LETTERS TO THE EDITORS

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Lunar Tidal Oscillations in the Ionosphere

USING the well-known radio methods of upper atmospheric exploration, Appleton and Weekes[1] showed that the E-layer of the ionosphere is subject to an unexpectedly large lunar tide. The tide was found to be semi-diurnal in character, of the order of 1 km. in amplitude, the maximum heights being reached about $\frac{3}{4}$ hr. before the lunar transits.

More recently Martyn[2] has shown that the ionospheric observations made at the equatorial Huancayo station of the U.S. Department of Terrestrial Magnetism indicate a semi-diurnal lunar tide for the F_2-layer, also of very substantial magnitude, and has shown that this lunar oscillation can be observed in both the heights and critical frequencies of that layer.

Counting the magnitude and phase of the semi-diurnal tides in the E-layer as established for the location of south-east England, we have therefore examined F_2-layer ionospheric data for the same location in order to discover whether there is any variation of phase and amplitude with height. It was also considered of interest to find out whether the lunar tide in the F_2-layer could be detected for a station as far removed from the equator as latitude $51\frac{1}{2}°$ N.

As the material for analysis we have used the Slough hourly values of both the F_2-layer critical frequency and also of a quantity, h_m, the height of the maximum ionization level of the F_2-layer. Values of h_m were calculated by a method we have previously described[3]. Semi-diurnal lunar oscillations have been found in the values of both f_{F_2} and h_m. The amplitude of the oscillation in the case of f_{F_2} is about 0·05 Mc./s., the maximum being reached shortly before the time of lunar transit. The amplitude of the oscillations in the case of h_m is about 2 km.; but here the maximum is attained approximately mid-way between lunar transits. Thus the lunar tidal effects in f_{F_2} and in h_m are seen to be approximately out of phase, a result not unexpected from our previous study of F_2-layer phenomena generally. What is unexpected, however, is that the lunar diurnal *height* variations for the F_2-layer are found to be entirely different in phase from those previously observed for the lower level of the E-layer, indicating an alteration of phase of lunar height oscillation with change of ionospheric level. An investigation of corresponding effects in h'_{F_2} data, which relate to an intermediate level, indicate a phase maximum at a time intermediate between those found for the E-layer and for the level of h_m for the F_2-layer.

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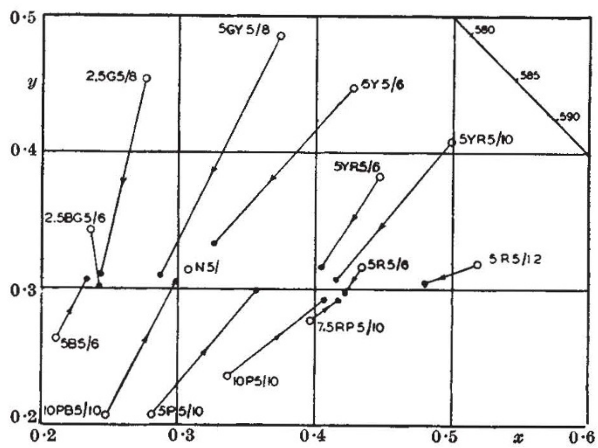
[1] Appleton, E. V., and Weekes, K., *Proc. Roy. Soc.*, **171**, 171 (1939).
[2] Martyn, D. F., *Proc. Roy. Soc.*, **189**, 241, 190, 273 (1947).
[3] Appleton, E. V., and Beynon, W. J. G., *Proc. Phys. Soc.*, **52**, 518 (1940).

Apparent Colours of Surfaces of Small Subtense

THE investigations of Hartridge[1] and others have substantiated the early conclusion of König[2] that the eye behaves as if tritanopic for coloured stimuli of small subtense, and it occurred to me that it would be of both theoretical and practical interest to determine the actual colours assumed under controlled conditions by small coloured surfaces. The first results are so striking a confirmation of König's conclusions that they are presented here as a preliminary report.

Small circular patches of a number of Munsell colours chosen from the 5-plane were presented against a black background (reflectance 2·6 per cent) singly and in random order to an observer seated at such a distance that they subtended 2 minutes of arc. The observer was provided with a chart having larger samples of all the Munsell colours in the 5-plane, systematically arranged, and a black mask with which any one colour could be isolated. The sample and the comparison chart were separately illuminated by 180 lumens m.$^{-2}$ of artificial daylight similar in colour to C.I.E. source 'C'. The observer was encouraged to be critical and to interpolate between the even values of chroma available; there was no possibility of interpolating between hues.



The figure is a portion of the C.I.E. mixture diagram showing the co-ordinates of the sample colours by open circles, and the mean location of the apparent colours at 2′ subtense by black dots. The (Munsell) neutral point is also indicated. Eight sets of observations by one observer are represented in the means.

Three main results will be noted: (1) the apparent displacements are in general directed towards or away from the short wave-length extremity of the spectrum locus ($x = 0·17$, $y = 0·01$); (2) the apparent colours lie closely about a line which if produced would cut the spectrum locus at about 491 and 630 mμ; (3) blue, green and blue-green are confused, as are also purple, red-purple, and orange; (4) yellowish-green, grey and purplish-blue are confused. The last two items, and indeed the entire picture, are in full accord with König's description of tritanopia. As an independent check of item (4), the Munsell colours lying near the straight line joining 5GY5/8 and 10PB5/10 were mounted side by side in order on the same piece of black card. At the experimental distance they appeared very nearly identical; though the extreme