

and  $-7\frac{1}{2}^\circ$ , my eyes being perfectly healthy. If a curve be constructed from the formula, the values of  $\alpha$  being taken as abscissas and those of  $D$  as ordinates, for parallelism of visual lines we have  $\alpha = 0$ ,  $D = \infty$ , and the axis of ordinates is hence an asymptote. A vanishing point should therefore be reached by the external binocular image. Its apparent distance, however, is still finite, and vision very easy. In passing to negative values of  $\alpha$  by increasing the stereographic interval, the distance estimated continues to grow in a positive direction. This is undoubtedly due to the sense of increasing relaxation of the internal rectus muscles and contraction of the external rectus; but the rate of growth bears no recognizable relation to any succession of values given by the formula.

The explanation just given is based upon experiments, the description and discussion of which must be withheld for the present. It may be simply stated that with binocular fusion of images from the same pair of conjugate pictures, I have tested the visual effect of varying the optic angle from  $-5^\circ$  to  $+45^\circ$ , vision becoming indistinct after the last named limit is passed. The value of the optic angle has been found to be largely, but by no means exclusively, effective in determining apparent distance in the stereoscope, especially for convergence of visual axes. Its effect is antagonized by the difficulty of focal adjustment and by the constancy of the visual angle, the latter element being particularly important when the axes diverge.

The variation in apparent magnitude of the combined image, dependent upon the value of the optic angle, has been noticed by Wheatstone<sup>(12)</sup>, Helmholtz<sup>(13)</sup>, and Meyer<sup>(14)</sup>. Helmholtz constructed his telestereoscope<sup>(15)</sup> for producing exaggeration of perspective when distant objects are viewed, but no reference is made, in this connection, to divergence of visual lines. The possibility of fusion by optic divergence seems to have been first noticed about 1860, by Burckhardt<sup>(16)</sup>; and Helmholtz notices the exaggeration of apparent distance thus produced, but explains it by saying<sup>(13)</sup>, "Infinity does not, in our visual conceptions, present an impassable limit. When our eyes occupy a position which is never presented in the normal observation of real objects, all that we can do, conforming ourselves to the rule which we ordinarily follow for the interpretation of abnormal sensations, is to compare the sensation produced with that which resembles it most, and which is distinguished from it only by more feeble convergence, that is, with what is given us by real objects very remote." Vision in the stereoscope is always to some extent abnormal. The error into which Brewster fell, and in which he has been generally followed, was in supposing that under such conditions no modifications would be imposed upon the mathematical law found applicable to normal vision, in which there is perfect coincidence between the impressions traceable to the optic angle, focal adjustment, and visual angle respectively.

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THE German government is considering the participation of German men of science in the plan of International Polar Research. The Reichstag has been asked to grant the necessary funds \$75,000.

#### REFERENCES.

- (8). "Science," Nov. 19th, 1881, and American Journal of Science for Nov., 1881.
- (9). Helmholtz, Opt. Phys., p. 878, *et passim*: or, Le Conte, Sight, pp. 90-144. Appleton, 1881.
- (10). Hering, Beiträge zur Physiologie, pp. 35-64, 1861; or, Le Conte, Sight, pp. 213-261, 1881.
- (11). Helmholtz, Opt. Phys., pp. 935-937, 873-877, 961-964.
- (12). Phil. Mag., 1852, p. 507.
- (13). Opt. Phys., pp. 823-828.
- (14). Pogg. Ann., lxxxv., p. 198.
- (15). Opt. Phys., p. 821.
- (16). Verhandl. d. Naturforsch. Ges. zu Basel, I, 145; or, Opt. Phys., p. 827.

#### FOREIGN NOTES ON THE SOURCE OF COMETS' LIGHT.

Numerous observations have been made abroad upon comet *b*, 1881, to settle the question as to the origin of the light of these bodies. Messrs. Thury and Mayer at Geneva compared the brightness of the comet's head, as ascertained by photometric measurements, with the brightness it would have had if its light had been derived solely from the sun, by reflection. It was found that the intensity of the light of the nucleus, as it withdrew from the sun, diminished at first faster, and after a time slower than would have been the case, had it shone solely by reflected light. The decrease in intensity took place, in fact, as if the nucleus, during its approach to perihelion, had acquired through the force of the sun's rays an intrinsic light, which accompanied violent action of some character; this violent action ceasing after the comet had measured some distance on its return track, its light decreased speedily in conformity therewith, but the nucleus continued to glow as if in a state of incandescence, and remained visible, according to the above observers, longer than could have been expected.

This method seems to be well adapted to an independent determination of this interesting question. In the data it is a question, not of absolute, but of relative quantities. Ignorance of the physical condition and nature of a comet's reflecting surface renders it impossible to compute the intensity of its light under reflection alone, with any degree of certainty. As not the absolute light, however, but the increase or decrease under the circumstances, is required, the necessity for such knowledge is eliminated.

Another conclusion as to the origin of the comet's light has been reached by Respighi, from spectroscopic evidence. According to him there is no doubt that the light in part is reflected, as is proved by the appearance of the Fraunhofer lines in the photographs of the comet's spectrum. As to the bright lines or bands, they also may be caused by reflected light, as will be seen when it is taken into consideration what changes this light must have undergone after it has passed through the gases and vapors which form the whole mass of the comet. "It is certain," he continues, "that the largest part of the light emitted by the comet comes from its interior, and that it has passed through thick strata of gases and vapors. It is there subject to the selective absorption which is peculiar to these vapors and their combinations. It is accordingly natural that dark lines and bands should thence arise, which are different from the Fraunhofer lines; and with the weak, but complete, spectrum of the light that is reflected from the exterior substance of the comet, another spectrum must appear, which is considerably modified through powerful absorption."

"The limits of a simple notice do not permit me to enter in detail into my numerous spectroscopic observations of the Comet *b*, 1881. But I can affirm that it does not require the supposition of an intrinsic light to explain the phenomena which they exhibit. For the discontinuity of the spectrum might arise from the same cause as the broad, dark bands in the spectrum of the sun near the horizon, or in those of the planets. In the case of comets, however, the phenomenon is greatly exaggerated by the immense thickness of the absorbing strata, the rich character of their chemical constitution and the weakness of the light which they reflect to us. One must therefore proceed as in the case of the spectrum of our atmosphere, and not consider so much the bright bands as those dark through absorption."

A COMMITTEE has been formed at Reggio, (Emilia) to collect funds for establishing a fitting monument to the memory of the Padre Secchi, in the form of a fine refractor, of which the objective is to have 70 centimetres diameter. Reggio thus follows the example of Arcetri, where a fitting scientific monument has been erected to the memory of Galileo.