	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*
Amount of blue	0	33*	33*	31*	42*	60	64*	120*	270*
Total excitation of green	>4000	94	49	41	35·5	35	34	35	35
Amount of green	>4000*	90	45	37	30	27*	25	20	0

accompanying table in each column the combinations of green and blue are given which make a spot *P* vanish (wave-length 480 mμ).

The amounts marked with an asterisk have been adjusted by the observer. As the blue field excites the green receptors also, the amounts of green have been corrected for this excitation (row 2). The sudden increase of the excitation of green from *e* to *d*, and the increase of the amount of blue from *d* to *e*, etc., shows that the interaction between the different mechanisms is small.

The visual acuity of the blue receptors is very small; on a green field *P* is seen as a blue gloom without a definite shape.

(*b*) The same results were found by a second method. Here two semicircular fields of the colour-mixing apparatus were used; the limits were determined where a difference between the upper and lower field became visible. Blue light, green light and mixtures of blue and green were used on both fields; only one of the components was varied.

These experiments are equivalent to measurements of wave-length discrimination, and hence wave-length discrimination can be explained by the theory used above, namely, that the eye includes three separate mechanisms, each having its own intensity discrimination and visual acuity.

Analogous measurements were carried out on the green mechanism. A green spot was used (λ = 550 mμ). The large field was illuminated by green and/or red light. No definite results were obtained for three observers, *G*, *P* and *L*, but we are sure that the intensity discrimination of the green mechanism is nearly as good as for the red mechanism. According to the measurements already reported[1], *G* had an exceptionally large number of green receptors; indeed his discrimination of *P* on a red field was 20 per cent better than for *P* or *L*. The green mechanism of *B*, however, showed a reduction of the discrimination by a factor of two. Indeed, she had a very low number of green receptors since her luminosity curve was only 4 per cent above my own curve (see ref. 1). Her reading of Stilling's test cards was somewhat reduced. In the Rayleigh test she required an amount of red that was *Q* times as large as the amount used by a 'normal' observer; *Q* being 1·1. This is no reason, however, for calling her a protanomalous, especially since her luminosity curve is very low. Moreover, for *G*, *Q* was 1·15, but *G* read the test cards very well.

The luminosity curve of *D* (trichromat) coincided with mine; indeed he read the test cards very badly; even worse than *K* (deuteranomalous). The coefficient *Q* for *D* and *K* was 0·9 and 0·3 respectively, but *K*'s luminosity curve was 10 per cent higher than mine and therefore he had more green receptors and a better colour discrimination.

We finally conclude that a flicker photometer may be a valuable instrument in the detection of colour blindness (but combined with the anomaloscope), especially because the colour-blind can adjust the minimum of flicker very accurately. Settings which suggest unusual sensitiveness or insensitiveness to red point to a colour-discrimination.

These measurements will be reported in more detail elsewhere. Our thanks are due to Prof. G. F. Rochat for his help and advice in the clinical tests.

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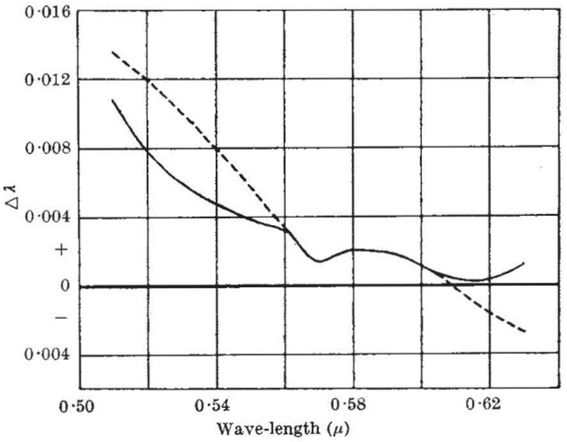
Foveal Colour Sensitivity

RECENTLY, during the measurement of the hue discrimination curves for small areas of the retina within the central fovea, it was noticed that if the two halves of the small circular matching field (diameter subtending 15′ at the eye) were set at the same wave-length λ, the lower beam, which did not quite match the upper beam in colour, had to be displaced slightly to a new wave-length $\lambda \pm \Delta\lambda$ if a perfect colour match was to be obtained.

These differences ($\Delta\lambda$) for various wave-lengths are shown in the accompanying graph. The full curve was obtained when the matching field was viewed directly so that its image lay upon the retina at the fixation point; whereas the broken curve was found when the field was displaced 20′ into the left visual field by the use of a small fixation light. Between 0·560 μ and 0·600 μ the curves appear to be the same, and throughout most of the spectrum investigated when both fields were set to the same wave-length, the lower field appeared slightly more blue than the upper one. Beyond 0·510 μ and 0·630 μ hue discrimination becomes so poor that $\Delta\lambda$ cannot be measured with precision. A further point of interest is the notch in the curve at 0·570 μ.

The measurements were made with the colorimeter developed by Dr. W. D. Wright[1,2]. The right eye was used and the field brightness was approximately 50 photons. A careful check of the wave-length calibration of the colorimeter was undertaken, and to make certain that the effect was not due to an error within the apparatus a small reversing prism was fitted to the eyepiece so that the position of the upper and lower beams was reversed. Since the lower field (now illuminated by the upper beam) still remained slightly more blue than the upper one, the effect could scarcely be due to faulty wave-length calibration.



The size of $\Delta\lambda$ (see graph) for any wave-length is only about half that of the hue discrimination step for the same wave-length under the same conditions, and $\Delta\lambda$ is merely the difference of wave-length which makes a colour match unsatisfactory, and is not sufficient for one to be able to record a reproducible hue step. The need for some adjustment of the wave-length control of the colorimeter, however, was readily seen by the observer.

Thomson and Wright[3] have shown that there is an increase of sensitivity to blue light as the image of the matching field is moved from the centre towards the edge of the central fovea, and the explanation of the colour difference here described may be that the fixation point was such that the two halves of the field lay upon areas of the retina of slightly different spectral sensitivity. The irregular shape of the curve may be due to the image of the matching field having a retinal position which depends upon the wave-length. Some difference in the anatomical position of the fixation point for red, green and blue light has been reported by Hartridge[4], and it may be that the position of the fixation point is a continuous function of the wave-length when small matching fields are used.

I would like to express my thanks to Dr. W. D. Wright for his help and to Miss M. Gilbert for recording the observations. My thanks are also due to the Medical Research Council for the use of the colorimeter at Imperial College.

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Interstellar Origin of Cosmic Radiation at Radio-Frequencies

RECENT publications of measurements of radiation from interstellar space[1] and from the sun[2,3] have important astronomical consequences. In the measurement of cosmic radiations at 5 metres wave-length, the maximum value of $13{\cdot}2 \times 10^{-21}\ \Delta\nu\Delta\omega$ watts/sq. metre was obtained. This is equivalent to a radiation intensity of 4×10^{-18} ergs/sec./kilocycle band-width/sq. cm./sq. degree. We have previously investigated[4] the theory of interstellar radiation arising from free-free transitions by electrons in the field of protons. From astronomical observations the numbers of protons and electrons in interstellar space, in the neighbourhood of the sun, are known to be of the order of 1 per cubic centimetre. On this basis we computed the expected intensity of radiation at the earth; the maximum predicted value is found to be 5×10^{-18} ergs/sec./kc./sq. cm./sq. degree, at about 1 metre wave-length. The accompanying graph shows the predicted free-free radiation from interstellar space as well as the presently available high-frequency measures. The plotted observations are the observed maximum intensities, in the region of Sagittarius. Data at the slightly longer wave-length bands, near 10 metres, would be of critical importance. The new and accurate observations by Hey, Phillips, and Parsons[1] lie remarkably close to our predicted curve. Their observations show relatively low concentration of the radio-frequency radiation to the galactic plane, compared to both interstellar matter and stars. Possibly a slight under-estimation of background noise might explain this effect.

Hey[2], working at 5 metres, and Pawsey, Payne-Scott and McCready[3] at 1·5 metres, have observed intense short-wave bursts of radiation from the sun, connected with sunspot activity. The energies received attain high values; their data are given in terms of an 'equivalent temperature'. After reduction to our units, the observed intensities are respectively of the order of 5×10^{-13} and 3×10^{-14} ergs/sec./kc./sq. cm./sq. degree. Pawsey, Payne-Scott and McCready[3] question the origin of the cosmic radiation in interstellar space, and "attribute it to similar [that is, to the sun] bursts of radiation from the stars, which, because of their large number, could yield an approximately constant value for any one area in the sky". We wish to point out some considerations which seem to vitiate this interesting new suggestion. In