Letters to the Editor.

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The Arrangement of Atoms in Crystals.

IN NATURE for January 6, p. 609, was published a note in which some figures given in my paper on "The Arrangement of Atoms in Crystals" (*Phil. Mag.*, vol. xl., August, 1920) were contrasted with similar figures given by Wyckoff (*Amer. Journ. Sci.*, [iv], vol. 1., pp. 317-60, November, 1920). These figures were estimates of the distances between atoms of metal, carbon, and oxygen in the crystals calcite, CaCO_3 , rhodochrosite, MnCO_3 , and siderite, FeCO_3 . In this note it is stated that our data differ considerably, "the deviations rising to 0.6 Å. in the distance from carbon to metal."

There are no discrepancies of this magnitude between Wyckoff's results and mine. The large differences to which the note directs attention are due to errors in quoting the results given in my paper, owing, I think, to a misconception of the structure which Wyckoff and I agree in assigning to these crystals.

I give the correct figures, the distances being expressed in Ångström units:

	Wyckoff.		Bragg.	
	I.	II.	Experimental	Sum of radii
Ca-O ...	2'30	2'42	2'30	2'35
C -O ...	1'21	1'28	1'42	1'47
Ca-C ...	3'04	3'206		3'206
Mn-O ...	1'96	2'13	2'10	2'11
C -O ...	1'22	1'32	1'42	1'47
Mn-C ...	2'83	3'072		3'072

If I understand Wyckoff's results rightly, we are in agreement as to the type of structure in the case of these carbonates, and the symmetry of the crystal alone suffices to fix the positions of the calcium and carbon atoms. The distance between them can be calculated from the molecular volume of calcite, Avogadro's number N , and the crystal axial ratios. The dimensions of the calcite structure have been made the subject of careful investigation (Uhler, *Phys. Rev.*, July, 1918), as it has been used for standard X-ray wave-length determinations. Taking the value $d_{(100)} = 3.028$ Å. given by Uhler, it follows that this distance from calcium to carbon atoms is 3.206 Å. Wyckoff gives the value 3.04 Å., and so ascribes to the whole structure a smaller scale. If, as I believe, his scale is too small, all his figures should be increased in the ratio 3.206 to 3.04. A similar increase of scale holds for rhodochrosite. Under I. are given Wyckoff's values, and under II. those values increased in what I believe to be the correct ratio.

Wyckoff gives figures which differ from mine for the distance between carbon and oxygen atoms. He has made a very careful determination of a certain parameter (denoted by "u" in his paper), and I believe his value for it, 0.25, to be much more trustworthy than my approximate value 0.30. Wyckoff's value confirms a determination 0.25-0.27 by W. H. Bragg (*Trans. Roy. Soc., A*, vol. ccxv., pp. 253-74) in 1915—a determination which I did not know when I published my figures. If the figures in column II. are accepted, this would mean that my estimate of the "diameter" of carbon in compounds is too high, and that a better value would be nearer that of fluorine, 1.35 Å. This is the only serious discrepancy between our results, and it does not seem to me that it affects in any way the general conclusions which I drew in my paper.

The figure 2.47 Å., quoted as being given by me

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for the distance Ca-C, has presumably been arrived at by the author of the note by adding the radii for these atoms. As they are partially separated by the oxygen atoms which surround the calcium atom, there is no direct connection between the sum of the radii and the distance between them. I used in my calculations the theoretical value obtained as above.

May I take this opportunity to correct another error in the note? The figures given for the "diameters" of the electro-negative elements are quoted correctly from my paper, but those given for the metals are one-half the value which I gave under this head.

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Manchester University, January 22.

A Case of Coloured Thinking with Thought-forms and Linked Sensations.

COLOURED thinking is such a peculiar condition that those interested in it will welcome the details of a well-marked case of it. It must be distinguished from linked sensations such as coloured hearing—one of the synæsthesiæ—in which heard sounds call up colours, as when the low notes of the organ suggest violet or the high notes white or yellow, etc.

Coloured thinking or chromatic mentation (psychochromæsthesia) is the visualising of concepts as coloured, the ability to think of a letter of the alphabet, a number, a date, a month, or a name as associated with some colour or other—white, black, red, green, etc. To those who have never experienced this sort of thing it is unintelligible.

One coloured thinker thus expressed himself: "When I think at all definitely about the word January the name appears to me reddish, whereas April is white and May yellow; the vowel 'i' is always black, the letter 'o' white, and 'w' indigo-blue. Only by a determined effort can I think of 'b' as green or blue, for to me it has always been and must be black; to imagine August as anything but white seems to me an impossibility, an altering of the inherent nature of things."

Of course, the same person who has coloured hearing—the commonest of the linked sensations—may likewise have coloured thinking, although most coloured thinkers do not also have linked sensations. The case the interest of which I think sufficiently great to report on now is one both of linked sensations and of coloured thinking. But there is also a third element of interest in it, namely, that of thought-forms. A thought-form or psychogram is the visualising of, say, the numerals or letters of the alphabet or months of the year in such a way that they seem to form some definite figure in space—for instance, an arc of a circle or a ladder sloping up to the right or left, and so forth. A psychogram is the uncoloured form of a concept or a series of them; the psychochrome is the concept itself exteriorised in colour.

The case the coloured thoughts, linked sensations, and thought-forms of which I subjoin is that of a student of this University (Miss A. M.), who has all the features characteristic of these cases. She has been a coloured thinker ever since she can remember; the colours have not altered with lapse of time, they are exceedingly definite, they do not agree with the colours seen by other thinkers for any one given concept, and, finally, the "seer" cannot account for them in any way.

The only feature in the present case not quite typical is that it is not so clearly hereditary as is usually observed. Miss A. M. says that neither of her parents is a coloured thinker, though her "mother associates colours with the characters of people." This has been called "individuation," and is not so uncommon as might be imagined.