1867, is in a great measure due to the disturbing action of Venus.

6. Wolf's 56-year cycle is determined by the joint action of Mercury and the Earth. And,

Finally, *the hypothesis proposed accounts, as we have seen, for all the well-defined cycles of spot-variations.*

NOTE ON THE CORRELATION OF COLOUR AND MUSIC

WHILST engaged in the preparation of an article on the Analogy of Light and Sound for the current number of the *Quarterly Journal of Science*, I was led to examine the grounds of the frequently-assumed relationship between the colours of the solar spectrum and the notes of the musical scale. It is well known that Newton found a connection between the relative spaces occupied by each colour and the relative vibrations of the notes of the scale. But this, I presume, cannot be more than an accidental coincidence. The common basis of comparison is obviously the ratio of the wave-lengths in the two cases. Although according to the tables given in text-books no satisfactory connection can be found, yet many considerations appear to justify a stricter comparison of these natural scales of colour and sound.

The ratio of wave-lengths of the two extremes of the spectrum is usually taken as 1 : 0.57, or corresponding to the interval of a seventh in music.

But this statement is only true when a glass prism is employed; the ultra-violet rays are then suppressed. Substituting quartz for glass, light of higher refrangibility is seen: the limits of the spectrum can thus be extended from the solar line A to the solar line L.* Now, the wave-length of A (according to Ångström) is 760 millionths of a millimetre, and the wave-length of L (according to Mascart) is 381 millionths of a millimetre, or as the ratio of 1 : 0·50, exactly corresponding to the interval of an octave in music.

The ratios of the extreme colours of the spectrum and the extreme notes of an octave are coincident.

The next object is to compare the ratio of wave-lengths giving rise to the intermediate colours of the spectrum with the ratio of wave-lengths giving rise to the intermediate notes of the scale.

The most careful localisation of the colours of the spectrum with which I am acquainted is that by Prof. Listing.† In his recent memoir on the wave-lengths of the spectra of the metals, M. Thalén gives Prof. Listing's estimation of the extreme limits of each colour as follows:‡

TABLE I.

Name.	Limiting Wave-lengths in ten-millionths of a millimetre.
Red	7234 to 6472
Orange	6472 to 5856
Yellow	5856 to 5347
Green	5347 to 4919
Blue	4919 to 4555
Indigo	4555 to 4241
Violet	4241 to 3967

Taking the *mean* of the two limits to represent the average wave-length of each colour, we have the following series:—

TABLE II.

Name.	Mean wave-lengths in ten-millionths of a millimeter.	Ratio.
Red	6853	100
Orange	6164	89
Yellow	5601	81
Green	5133	75
Blue	4737	69
Indigo	4395	64
Violet	4104	60

* Mr. Crookes informs me that on favourable occasions he has even seen beyond L.

† Poggendorff's "Annalen," 1868, vol. 131, p. 564.

‡ Trans. Roy. Soc. Upsal, third series, vol. vi.: also Annales de Chimie et de Physique, October 1869, and NATURE, No. 2.

Calling the wave-length of the mean red 100, the numbers in the third column express the corresponding ratios of the mean wave-lengths of the other colours.

In the next table is given the similar data as regards sound. The *first* column contains the names of the musical notes; the *second* their actual wave-lengths starting from the middle C; the *third* column gives the relative wave-lengths in fractions of C; and the *fourth*, the ratio without fraction, C being taken as 100.

TABLE III.

Name.	Wave-length in inches.	Ratio of wave-lengths.	
C	52	1	or 100
D	46⅓	8/9	89
E	42	4/5	80
F	39	3/4	75
G	35	2/3	67
A	31	3/5	60
B	27½	15/28	53
C_2	26	1/2	50

Placing together the ratio given in the last columns of Tables II. and III., the following remarkable correspondence comes out:—

TABLE IV.

Colour.	Ratio.	Notes.	Ratio.
Red	100	C	100
Orange	89	D	89
Yellow	81	E	80
Green	75	F	75
Blue . 69 / Indigo 64 } mean,	67	G	67
Violet	60	A	60
[Ultra-Violet	53]	B	53
[Obscure	50]	C_2	50

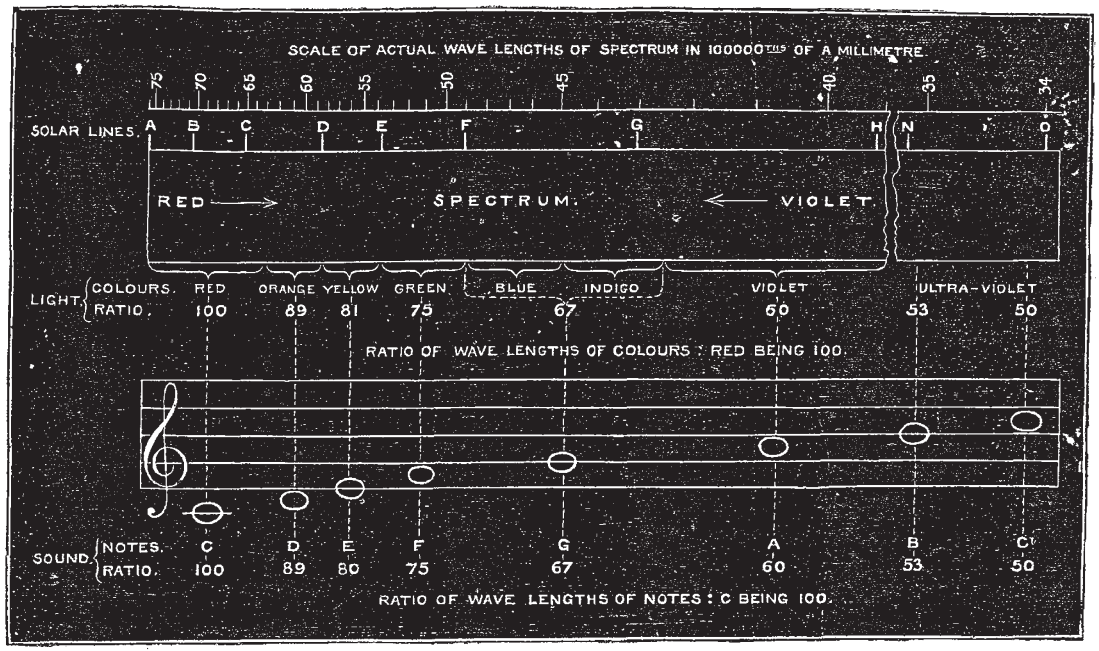
Assuming the colour *red* to correspond to the note C, then we find *orange* exactly corresponds to D; *yellow* is almost exactly the same as E; and if we take the wave length of E from observation and not from theory, we have 52 : 42 = 100 : 80·8, a still closer approximation to yellow. The ratio of green is identical with that of F. *Blue*, however, does not correspond to G, nor *Indigo* to A; but blue and indigo are practically one colour in the spectrum,—the line of demarcation, difficult to fix between any other colours, is impossible to be established here. I think, therefore, I am justified in putting them together, and if we do so we find their mean ratio exactly corresponds to G. Violet now exactly corresponds to the ratio given by A. Here all distinct colour ends. But beyond this region Sir John Herschel detected a lavender colour, which finally shades away into a dusky grey. The wave-length of this ultra-violet region is not given by Prof. Listing; hence the ideal position is calculated and inserted in the table within brackets. As the lower C is placed at the *mean* red, the upper C would then correspond to a region in the spectrum altogether obscure: viz., at the solar line O. But as already stated above, if we place the lower C at the *extreme* red, then its higher octave would fall on the line L, or within the range of vision.* The great difference of position thus produced at the violet extremity by a slight movement at the other end of the spectrum, is caused by the crowding together of the colours at the red end. This is shown, together with the correspondence of the ratios of sound and colour, in the accompanying diagram.

The musical scale is thus literally a rainbow of sound. Harmony in colour and music may thus, probably, be found to have a common physical basis. There are many indications that this is the case. For example, the juxtaposition of two colours nearly alike is bad, and so also two adjacent notes of the scale sounded together produce discord. The succession of colours in the spectrum

* A suggestion, made, I believe, by Sir J. Herschel, that the colours of the spectrum would probably repeat themselves if we could see beyond the lavender, both supports, and gains support from, this analogy.

and of notes in the scale is the most harmonious that can be found; any disturbance of the order in either case makes the succession less pleasant. Discord or harmony may be the result of the combination of certain notes, by C and G, or the harmonious interval of a fifth; the latter combination corresponds to C and F, or the slightly less pleasant interval of a fourth.

This apparent correlation of music and colour suggests



and so also with colours. A pleasant effect is produced by the juxtaposition of red and blue, or of red and green: the former combination corresponds to the ratios given

many other speculations, but at present I would only venture to submit the foregoing considerations to the opinion of physicists.

W. F. BARRETT

THE SLAVONIANS IN TURKEY

A VERY careful and complete account of the result of the latest researches in the ethnology and geography of the Turkish Slavonians is given in the new number of Petermann's *Mittheilungen* by Professor Francis Bradashka, of Agram. The author is himself a member of that branch of the great Slavonic race to which the Turkish Slavonians belong, and evidently takes a strong political as well as scientific interest in their position; but his work is on the whole singularly free from political bias, and may be safely referred to by those who desire to increase their knowledge of the subject. The facts of Turkish ethnology are scattered in a variety of books and articles in periodicals, most of which are very difficult of access, and the only place where they could hitherto be found in a condensed form is an appendix to the fourth number of the *Mittheilungen* by M. Lejean, published in 1861. M. Lejean's paper, however, though full of valuable information and accompanied by an excellent ethnological map, gives little more than a bird's-eye view of the subject; and Professor Bradashka, besides correcting some important errors in it, has added much statistical and geographical detail which throws a new light on some of the most interesting questions of Turkish ethnology. One of these is the origin and development of the Albanian (Shkipetar) settlements in Turkey. Herr von Hahn, one of the best known authorities on this subject, holds that the Shkipetars were the original inhabitants of old Servia and the districts between Albania and the Vardar river; and that while these countries were under the Servian rule, the Shkipetars were compelled by their conquerors to take refuge in the hills, whence they afterwards descended when the Servians were beaten in their turn by the Turks. Professor Bradashka, on the other hand, shows, as we think, conclusively, that the countries in question were originally inhabited by Servians, and that the Shkipetars who now occupy them are the descendants of immigrants from Albania who settled there after the break-up of the Servian Empire. A very interesting and important fact brought out by the Professor in connection with this subject is, that the Shkipetars are gradually edging out the Slavonians from many districts which were formerly occupied almost exclusively by the latter race. This is especially observable in the towns. In Vuchitrn, Novo Brdo, and Dyakova, nearly all the inhabitants are now Shkipetars; and in Matochia, the ancient residence of the Servian kings, there are more Shkipetars than Servians. Old Servia was almost entirely Servian when Shafazyk wrote in 1849; it is now predominantly Shkipetar. There are also now Shkipetar settlements, not mentioned by M. Lejean, at the mouth of the Maburitza, and on the eastern and western shores of the lake of Scutari (Skodra).

The acceptance of the Mahometan religion by many of the Slavonians in Turkey has led to great confusion as to the Turkish population of the country. Some unscrupulous partisans of the Ottoman rule have not hesitated to state that there are six millions of Turks in European Turkey—an absurd exaggeration which can only impose on people who are totally ignorant of the facts. Professor Bradashka agrees with the best authorities in estimating the Turkish population at under a million, and points out a singular blunder made by M. Lejean, in his otherwise very accurate map, as to the Turkish inhabitants of Bulgaria. According to his map the whole of Eastern Bulgaria, or about a third of the whole province, is Turkish. This the Professor shows to