parents. . . . It was the original intention," of the author, "to summarise all the principal child-study investigations that have been made." But this plan was evidently abandoned at a very early stage, and we have instead the present popularly written volume, which we can heartily recommend both to teachers and parents. Its style is pleasing, and its matter fairly correct, embodying the experience of fourteen years' study and teaching in the subject. Were the contents as widely read as they deserve to be, the immense importance of child-study, as a basis for methodical teaching and rational education, would be more generally realised.

The greater part of the book is devoted to the development of instincts—a word used in an extended sense by the author to embrace the phenomena of imitation, curiosity, migration, and even æsthetics, morality, and expression. These nine chapters, together with those on heredity, individuality, and on the development of the intellect, are all admirably written, containing excellent food for the parent's reflection and stimulating the interest of the teacher in her work. It seems strange that the subject of fatigue should be relegated to the chapter entitled "Abnormalities." This latter contains some useful hints on the mental and physical defects of children, but the accompanying pathological and anatomical remarks are in several instances inaccurate and misleading. C. S. M.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE *No notice is taken of anonymous communications.*]

Residual Affinity.

THERE appears to be a tendency among chemists to abandon their own doctrine of definite valency, and to recognise an indeterminate and fluctuating number of links connecting atoms with each other.

The electron theory of the physicist, which assigns one indivisible unit of charge to a monad, two to a dyad, &c., has therefore encountered some opposition, inasmuch as it seems to tend to harden the old doctrine of "bonds" whereby atoms were supposed to be linked only in a simple definite and numerical way, no fraction of a bond being contemplated.

Assuming this rough statement to represent something like historical truth, I have a few remarks to make on the subject.

First, the possession by an atom of a definite charge, numerically specifiable as a simple multiple of an indivisible unit, must be accepted as a physical fact.

Second, this fact corresponds with those other facts which originally led chemists to assert, for instance, that nitrogen was a triad or pentad, carbon a tetrad, &c.—a position which it would seem absurd to abandon. (Incidentally it may be noted that a monad must be either electro-positive or electro-negative, but that a tetrad need not be either, since its pairs of charges may be opposite in sign.)

Third, there is nothing in these doctrines inconsistent with the existence of fractions of a bond and any required amount of "residual affinity."

It is this last thesis that I wish briefly to develop. Indeed, in 1902, in a paper on electrons published in the *Journal* of the Institution of Electrical Engineers, vol. xxxii., p. 103, I showed how it was possible to regard ordinary mechanical cohesion on the electric theory; and likewise that it was easy to regard molecular combination from the same point of view.

In a short conversation with Prof. Armstrong, at the Mansion House recently, I realised more clearly than before where the imaginary difficulty now lies.

It has been an occasional habit with physicists when speaking of lines of force to think of a single line of attraction or elastic thread joining each negative electron to its corresponding positive charge; each unit charge, in fact, being regarded as the cut end of a line of force and nothing else. But so far as I know it has never been considered that these lines of force so interpreted were physical realities, and that one and only one line really appertained to each unit charge; though in his recent remarkable book reviewed in these columns on May 26, p. 73, Prof. J. J. Thomson goes near to assigning so great a physical reality to the lines of force as would make the number issuing from any charge a commensurable number; that is to say he begins hypothetically to regard each line of force as a discrete physical entity. But even so there is no evidence that each unit of charge ought to have assigned to it one solitary line of force, it might have a great number; though it is true that on that view it becomes a definite question how many lines of force a unit charge possesses, whereas on the ordinary vaguer view of a centre of force the influence of which is felt in all directions, any specification of number of lines is either meaningless or a mere question of convenience of measurement, like the number of miles in the circumference of the earth, or the number of cubic feet in a room: a number which is necessarily and always incommensurable.

On any view electrons are supposed to repel and to be attracted with a force varying as the inverse square of the distance, and this is only consistent with a very large number of lines of force radiating from each and starting out in every direction equally.

When opposite charges have paired off in solitude, every one of these lines start from one and terminate on the other constituent of the pair, and the bundle or field of lines constitutes a full chemical "bond"; but bring other charges or other pairs into the neighbourhood, and a few threads or feelers are at once available for partial adhesion in cross directions also, the quantitative distribution of the force being easily calculable from geometrical data.

Briefly, the charge is indivisible, it is an atomic unit (up to our present knowledge); but the lines of force emanating from it are not indivisible or unified at all. The bulk of them may be occupied with straightforward chemical affinity while a few strands are operating elsewhere; and the subdivision of force may go on to any extent, giving rise to molecular combination and linking molecules into complex aggregates, so that a quite gradual change of valency is conceivably possible, the number of wandering lines being sometimes equal to, or even greater than, the number of faithful lines—though this would usually represent an unstable condition not likely to persist.

I state the position in order that physicists who see reason to disagree with it may intervene in good time and prevent any premature acceptance of a harmonising interpretation by chemists; because so long as there is any real outstanding difficulty it is clearly best for the progress of science that diverse views should continue.

OLIVER LODGE.

On a Dynamical System illustrating Spectrum Lines.

I DESIRE to express to Prof. Nagaoka my regret at my misinterpretation of his letter to NATURE of February 25, which was due simply to my failure to find any mention there of the larger system of which he speaks. No doubt his ring is quasi-stable if the central positive charge is large enough; but is it allowable to leave out of account the rest of the system? Waiving this objection, I would point out that there are upper limits to the central charge which cannot be exceeded without making the whole system positive, or the velocity of the ring greater than that of light. It may very well be that either limit is too low to allow a stable system to be reached; the discussion of this point must be reserved for another time.

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A Correction.

IN my letter to NATURE of June 16 (p. 151) concerning the source of radio-active energy, I should of course have halved the expressions given for the electrostatic energy of an isolated electron, and for energy set free by annihilation of matter. C. V. BURTON.

Cambridge, June 18.