at Perivale, higher up the river, which, 25 years ago, set an example that has been widely followed of preserving for urban districts the interesting birds of the countryside. It will not be necessary for the Selborne Society to take over the mansion, but if funds allow, as this has been fitted up as a hospital by the government, two good things might be done at once, for it could most appropriately be placed at the disposal of some charitable organization, or it could be used as the beginning of a folk museum, which ought to be inaugurated in this country before it is too late. The property was advertised as for sale by auction in building plots a few days ago, but some members of the Selborne Society have, for the moment, saved it from this fate. Donations can, therefore, now be invited towards its purchase and maintenance, which should be sent to the treasurer, Sir John Otter, at the Hermitage, Hanwell, W.7."

UNIVERSITY AND EDUCATIONAL NOTES

NORTHWESTERN UNIVERSITY, which has announced plans for extensive improvement of its downtown campus, is preparing to add to its Evanston, Ill., campus a $750,000 union building.

DR. FRANK VINSONHALER, professor of ophthalmology at the school of medicine of the University of Arkansas, has been made dean of the school.

H. W. VAUGHAN, professor and animal husbandman in charge of beef cattle investigations in the University of Minnesota, has been appointed head of the animal husbandry department at the University of Montana.

JOHN LESLIE HUNDLEY, of the University of North Dakota, has been appointed assistant professor of physics at Tulane University.

E. D. COON has returned to the University of North Dakota as assistant professor of chemistry, after having spent a year's leave of absence at the University of Wisconsin, working under the direction of Professor E. O. Kraemer in colloid chemistry.

IT is stated in *Popular Astronomy* that Harry H. Plaskett, of the Dominion Astrophysical Observatory at Victoria, B. C., has been appointed lecturer in astrophysics in Harvard University, beginning February, 1928. A leave of absence for one year has been granted Mr. Plaskett by the Canadian government.

DR. OTTO STRUVE, of the Yerkes Observatory, University of Chicago, has been promoted to an assistant professorship of astronomy.

DR. D. S. VILLARS, who spent the past year at Göttingen in the laboratory of J. Franck, has been appointed associate in chemistry at the University of Illinois.

THE title of professor of chemistry in the University of London has been conferred on Dr. J. F. Spencer, in respect of the position held by him at Bedford College.

SIR EDWARD FARQUHAR BUZZARD has been appointed Regius professor of medicine in the University of Oxford from January 1, 1928, in the room of Sir Archibald Garrod, who has resigned.

DISCUSSION AND CORRESPONDENCE

THE PHYSICIST AND THE FACTS OF COLOR

THERE is probably not a single physicist who has gone so far in the analysis of his color-sensations as to know that the violet, which plays such an important rôle in his list of colors, is not a unitary color at all, but plainly a "dual color blend" of some red and more blue. It can be got not only by a certain homogeneous light-frequency, but also by a physical mixture of some red light and more blue light. It no more deserves a separate enumerating than do the other dual color blends, *viz.*, the blue-greens, the yellow-greens, the reddish-yellows and the bluish-reds (what we also call the purples). In Figure 1 is

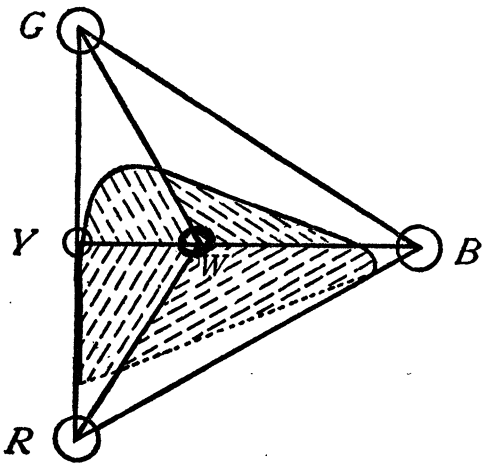

FIG. 1. The *quadrigeminal* color area—*triangular* in shape.

illustrated at once the two fundamental facts of color-vision: (1) the Young-Helmholtz fact that vision consists in a tri-receptor initial process (it is sufficient to put into your color-mixing-apparatus three fundamental light-frequencies—those which look to us red, green and blue); and (2) the Hering fact that vision (when it comes to sensation) is nevertheless tetrachromatic—there are four chromatic sensations—Yellow is just as good, just as striking and just as unitary a sensation as are Red and Green and Blue. (I write these names with capitals when the colors which

I refer to are unitary.) Figure 1 and Figure 2 are two different ways of representing diagrammatically the fundamental facts of color-vision—the fact of "matching by mixture" and the fact of tetrachromatism. Figure 1 represents the Thomas Young color-triangle with the introduction of definite points (circles) for yellow and for white. Vision is made up of all possible blends (some thirty thousand in all) of five unitary sensations—one achromatic (white) and four chromatic, which are, in the order of their development, Yellow and Blue, Red and Green. (When Hering chose his red and green, since it was essential to his theory to make them complementary colors, he took a bluish red and a bluish green—what I shall write as R_b and G_b. These colors are indeed complementary—R and G *and* B are (in the right proportions) a "white-constitutive" combination (triad)—but it is only by a curious illusion that his colors can be thought of as red and green.[1] This illusion, however, imposed upon his readers by Hering, he has been tremendously successful in inducing in the minds of his followers for some seventy-five years.

But it is one of the very numerous misfortunes that beset the subject of color that the spectrum, which would have been much more easily understood if there had been a simple blue at the high-frequency end, in reality shows there a recrudescence of the red with which it begins. A diagram of the course of the three initial-process curves is given in Fig. 2.

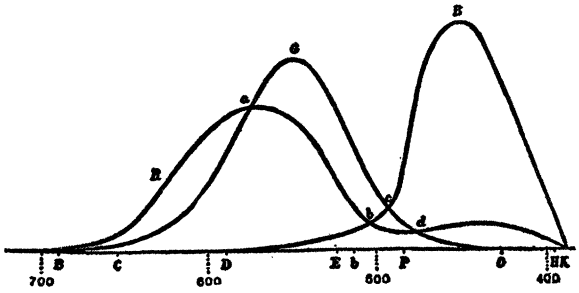

FIG. 2. R, G and B distribution curves. These are the curves of König and Dieterici, in their final corrected form. Abscissae, wave-lengths of the interference spectrum of the arc light; ordinates, arbitrary scale.

Diagrams have been laid down for the (four) distribution curves of the Hering colors also, but they are all purely the work of the imagination (*Am. Journal of Physiology*, **32**, 30, 1913). The Koenig-Helmholtz curves, on the other hand, are the product of an enormous amount of work in "matching the spectrum by mixtures of light-frequencies," carried out by Koenig in the Helmholtz laboratory. These curves have also been magnificently confirmed by their coincidence, respectively, with the two types of chroma-blindness, the deuteranopic (that of the vision of the human mid-periphery) and the protanopic (the color-vision of the bees); defective human vision (what every twentieth man you meet has got) is about equally divided between these two types.

On the other hand, we have much to be thankful for that, except for this second maximum of the red, the three curves are as simple as they are—they might have been so complicated as to be quite unravelable. It is also fortunate that they are only three in number, and not four even, in spite of the fact that the different chromatic sensations that they end in producing are four and that the light-sensations in all are five—white also is a color but an achromatic one. No reason is known for the second maximum of red, but of course no reason is known for the shape of any of the three resonance curves.

On the other hand, the physicist, who makes so much of violet, is capable of wholly overlooking the fact that there is another color in the spectrum (and in the world) which there is every reason for mentioning—it is in fact the most brilliant color of them all, *viz.*, yellow. It is true that all you need to put in in order to produce, by mixing, the complete spectrum is red and green and blue; but if you would only take the trouble to look at this spectrum which you have produced, you can not fail to see that while two of the dual chroma blends which you might expect[3] are indeed present, the third (what should be the red-greens) is conspicuous by its absence, and not only is that the case but something else—something entirely new, not in the least resembling a reddish green or a greenish red—has jumped in to take their place. It is exactly the same as if, on mixing in your test-tube a certain proportion of hydrogen and chlorine they should both of them absolutely vanish, and their place should be taken by a hydrochloric acid which has no trace of any of the properties of either of its constituents. Of its constituents, we say! Ever since the discovery of chemistry by Lavoisier magical events of this sort are no longer magical—we say at once, when properties perform this dance of disappearing and reappearing, that "a chemical reaction has taken place." Then why avoid employing the same term and making use of the same conception when (1) red and green vanish and have produced yellow, and (2) yellow and blue vanish and have produced white—especially since, if you look at the development of the color-sense, yellow is seen to be the color which red

[1] The real red and the real green, when mixed, give yellow, as every physicist knows.

See Apppendix on The Nature of the Color Sensations, in Helmholtz, Physiological Optics (English translation) II, 468.

[3] The blue-greens and the red-blues.

and green were developed out of, and white (at a still earlier time) the color which yellow and blue were developed out of? Does the great discovery of Lavoisier—the occurrence of the chemical reaction—exist for the color-physicist in vain?[4]

Violet is a popular but unscientific name for a slightly reddish blue, as any one can see by giving the matter a moment's attention. A child can perform this analysis. My little girl, when three years old, stopped on the street—her scientific curiosity aroused—when she saw for the first time a brilliant purple surface, and exclaimed "Bu!—wed!—wed!—bu!" This is proof positive—what the Eskimos have also furnished proof of—that purple really is at once blue and red or red and blue. And yet a physicist even at the present day (Frank Allen) can propose a theory in which violet (a red-blue) is a fundamental color—that is, a sensation which is assumed to have a single physiological correlate attached to it! And Professor Knight Dunlap has proposed a theory (*The Psychological Review* **22**, 99, 1915) which he seems, however, not to have insisted upon in later years, in which the elements assumed are mauve, peacock and yellow (in other words, red-blue, blue-green and green-red)! The fundamental principles which make such an assumption as this quite impossible have been admirably set forth by Professor G. E. Mueller. (*Zeitschrift. f. Psych. 10,* 2, 321, 1896.)

But color is a subject in which the physicist is very apt to engage in fallacies. So distinguished a scientist as Professor Millikan is capable, when speaking of color, of committing a plain "wrong conversion," as the logician has called it. He says (textbook on Physics, by Millikan and Gale) after having shown that white light can be separated up into all the colors of the spectrum, "we have shown that white light is composed of all the colors of the spectrum." But in fact white light is composed of red, green and blue; or—just as well—by the mixing of the most homogeneous obtainable yellow and blue light rays; it is not at all necessary to put in all the blue-greens, the green-yellows, etc., nor even yellow. Moreover, white can be seen *at every point of the spectrum* (with no mixing whatever) in these several (additional) cases:

B. The normal eye (*a*) in a faint light,
(*b*) in the extreme periphery of the retina,
(c) when a minute point is looked at,
C. The totally chroma-blind,
D. The lower animals (below the bees).

[4] See "Tetrachromatic Vision and the Genetic Theory of Color." SCIENCE, *55*, 555–560, 1922.

Until the physicist can be persuaded to give his attention to such facts as these, he will never be able to speak with intelligence on the subject of the color-sensations. But the case is not altogether hopeless. Professor Peddie has said in *Nature* (July 18, 1925) that the theory which I have proposed for holding together all these very complicated facts—the genetic theory of color—"may well turn out to be the real state of things"; and Professor Crew, in the new edition of his "General Physics" has used it as the *cadre* in which all these facts can best be understood. The physicist is recommended to read Professor Crew's exposition.

CHRISTINE LADD-FRANKLIN
COLUMBIA UNIVERSITY

ADDITIONAL RECORDS OF THE OCCURRENCE OF THE FRESH-WATER JELLY-FISH

THROUGH the kindness of the Bureau of Fisheries the following communication and specimens of this fresh-water medusa were brought to the attention of the National Museum:

July 30, 1927

The Commissioner,
U. S. Bureau of Fisheries,
Washington, D. C.

Dear Sir:

Inasmuch as the organism Craspedacusta is considered so rare according to Ward and Whipple in their "Fresh-Water Biology," I would like to take this opportunity to let you know that we have found our Slow Sand Filters swarming with the Medusa form of above, and specimens taken into laboratory are apparently thriving on the organisms in raw water. Our supply is fresh water taken from above Great Falls above tidal water possibilities and I would appreciate if you could tell me where their source might be.

This is the first time this organism has ever been noted here in our twenty-three years' operation.

Very truly yours,
(Signed) CARL J. LAUTER,
Chief Chemist

Mr. Lauter tells me the medusae he brought to the Bureau of Fisheries on July 30 were first noticed on July 28, and that they occurred at one time or another thereafter in practically every bed.

Each filter-bed is about 200 feet square and about four feet of water above the level of the sand. The beds are virtually in total darkness and there is very little circulation of air. The temperature of the water at this time of the year differs but little from that of the open storage reservoir from which it is drawn. At 8 A. M. on August 17 the temperature of the water at the surface in the filter was 74° F.