editor, Dr. Cleveland Abbe, jr., for valuable assistance in reading many of the foreign books and papers consulted in the preparation of this paper, and to Prof. C. F. Talman for his criticism of the manuscript, and for bringing to my attention certain publications that had been overlooked.

## VON BEZOLD'S DESCRIPTION OF TWILIGHT.[1]

The oldest and best description of the phenomenon of twilight is that by von Bezold.[2] It is a summary of many observations of all phases of the phenomenon into a single picture, although not all phases usually appear with equal distinctness on any one day, and is based on the evening twilight of Central Europe.[3] It is here given literally, since nearly all systematic and theoretical concepts and investigations of twilight are based upon it.

As soon as the sun begins to approach the horizon on a cloudless [4] evening, the lowest part of the sky all about begins to assume a color in greater contrast to the higher parts of the sky than it has when the sun is higher in the heavens.

In the west—which may be defined once for all as that portion of the sky lying on the sun's side of the

[47] Op. cit., p. 117.

[48] *Fabry, Charles.* The intrinsic brightness of the starlit sky. Astrophysical journal, 1910, 31: 399.

[49] *Yntema, Lambertus.* On the brightness of the sky and the total amount of starlight. Groningen, 1909. 4° p. 37.

[1] Translated from *Pernter & Exner.* Meteorologische Optik, IV. Abschnitt. Wien, &c., 1910. Pp. 745–751, 754–755. By C. Abbe, jr.

[2] Poggendorff's Annalen, 1864, 123:240–276. Republished in full on pp. 1–30 of *von Bezold's* "Gesammelte Abhandlungen aus den Gebieten der Meteorologie und des Erdmagnetismus. . . ." Braunschweig, 1906. viii, 448 p. 4°.

[3] In von Bezold's "Gesammelte Abhandlungen", p. 2, he states this description to be based largely on 24 observations by himself at Munich from Oct. 20, 1863, to Apr. 15, 1864.

[4] "Cloudless" (wolkenfrei) as here used indicates only the absence of greater cloud masses, particularly in the western and eastern skies. Detached small clouds, particularly if located in the north and south, of course can not influence the general course of the phenomenon.—"Gesammelte Abhandlungen." p. 2, footnote 1.

sun's vertical, while the eastern sky lies on the opposite side—this color is at first an extremely transparent white which changes to yellow in the course of time. On the north and south it is at first a weak then a somewhat stronger and more opaque ocher-yellow, while in the east it gradually changes from a dirty ocher-yellow into a dull purple. Close to the horizon the coloring is everywhere duller, while at a somewhat greater altitude a clearer stratum is noticeable. The purple tones in the eastern sky approach gray ash colors at the horizon and gradually pass into the blue at higher levels, so that at sunset they are no longer recognizable at an altitude of 6° to 10° (depending on the state of the atmosphere). There often appears a brighter whitish to yellowish layer between the clear transparent blue of the sky and the opaque purple near the horizon.

As soon as the sun sinks below the horizon the ash-colored shadow of the earth rises in the eastern sky in the form of the *dark segment*, first described by De Mairan.[5] This dark segment now appears actually to shove itself up over the purple portion of the sky so that the latter becomes a visibly decreasing zone forming *the first eastern twilight arch* or the *first anti-twilight* (Gegendämmerung). Since the upper part of this bright zone executes little or no upward movement, it is displaced or covered sooner or later by the dark segment according as the latter has reached a lesser or greater height. As soon as this brighter zone no longer separates the dark segment from the already rather dark sky above it, the boundary of the segment is no longer observable; at its best the arch-like area corresponding to the segment is distinguished by its ashy tone from the higher portions of the sky. * * *

I have never been able to trace the dark segment higher than to an altitude of 12°, usually it disappeared from my sight when at but half that height.

As for the form of the dark segment, I think it is very well described by this name. Its boundary is an arc that probably approaches rather closely that of a great circle. The two limbs, however, which should touch the horizon are usually so blurred that I do not trust myself to decide whether they are 180° apart or not so much, though I am inclined to believe the latter to be nearer the truth.

The boundary of the dark segment is best determined near its summit, and even there it is not sharply defined except after it has risen 1° or 2° above the horizon and until a little while before it disappears entirely. Close to the horizon one usually observes a gray layer, probably due to haze, smoke, etc., and easily causing mistakes, so that often one thinks he sees the dark segment some time before sunset, which is of course quite impossible. Under the most favorable circumstances the boundary of the segment may indeed be determined to within 10 or 6 or perhaps even fewer minutes of arc. * * *

While these observations are being made on the eastern sky, the following phenomena are taking place in the west:

The bright whitish light, already mentioned above, spreads before sunset to a considerable altitude in the vicinity of the sun's vertical. This vertical expansion I noticed particularly on several occasions while the sun was still about 4° above the horizon; also, it seemed to me that at about this time the light had a touch of purple. In making observations of this point one must, of course, screen the eyes from the direct sunlight.

As the sun more closely approaches the horizon the whole western sky, from the horizon up to an altitude of 8° or 12°—depending on the condition of the atmosphere—takes on an increasingly pronounced yellow hue (Färbung) which often grades into a red or even brownish red close down to the horizon line. At the same time there remains above the sun a bright and extraordinarily transparent spot of [lesser] vertical but relatively great horizontal extent, which forms the boundary between the yellow portion and the blue sky, which latter to be sure is still bright to a considerable altitude. After the sun has actually set, the yellow grows deeper, often turning into orange, while the transparent spot increases its horizontal dimension and gradually changes to a bright zone called by Brandes the "twilight glow" (Dämmerungsschein). The portion of the sky above this zone darkens rapidly. Since the yellow wall of the evening sky later takes on also the form of a segment, and as the function representing the sinking of this segment is simply the continuation of that which holds for the "twilight glow" (Dämmerungsschein), I shall call this yellow portion the *first bright segment* and shall call its boundary the *first western twilight arch*.

While these phenomena are developing over the lower portion of the western sky, purple tones are developing at an altitude of about 25° above the [western] horizon. First, there appears against the already darker sky at the altitude mentioned, a bright spot that rapidly takes on a decided purple tone. This color most closely approaches that obtained by superposing the ends of two spectra; it might also be called rose-color and often has a dash of red. This bright spot broadens with extraordinary rapidity and often has the form of a circle which, by reason of the steady increase in its radius, literally seems to slip down behind the yellow segment. As the last purple tones die out of the eastern sky one certainly can clearly observe this phenomenon which I shall call *the first purple light* (erste Purpurlicht).[6] As the sun continues to sink this light greatly increases its intensity and reaches a maximum when the sun's depression amounts to between 3° 40′ and 4° 50′, according to my observations, depending on the condition of the atmosphere. At about this time buildings having a westward-facing wall which had appeared quite dim soon after sunset and shown no contrast between light and shade, now appear to be brightly flooded with rosy or flesh-colored tones, the analogue to the afterglow of mountain ranges. One can notice again fairly sharp shadows, and recognize architectural details that had completely disappeared just after sunset. This illumination is sufficient to enable one to recognize distinctly the development of the purple light, even when in narrow streets in the middle of the city where the western sky is not visible.[7] * * *

While it is very difficult to observe accurately the earlier stages in the development of the *purple light*, and further it proceeds quite differently on different days, nevertheless after that time when it approaches its maximum intensity the course is fairly regular. At that time, with a cloud-free (reinem) sky the light has an almost circular form with its center lying a little above the yellow segment, which appears to cover the lower portion of the circle. * * *

Above the bright segment, and on either side the purple light, appear two light blue-green areas. The greenish tinge there always present does not arise from contrast effects, as one may readily convince himself by screening out [other sources of light]. * * *

The center of the purple light now moves downward rapidly and its radius steadily increases; soon it has assumed the form of a semicircle whose center lies in

[5] *Mairan, J. J. D. de.* Traité physique et historique de l'aurore boréale. 2de éd. Paris, 1754. pp. 400–403. The original description is reprinted and translated on p. 623–4 of this issue of the REVIEW.

[6] Colored illustrations of the purple light and other twilight phenomena may be found in—

Annali, Uff. Cent. Met. Ital., ser. 2, v. 7. pt. 1, 1885.

*Kiesling, J.* Untersuchungen über Dämmerungserscheinungen zur Erklärung der nach dem Krakatau-Ausbruch beobachteten atmosphärisch-optischen Störung. Hamburg, &c. 1888. vi, 172 p. 4°. Notably Tafel 5.

*Heim, Albert.* Luft-Farben. Hofer & Co., Zürich, 1912. 93p. 19 col. illust. Particularly figs. 16, 17, 18, 21.—C. A., jr.

[7] As to the true photometric intensity of this illumination see Kimball's figure 1 and his remarks on p. 618.

the boundary of the bright segment; and finally this light becomes a narrow zone of very slight altitude, but of more significant linear extent. The bright [yellow] segment is then bounded sharply by this zone, which is properly so called from this time on. This boundary is *the first western twilight arch*.

At about the time when the first purple light contracts to that narrow zone, and is soon to disappear altogether, there occurs that strikingly rapid decrease in the general daylight which is regarded as *the end of civil twilight*. At this time the sun's depression is about 6°. * * *

The [purple light] often embraces long dark-blue, even greenish, stripes [crepuscular rays] converging toward the sun. These stripes, mentioned already by Howard, are really the shadows of clouds below or close to the horizon as he supposed, which is best shown by the fact that one often has the opportunity to observe the clouds causing them, as well as the the shadows from the clouds. On perfectly cloudless days, when these stripes always develop quite late, they may well be due to terrestrial objects. These stripes are of interest, because as soon as they appear the contrast permits one to observe that the purple tones extend much higher than otherwise they would appear to do. If these stripes do not appear until the purple light has sunk far down, and this is usually the case, then one sees it again suddenly in portions of the sky whence one believed it to have long since disappeared. Thus it appears, in such cases, that the purple light is really still present behind the yellow bright segment; in other words, that the purple light owes its development to higher atmospheric strata than does the bright segment. Under these conditions the boundary of the latter is scarcely recognizable. When the purple light has wholly disappeared the two light blue-green wedge-shaped areas, spoken of above, still remain long visible, probably the most striking proof that here we have not a case of subjective deception. * * *

As soon as the purple light has disappeared, and if there are no shadow stripes present, the altitude of the bright segment may be determined with some accuracy, perhaps to within 10 or 15 minutes of arc. According to my measurements the sinking of the segment keeps rather close step with that of the sun, so that if $-\omega$ is the sun's altitude or $\omega$ its depression, $\theta$ the altitude of the summit of the bright segment we have the equation

$$\omega+\theta=\gamma,$$

where $\gamma$ is a constant whose value differs on different days and, according to my observations, varies between 8° and 12°. This empirical formula may be extended to the first portion of twilight when only the twilight glow forms the, to be sure, poorly defined boundary of the bright segment.

If now, one turns his attention again to the eastern sky, the latter is found to have a slight general coloration, or at least to be illuminated, and he will also probably discover traces of *a second dark segment* which rises from the horizon about the time when the purple light has completely disappeared or has contracted to the above described hazy stratum.

This second coloring is often scarcely sufficient to permit of its presence being certainly determined, and during my observations it was never intense enough to permit any accurate measurement of the altitude of the second dark segment. Clouds observed in this second illumination of the eastern sky seemed to me to shade off rather more gradually as though overtaken by the edge of a shadow. The second dark segment disappears again, though at a somewhat greater altitude above the horizon, just as did the first [dark segment].

In the western sky, however, there is preparing a repetition of the phenomena already observed. Thus, while the first twilight arch is descending—in accord with the law stated—there is gradually developing at an altitude but little lower than that where the first twilight arch appeared, a second but less brilliant phenomenon of the same kind. The first twilight arch gradually loses its dull-purple boundary, without decreasing in sharpness, however, and above it there appears a somewhat dull greenish-yellow layer against the upper part of which there stands out a brighter zone—the *second twilight glow* or *second western twilight arch*, which is the boundary of the *second bright segment*. On a number of occasions I have observed both arches showing most distinctly one above the other.

Above this arch there develops, under favorable conditions, a *second purple light*, perhaps at a somewhat lesser altitude than did the first but with quite the same sequence of changes, although its color is more in the yellow-red. Sometimes I have seen this second purple light quite intense, e. g., on November 18, 1863 [at Munich], when it was stronger than the first light often is. A number of times the second light was fairly decided, but on most days I did not see it at all.

The time of maximum intensity can be determined but imperfectly, because of the greatly decreased sharpness of the phenomenon; however in the four cases when such a determination was made the result was remarkable. On each occasion the sun's depression at the time of the maximum of the second purple light was almost 2.2 times as great as that corresponding to the maximum of the first purple light, although the latter depression had very divergent values on the four days.

Finally, the second purple light also disappears in a manner analogous to that of the first, sinking down behind the second bright segment which is now the only remaining illuminated portion of the sky and whose disappearance marks *the end of astronomical twilight*. * * *

It was not until my later series of observations that I became aware of the fact that from the instant when the sun stands about 7° below the horizon onward, the portion of the sky which still receives any light at all from the sun is fairly well distinguished from the already perfect night sky of the east. This latter is probably the continuation of that same first dark segment which earlier had disappeared from our sight and now reappears after it has already passed to about 30° west of the zenith. At this time it embraces more than half the horizon and rapidly sinks like a black veil until it merges with the second western twilight arch, the latter meanwhile holding undisturbed to its own downward course. * * *

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Concerning this account by von Bezold, Exner goes on to say [8] that this is the first detailed description of the normal twilight, although it had been observed and discussed from a much earlier date. Von Bezold has sharpened the concepts of the individual phases or phenomena and gave them the names which we shall employ in the senses already indicated. * * *

Accurate determinations of the colors observed rarely have been made, only a very few spectroscopic measurements exist. * * *

Before describing in more detail the position of the phenomena in the sky and their time of occurrence with reference to the sun's position, we shall summarize the individual phases chronologically, following von Bezold's system.[9]

(*a*) *First anti-twilight or Gegendämmerung.*[10]—This is seen in the eastern sky at sunset and in the western sky at sunrise, the sun being close to and either above or below the horizon. We shall use the term also for [the western phenomenon] at dawn although the anti-twilight thus defined is the second chronologically. Here and elsewhere we would apply the designation "*first*" to the

[8] *Pernter & Exner.* Meteorologische Optik, pp. 751, 754.

[9] A recent classification of the successive "twilights" is put forward by Prof. *F. R. Paul Gruner* of Bern who recognizes four main twilights, viz, Diurnal, Civil, Astronomical, and Nocturnal. He also gives useful hints for those wishing to contribute further observations on this little-studied subject. (*See* Nouvelles remarques concernant les lueurs crépusculaires du ciel, *in* Arch. d. sci. phys. et nat., Genève, 1916, 4me pér., t. 42, p. 32-46.)—C. A. jr.

[10] The term includes the eastern twilight arch (at sunset; western, at sunrise) and the dark segment. It would be less confusing if we followed Mairan by calling the twilight arch opposite the sun the anticrepuscular or anti-twilight arch.—C. A. jr.

principal phenomenon as being more frequently and more readily observed than is the "*second.*"

(*b*) *Twilight glow or Dämmerungsschein.*—The same remarks apply to the twilight glow which lies above the sun's position. As soon as the sun is several degrees below the horizon, however, the glow is no longer (or not yet) visible.

(*c*) *First twilight arch.*—The first twilight arch, the boundary of the first bright segment, lies in the west in the evening, in the east in the morning. It is visible when the sun stands below the horizon.

(*d*) *First purple light.*—The first purple light appears over the first twilight arch, in the evening it appears almost immediately after the disappearance of the first Gegendämmerung, while in the morning the reverse order occurs.

*Civil twilight* ends, in the evening, at the setting of the first purple light, and begins in the morning at the rise of the same.

*First twilight* is the name frequently applied to all the above phenomena from (*a*) to (*d*) collectively; in distinction to these is the series which follows under (*e*) to (*g*), known collectively as the *second twilight.*

(*e*) *Second anti-twilight or Gegendämmerung.*[11]—The second anti-twilight begins, in the evening, in the eastern sky about the end of civil twilight; conversely in the morning it ends in the west at the beginning of civil twilight.

(*f*) *Second twilight arch.*—This arch, which forms the boundary of the second bright segment, appears in the evening after the setting of the purple light. In its initial stage it is simultaneously visible in the western sky with the first arch; the inverse condition occur in the morning.

(*g*) *The second purple light.*—The second purple light appears above the second twilight arch. In the evening it sinks behind, and in the morning it rises from behind that arch.

*Astronomical twilight* ends with the setting of the second twilight arch; in the morning this twilight begins with the rising of that arch.

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### MAIRAN'S DESCRIPTION OF ANTI-TWILIGHT.

Elsewhere in this issue reference is made [1] to the first published description of twilight phenomena where the dark segment and the first anti-twilight arch—as observed in the east on a good day soon after sunset—are given their present names. This description was by Mairan, who published it in a somewhat inaccessible work [2] that happens to be in the Weather Bureau library. It also contains a reference to what is perhaps the earliest printed mention of the phenomena.

We reprint the French passages with a translation; our French version follows the original closely, except in capitalization and in the use of the sign "&". A marginal reference in the original is here given as a footnote, and * * * indicate omissions of passages not bearing on the description proper.—C. A. jr.

XII^me^ ÉCLAIRCISSEMENT.

*Sur l'Anticrépuscule.*

Qu'il me soit permis, pour abréger, de nommer ainsi un phénomène qui ne manque presque jamais de paroître dans les jours sereins avec le crépuscule, et qui lui est opposé, non seulement par le lieu du ciel qu'il occupe, mais encore par le renversement de sa partie lumineuse, d'autant moins vive qu'elle est plus prés de l'horizon.

Il ne faut que regarder le ciel un peu avant le lever du soleil, ou quelques minutes après son coucher, pour reconnoître le phénomène ou le météore dont il s'agit. Il est très-visible, et vrai-semblablement aussi ancien que le monde; et il y a tout lieu de s'étonner, qu'il n'en soit pas parlé davantage dans les livres de physique ou d'astronomie, tant anciens que modernes. Je n'en connois qu'un où il en soit fait mention expresse, et qui fut imprimé à Ulm en 1716, ayant pour titre *des Couleurs du Ciel.*[3] M. Cramer, qui avait très-bien remarque l'anticrépuscule, et qui avoit même fait quelques recherches d'optique sur ce météore, s'étonnoit comme moi du silence des auteurs à cet égard. Il m'en écrivit il y a plusieurs années, et je lui communiquai ce que j'en savois, avec la note du livre de Funccius. D'autres occupations l'empêchèrent sans doute de pousser plus loin se recherches, ou de les publier. Heureux, si je pouvois encore consulter sur ce sujet, comme sur toute autre matière, un ami si fidèle, si sage si éclairé, et dont je regretterai éternellement la perte. * * *

On remarquera donc le soir d'un beau jour, au coucher du soleil, par exemple, ou quelques minutes après, à la partie opposée du ciel et immédiatement sur l'horizon, une espèce de bande ou de *Segment obscur,* bleuâtre et pourpré, surmonté d'un *arc lumineux* et coloré, blanche-âtre, orangé, et enfin couleur de rose à son bord supérieur, tirant quelquefois sur le couleur de feu. Car ces couleurs, ou plûtôt ces nuances des couleurs vraies n'y sont jamais ni bien tranchées ni bien décidées. Ce n'est aussi que par des circonstances plus ou moins favorables, selon que l'air est plus ou moins dégagé de vapeurs, d'exhalaisons et de nuages, que l'anticrépuscule d'un jour, ou d'un climat, differe de celui d'un autre. Du reste, rien n'est plus uniformément constant que ce phénomène, qui est purement optique, et en cela bien différent de l'aurore boréale, dont le sujet est physique, mais variable et accidentel. * * *

Cependent le soleil s'enfonce encore sous l'horizon, le crépuscule s'abaisse, et l'anticrépuscule s'élève d'autant; les rayons du soleil qui alloient frapper la voûte au zénit ou près du zénit n'y parviennent plus, ils se réfléchissent sur des points plus proches du soleil, et l'anticrépuscule s'élève encore; son arc lumineux et coloré se détache du segment bleuâtre et pourpré, qui ne demeure bien-tôt que gris ou cendré, il mont toûjours et parvient enfin jusqu'au zénit, où il est encore sensible lorque l'air y est pur; car après être monté jusqu'à une certaine hauteur, il s'affoiblit de plus en plus, et disparoît enfin totalement. J'ai observé l'anticrépuscule une infinité de fois dans les parties les plus méridionales de la France, à Paris et aux environs.

La bande bleuâtre et pourprée de l'horizon ne demeure plus que grise et cendrée, lorsque l'arc anticrépusculaire [5] s'en est détaché, parce que les rayons rouges du soleil et de la partie la plus brillante du crépuscule ne s'y réfléchissent plus. * * *

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[Translation.]

*On the anti-twilight or anticrepuscule.*

Permit me, for the sake of brevity, to thus name a phenomenon that almost never fails to appear on fine days (jours sereins) at twilight, and which is opposite to this latter not only as to location in the sky but also

[11] This term includes the second eastern twilight arch (at sunset; western at sunrise) and the second dark segment.—C. A. jr.

[1] Von Bezold's description of twilight, p. 621.

[2] *Mairan, [Jean Jacques Dortous] de.* Traité physique et historique de l'aurore boréale. Seconde édition, Revûe, & augmentée de plusieurs éclaircissemens. Paris, Imprimerie royale, (1754). (Suite des Mémoires de l'Académie Royale des Sciences, Année M.DCCXXXI.) [xii], 570, xxi p. 17 pl. 25½ cm. pp. 400-403.

[3] *Funccius, Joh. Casp.* De coloribus cœli. Ulm, 1716. Sect. IV, §xxx.