have to trust an imperfect memory or else search laboriously through original memoirs.

Leeds, August 2. NORMAN R. CAMPBELL.

### Perseid Meteoric Shower, 1910.

THE only night really good for witnessing the Perseid shower near its maximum this year was August 10, when the clear state of the sky afforded every facility for securing observations.

I began watching at 9h. p.m., and up to 11h. 45m. p.m. there were fifty-two meteors, so that the horary rate was nearly twenty, of which about three-fourths were Perseids. The finest specimen appeared at 10h. 6m.; it had a long and slowish flight from 328°+37° to 301°+8°, and left a bright streak just above the small stars of Delphinus for fifteen seconds. The meteor itself was much more luminous than Venus, and was also observed by Mr. T. K. Jenkins at Nantyglo. From a comparison of the recorded paths, I find the height 75 to 48 miles over Wiltshire, and the end point near Blandford, Dorset.

The velocity was decidedly slower than that of the ordinary Perseid, its observed speed being 27 miles per second.

I saw brilliant Perseids also at 11.34 and 11.46, the former shortening towards α Andromedæ and the latter just under Polaris, and at 11.34½ there was a beautiful slow-moving Draconid falling from 303½°+33° to 311°+19½°. Its pear-shaped nucleus threw off a tail of yellow sparks as it sailed down the sky.

I think the display of August 10 was better than it was last year, and gave promise of a pretty abundant shower on August 11 and 12, but I cannot speak as to its actual character, the firmament being cloudy on those dates at Bristol.

There were a few breaks in the clouds on August 12, and I happened to notice a fine meteor at 11h. 49m. shooting upwards from 355°+40° to 338½°+50°. It was as bright as Jupiter at least, and left a train, but it quickly disappeared. The meteor was not a Perseid, but apparently belonged to a shower with radiant lying eastwards of α Andromedæ, or at 9°+27°. The meteor was also seen by Mr. G. Powell at Aberdare, and I find its height 89 to 53 miles. It was nearly over Bath at end point. Velocity 40 miles per second, and certainly more rapid than the Perseid alluded to above, though it should have been the swifter of the pair.

Several observers have written me describing the Perseid shower as fairly rich on August 10, though the maximum was not due until the morning of, or night following, August 12. Some large meteors were also recorded on August 5, which was a very clear night, and the Perseid display was in pretty strong evidence even at that early date.

W. F. DENNING.

### Brilliant Meteor of July 31.

AN exceedingly beautiful meteor, one of the finest I have seen, was observed from this vessel, while at sea, on the night of July 31. The time of observation was 10h. 0m. ship's apparent time, or 13h. 0m. G.M.T., the position of the ship at the time of observation being latitude 43·34° N., longitude 43·37 W. The duration of the flight was between fifteen and twenty seconds, and the meteor was much more brilliant than Venus. It pursued an almost horizontal course, about 8° above the horizon, passing below the constellations Ursa Major, Perseus, and Aries, in all traversing an arc of about 135°.

At first the meteor appeared as a brilliant steel-blue ball, with a short tail of the same colour. It disappeared at a point about 90° from its first position, reappearing almost immediately, and exploding and dividing into three or four parts, with a luminous tail some 3° in length, and of a vivid red and blue colour. Its motion was slow, and it conveyed to all who witnessed it, officers and passengers alike, the impression of being at no great distance from the ship when it exploded.

The night was very fine; and the chief officer, who was on the bridge at the time, reports that when it disappeared it left a small black cloud in the sky. At the time of seeing this meteor we were in wireless communication with the U.S.N. *Texas*, and it is hoped that other observations may be forthcoming from other vessels at sea. A. L. CORTIE.

On Board S.S. *Cymric*, August 3.

## *ON COLOUR VISION AT THE ENDS OF THE SPECTRUM.*

IT is half a century since Maxwell[1] investigated the chromatic relations of the spectral colours and exhibited the results on Newton's diagram. The curve "forms two sides of a triangle with doubtful fragments of the third side. Now, if three colours in Newton's diagram lie in a straight line, the middle one is a compound of the two others. Hence all the colours of the spectrum may be compounded of those which lie at the angles of this triangle. These correspond to the following—scarlet, wave-length (in Fraunhofer's measure), 2328; green, wave-length, 1914; blue, wave-length, 1717. All the other colours of the spectrum may be produced by combinations of these; and since all natural colours are compounded of the colours of the spectrum, they may be compounded of these three primary colours. I [Maxwell] have strong reason to believe that these are the three primary colours corresponding to three modes of sensation in the organ of vision, on which the whole system of colour, as seen by the normal eye, depends."

Later observations, such as those of König and Dieterici,[2] have in the main confirmed Maxwell's conclusions. The green corner is indeed more rounded off than he supposed. It is with regard to the "doubtful fragments of the third side" that I have something to say. According to Maxwell's results with both of his observers the extreme red deviates from the less extreme by a tendency towards blue. Neither my friends[3] nor I can perceive anything of this. When the extreme and the less extreme red are seen in juxtaposition in the colour-box, no difference whatever can be perceived after the brightnesses are adjusted to equality. I have not any precise measurements of wave-length, but the extreme red passed a cobalt glass while the less extreme was stopped. Observations at the ends of the spectrum are more difficult than elsewhere. Owing to deficiency of illumination at these parts there is more danger of false light finding access. To get satisfactory results I found it desirable to supplement the action of the prisms by placing red glass over the slits. It is probable that Maxwell was misled by some defect of this sort, since the differences he found would appear to lie outside the errors of observation. The German observers, it should be added, also found the colour constant at the red end.

At the other extreme the tendency of the violet towards red is, to my vision, not in the least doubtful. Some remarks made a few years ago by Dr. Burch, who speaks of violet in terms which I could not possibly use, were the occasion of a more particular examination. Although, so far as I remembered, I had never made the trial, I was confident that I should be able to match violet approximately with blue *plus* red, and full blue with violet *plus* green. And it seemed further that this must be the general estimation, as there is no widely spread protest against describing the upper extreme of the spectrum as "violet"—a name which would be quite inappropriate in the absence of an approach towards red.

[1] Phil. Trans., 1860.
[2] Helmholtz, "Phys. Optik," 2nd edition, p. 340.
[3] Mr. Gerald Balfour included.

The light which the flower of that name sends to the eye undoubtedly includes red rays.

The apparatus employed is on the model of the first described in an early paper,[1] the only difference worth mentioning being that the side upon which the movable slits are disposed is made oblique, to meet the variation in focal length along the spectrum. By this means any desired mixture of spectrum colours can be exhibited in juxtaposition with any other. For example, the violet can be shown alongside the blue, and any addition can be made to either. A few trials in 1907 confirmed my anticipations, an approximate match being easily attained by addition of *red* to the blue or of *green* to the violet. The slits by which the light entered were protected with suitable coloured glasses, cobalt glass being used for the blue and violet slits. In this way, as already mentioned, the danger of false light is obviated. I do not affirm that the mixture of blue and red looked *exactly* the same as the violet. I thought that I could recognise the violet as being more saturated, but the difference, if real, was very small and certainly a mere fraction of the original difference between blue and violet. Needless to say, the blue chosen was a full blue, showing no approximation to green.

The point of greatest interest lies in the contrast between my observations and those of Mr. Gerald Balfour, who was with me at the time. Mr. G. Balfour is one of the three brothers whom I found in 1881 (*loc. cit.*) to make anomalous matches of mixtures of red and green with spectrum yellow. To effect the match they use much smaller amounts of red than is required by normal eyes. But their colour vision is as acute as usual, and the abnormality is quite distinct from what is called colour-blindness. To Mr. Balfour's vision the violet of the spectrum is *not* redder than the blue, and such addition of red to blue as I required to make the match gave, in his estimation, a "reddish purple." Curiously enough, Mr. Enock, who was my assistant at that time, bore similar testimony, no addition of red on either side improving the match, which was indeed nearly complete as it stood. It is probably not a coincidence that Mr. Enock is also abnormal in his red *plus* green=yellow match, coming perhaps about half-way between myself and the Balfours.

When a few months ago I commenced to write out an account of these observations, it occurred to me that it would sound strange if I described my own judgments as normal and those of two other male observers as abnormal, and I sought to confirm my own judgment by that of others, especially of women. As to this, there was no difficulty. I usually showed first the simple blue and violet with about equal illumination[2] and asked the observer to describe them. In nearly every case the names blue and violet were correctly given. Can you describe one as redder than the other? was the next question. In most cases the answer came, "the violet is the redder"; but in some others all I could get at this stage was a negative. When, however, the same addition of red light that I require was made to the blue, every female observer that I have tried agreed that now the difference had practically disappeared. I can say with confidence that in this matter my own vision is normal.

Lately I have had another opportunity of repeating the observation with Mr. G. Balfour. It is certain that he sees no colour difference at all between the blue and violet. When to the blue an addition of red (less than I require for a match) is made, he describes the mixture as a reddish-purple, strongly distinguished from the violet. Mr. A. J. Balfour also could see no difference between the blue and violet, but he seemed rather less sensitive to additions of red. A determination of wave-lengths gave for the (mean) violet 415 (above G), and for the blue 440. The red was rather extreme.

That ordinary normal vision is very approximately trichromic cannot be doubted; but a question may be raised as to the possible existence of a very subordinate fourth element of colour. Thus Dr. Burch's descriptions might suggest that in his vision the sensation of violet depended upon such a fourth element. I am speaking here of fundamental sensations, not of such judgments as make yellow appear a distinct sensation to normal eyes, although certainly resolvable into red and green. The only way to get a final answer to such questions is by making matches with superposed colours; but to this method some workers seem singularly averse. In my own case I am certain that there is no fourth element of colour practically operative.

The character of the three primary sensations in normal vision is another and a much more difficult question. Perhaps in recent years we have rather lost sight of the argument which weighed with Maxwell in the passage above quoted. The better to see its significance, let us suppose that the spectrum is *accurately* represented on Newton's diagram by two sides of a triangle, and inquire into the significance of this disposition. The only explanation which does not involve highly improbable coincidences seems to be that in each spectrum colour only two of the three elements are involved. If the third is involved at all, how comes it to be involved in such a way as to make the spectrum straight? And the fact that near the red end variation of wave-length entails no variation of colour, makes in the same direction. That the green corner is rounded off and that (if it be so) the sides are not quite straight, may diminish, but cannot destroy, the cogency of the argument, while the less precise character of the conclusion is not without advantages.

RAYLEIGH.

[1] NATURE, vol. xxv., p. 64, 1881; Sci. Papers, i., p. 544.

[2] This adjustment can be made by partially cutting off the light on the side required by means of strips of glass interposed. By varying the number (up to 5 or 6) or inclination, the proportion of light transmitted can be regulated. This procedure was found more convenient than altering the widths of the slits.

## MORE ANTARCTIC NATURAL HISTORY.[1]

(1) THE fifth, probably the penultimate, volume of the natural history results of the voyage of the s.s. *Discovery* has followed its predecessors without loss of time, and it resembles them in quality and interest, reflecting great credit on all concerned. The first memoir, by Dr. H. W. Marett Tims, deals with the embryos of Weddell's seal. The author finds in the musculature some additional support for Mivart's suggestion of a lutrine origin for the Phocidæ, and he has discovered in a very early embryo what seems to be the vanishing point of a vestigial external ear. Prof. Herdman deals like an old hand with the small but interesting collection of tunicates, comprising twenty-two species, of which ten are new to science. None of them are very remarkable forms in any way, but they confirm the impression which other collections

[1] (1) National Antarctic Expedition, 1901–4. Natural History, vol. v. Zoology and Botany. (London: British Museum [N.H.], 1910.) Price 30s.

(2) British Antarctic Expedition, 1907–9, under the command of Sir E. H. Shackleton, C.V.O. Reports on the Scientific Investigations. Vol. i., Biology, parts i.–iv. Pp. 1–79, 13 pls., 3 figs. (London: Published for the Expedition by W. Heinemann, 1910.) Price 12*s*. 6*d*. net.

(3) Expédition Antarctique Belge. Résultats du Voyage du *S.Y. Belgica* en 1897–8–9. Sous le Commandement de A. de Gerlache de Gomery. Rapports scientifiques. Botanique—Diatomées. By H. Van Heurck. Pp. 128+13 plates (1909). Geologie—Petrographische Untersuchung der Gesteinsproben, 1 Theil. By A. Pelikan. Quelques Plantes Fossiles des Terres Magellaniques. By Professor A. Gilkinet. Pp. 50+2 pls. +6 (1909). Oceanographie—Les Glaces—Glace de Mer et Banquises. By H. Arctowski. Pp. 55+7 pls. (1908). *Zoologie*—Schizopoda and Cumacea. By H. J. Hansen. Pp. 20+3 pls. (1908). (Anvers: J. E. Buschmann.)