minimum seems to have been less than the later; while in Geneva the earlier minimum is the deeper.

The facts above given may be usefully compared with Dr. Lockyer's recent important researches, pointing to a cycle of about thirty-five years in the sun-spot variations. It may be doubted if the annual mean temperature of these European stations shows any good evidence of being ruled by the eleven-year cycle of sun-spots; and if it did, the method of smoothing here adopted might even obscure such an effect somewhat. This, however, does not seem to affect the validity of evidence from other orders of data. ALEX. B. MACDOWALL.

Resultant Tones and the Harmonic Series.

IN reply to Prof. Thompson's criticism of the plan of recovering differential resultant tones by means of the harmonic series, may I say that my position is that of a road-maker, not a discoverer—a Macadam rather than a Columbus.

So long as authorities teach that resultant tones have a vibration frequency which is equal to the difference between the vibration frequencies of their generators, so long will the harmonic series afford an easier means to the same end.

This applies also, of course, to summational tones.

The question whether these latter are only "one of the myths of science" or not I leave to abler heads than mine to decide.

Meanwhile, the fact that the perfect fourth, the minor third and the minor sixth give, as the sum of their vibration frequencies, a vibration frequency which is intermediate between two notes, thus exactly agreeing with the harmonic series, $3 + 4 = 7$, $5 + 6 = 11$ and $5 + 8 = 13$, is at least interesting.

MARGARET DICKINS.

Tardebigge Vicarage, Bromsgrove, May 9.

Magic Squares.

HAVING attempted some years ago to determine the number of magic squares of five having a nucleus forming a magic square of three, I was interested to find that further progress towards a solution of the problem has been made by your correspondent Mr. C. Planck, who seems to have found fifty-one solutions more than I from the same twenty-six nuclei, whereas I have only in one case, namely for the nucleus R (5, 7), found one more solution than he. The twenty-one solutions for this nucleus are appended in the following table, from which both the equations and the numbers forming the first row and the first column of the border may be read off without difficulty, if the first dotted number be put at the head of the column, and at the foot of the same the complement of the second. Thus, from the first row of the table,

$$\bar{1} . \dot{2} . \dot{4} . \bar{6} . \overline{12} \mid \bar{3} . 8 . 10$$

we gather that the first row of five minors (numbers less than 13) may be converted into a normal row with sum 5×13 by replacing the three barred numbers by their complements, since $2 + 4 + 13 = 1 + 6 + 12$, whilst the remaining three minors, together with the dotted pair, furnish a normal column when 4 and 3 are replaced by their complements, since here again $4 + 3 + 13 = 2 + 8 + 10$. The border with nucleus, accordingly, when completed, is

	a	*b*		*b'*	*a'*
a	2	25	20	14	4
b	8	11	21	7	18
	10	9	13	17	16
b'	23	19	5	15	3
a'	22	1	6	12	24

1	$\bar{1}$	$\dot{2}$	$\dot{4}$	$\bar{6}$	$\overline{12}$	$\bar{3}$	8	10
2	$\bar{1}$	$\dot{2}$	$\dot{4}$	$\bar{8}$	$\overline{10}$	$\bar{3}$	6	12
3	$\bar{1}$	$\dot{2}$	$\bar{4}$	$\dot{6}$	10	$\bar{3}$	8	12
4	$\dot{2}$	$\bar{3}$	$\bar{4}$	$\dot{6}$	12	$\bar{1}$	8	10
5	$\bar{1}$	$\dot{2}$	$\dot{6}$	$\bar{8}$	$\overline{12}$	$\bar{3}$	4	$\overline{10}$
6	$\dot{2}$	$\bar{3}$	$\dot{6}$	$\bar{8}$	$\overline{10}$	$\bar{1}$	4	$\overline{12}$
7	$\dot{2}$	$\bar{3}$	$\bar{4}$	$\dot{8}$	10	$\bar{1}$	6	$\overline{12}$
8	$\dot{2}$	$\bar{3}$	$\bar{6}$	$\dot{8}$	12	$\bar{1}$	4	$\overline{10}$
9	$\bar{1}$	2	8	$\overline{10}$	$\overline{12}$	3	$\bar{4}$	$\bar{6}$
10	$\dot{2}$	$\bar{3}$	$\bar{4}$	6	$\dot{12}$	$\bar{1}$	8	$\overline{10}$
11	$\dot{2}$	$\bar{3}$	$\bar{8}$	10	$\dot{12}$	$\bar{1}$	4	$\bar{6}$
12	$\bar{1}$	$\dot{4}$	$\dot{6}$	$\bar{8}$	12	2	$\bar{3}$	$\overline{10}$
13	$\bar{3}$	$\dot{4}$	$\dot{6}$	$\bar{8}$	$\overline{12}$	1	$\bar{2}$	$\overline{10}$
14	$\bar{1}$	$\dot{4}$	8	$\overline{10}$	$\dot{12}$	$\bar{2}$	3	$\bar{6}$
15	$\bar{1}$	2	$\bar{4}$	$\dot{6}$	$\dot{10}$	$\bar{3}$	8	12
16	1	$\bar{2}$	$\bar{4}$	$\dot{8}$	$\dot{10}$	$\bar{3}$	6	12
17	$\bar{1}$	2	$\bar{6}$	$\dot{8}$	$\dot{10}$	$\bar{3}$	4	$\overline{12}$
18	$\bar{2}$	3	$\bar{6}$	$\dot{8}$	$\dot{10}$	$\bar{1}$	4	12
19	$\bar{3}$	4	$\bar{6}$	$\dot{8}$	$\dot{10}$	$\bar{1}$	2	$\overline{12}$
20	1	$\bar{2}$	$\bar{6}$	$\dot{8}$	$\dot{12}$	$\bar{3}$	4	$\overline{10}$
21	3	$\bar{4}$	$\bar{6}$	$\dot{8}$	$\dot{12}$	1	2	$\overline{10}$

When the number 603 is multiplied by 288 we get 173,664 for the number of such nuclear squares. When we proceed to inquire as to the number of all types of magic squares of five, we must begin by doubling the above number, since every magic square with odd root may be varied by permuting the rows above the mid-row, together with the rows below the same, and at the same time the columns on either side of the mid-column, so that the above square may be transformed by reversing the order of the marginal letters *a*, *b* and *a'*, *b'*, as follows:—

	b	*a*		*a'*	*b'*
b	11	8	21	18	7
a	25	2	20	4	14
	9	10	13	16	17
a'	1	22	6	24	12
b'	19	23	5	3	15

If now we add to the number 347,328 thus obtained the squares in which each row and each column contains all the units 1 . 2 . . 5 increased by the four increments 5 . 10 . 15 . 20 without repetitions of either, of which there are at least 21,376, we get 368,704, without considering other types, probably some hundreds of thousands in number, which would certainly bring the minimum to more than half a million.

Shipley, Yorks. J. WILLIS.