

and 1999. In consequence, the number of transits in the century, fourteen, is slightly above the average.

In the course of this work I detected an error in the *Nautical Almanac* for 1878, p. 402; the least distance of centres of sun and Mercury should be  $4' 47'' \cdot 4$ , not  $3' 47'' \cdot 4$ . It is well to note this, as it is likely to confuse those who are using the 46-year cycle to predict the circumstances of future transits. I used methods of this kind in my paper on transits of Mercury in the *Observatory* for 1894, p. 394. I there obtained  $16' 1''$  as the least geocentric distance of centres in 1937; this estimate took no account of perturbations, but its close agreement with my present more careful result serves as a check on the latter.

A. C. D. CROMMELIN.

### Mathematical Theory of Relativity.

THOSE results in the mathematical theory of relativity that have received experimental confirmation are connected with problems that might be classified as the single-line type. These problems are in the same category as those discussed in particle dynamics and their analogues in geometrical optics.

When, however, we come to problems involving a congruency of lines, logical difficulties arise. It seems clear that we can no longer identify any one of the fundamental co-ordinates with 'time.' Thus, consider the question of 'volume.' In the classical theory the element of volume is invariantive. In the case of a four-dimensional continuum, it is the fourfold element that is invariantive, whereas the threefold element is defined by the four components of a tensor.

Now, taking the four-dimensional continuum, the ground-form of which is given by the equation,

$$ds^2 = dx_4^2 - dx_1^2 - dx_2^2 - dx_3^2,$$

we readily obtain a group of a type similar to that of the rotations about a point in Euclidean geometry, which forms the basis of the treatment of the angular velocities of a rigid body. This, however, simply provides us with one fourfold continuum suffering displacement through another, which is not exactly what is required. We have, in fact, introduced a fifth variable, namely, the parameter by which the infinitesimal transformations of our group are defined. Thus a supplementary relation, preferably of a differential type, is needed to define our moving system, and this must be invariantive in character. The above-mentioned parameter will then furnish a time measure for the system as defined. It seems that in only some such way can we provide a logical geometrical picture of rotation, which is an undoubted physical phenomenon.

At present difficulties arise through the necessity of using the old technical nomenclature in connexion with the new ideas, and thus often for purposes for which it was not strictly intended. In the case of the historical dispute concerning the measurement of 'force,' the difficulties were eventually dissipated by the emergence of the concepts of 'momentum' and 'energy.' It may be anticipated that something similar might happen with regard to the new theories.

Einstein has lately indicated that he has not found the new differential geometry any more capable of giving the required generalisation of the electromagnetic equations than the older Riemannian geometry, though the former was introduced with this purpose in view. May it not be that too close an analogy with Maxwell's equations has been contemplated? Thus one would suggest the introduction of a time measure for the electromagnetic field by some such general method as indicated above, together with some compensating addition to the set of equations.

J. BRILL.

### The Oogenesis of Daphnia by Intra Vitam and Post Vitam Staining.

RECENTLY the claims of neutral red as an intra vital stain for the Golgi bodies have been urged by Dr. Parat and his pupils.

Daphnia is easily stained intra vitally in weak solutions of neutral red, the stain colouring these animals bright pink in a few hours. Janus green solutions also work perfectly on such fresh-water crustaceans.

We have found that the growing oocytes of Daphnia exhibit bright red granules after staining in neutral red. In the gland and gut cells also, red granules are conspicuous. The youngest oocytes and oogonia do not exhibit such red granules, the latter appearing at the time of yolk formation.

Daphnid ovaries fixed in Champy's fluid and stained in iron alum hæmatoxylin show empty vacuoles, with a chromophile cortex, which correspond in position and size with the neutral red granules of the intra vitally stained specimens.

These vacuoles are merely the familiar yolk spaces within the Golgi bodies as described by Ludford, Brambell, the present writers, and many other authors. The dictyosomes or Golgi bodies of the oogonia before the inception of yolk formation stain pink in neutral red, and it is only when the yolk spaces are formed that their acidic contents stain bright red in neutral red.

The mitochondria stain green in Janus, and occupy the usual position in the early and growing eggs.

These results may be confirmed by the Nassonow and Da Fano methods, although the latter causes much shrinkage, and is extremely capricious on crustacean material.

With the assistance of Miss Kennelly, we have tried these stains on Limnæa and certain other fresh-water molluscs. The neutral red will stain a Limnæa bright pink in a few hours, and the molluscs appear to live quite happily in this condition.

We have been unable to confirm Mme. Karpova's claims as to a 'vacuome' in mollusc spermatocytes. On the contrary, neutral red vacuoles only appear during oogenesis, as already described in Patella and Limnæa by Ludford, Brambell, and one of the present writers.

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### Variation of Intensity Ratios of Optically Excited Spectrum Lines with the Intensity of the Exciting Light.

THE principle referred to by Prof. Wood in his letter to NATURE of Nov. 19, that the product of a two-stage absorption increases at first as the square of the intensity of the light, that of a three-stage absorption as the cube, and so on, is evidently capable of wide application.

The necessary data for the examination of the photographic action from this point of view have now been obtained at this Observatory, where the principle was recognised some time previous to its statement by Prof. Wood (see *Proc. Roy. Soc. Edin.*, 47, p. 47 footnote; 1927). The results show a striking similarity to those found by Prof. Wood for mercury vapour. The latent image (in so far as it is developable) is made up for the most part of a slowly developing image resulting from a two-stage absorption process, and of a rapidly developing image formed by absorption in three or more stages. By an extension