mannose is now nearing completion, and the results of the X-ray analysis of *d*-mannitol and *d*-mannose are to be incorporated in a paper which is in preparation.

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The Nature of Time.

EDDINGTON [1] has argued that the second law of thermodynamics definitely requires a one-way flow of time, although all other physical laws are equally valid for $+t$ and $-t$. Lewis [2] has taken the opposite stand, and concluded that entropy entails no temporal implications, hence time must be considered as twofold. Both agree that consideration of an individual particle yields no clue to the dilemma.

Pressing Eddington's 'time's arrow' argument, it appears theoretically possible to interconnect all elementary volumes of equal entropy in the universe by hyper-surfaces orthogonal to the time lines tangent to 'time's arrow'. Since entropy is a relativity invariant, this would determine a unique lattice for separating space and time, contrary to the principle of relativity.

It has occurred to us that since the only real argument in support of one-way time is derived from a consideration of statistical assemblages, it may be that time itself is discrete and should be statistically treated. To our knowledge this possibility has not previously been suggested, although Eve [3] has recently pointed out the intimate association of frequency (and therefore time) with mass and energy, both of which have been found to be discrete.

Pursuing the thought a little further, if the unit of time were intimately connected in some way with the electron or proton, some light might be shed on the mystery of quantum jumps. Since h/mc^2 has the dimensions of time, a possible value for a quantum of time would be $8{\cdot}12 \times 10^{-21}$ sec. obtained by substituting the mass of the electron for m in the above expression.

If time is found to be essentially discrete and statistical, then, since action and matter are already so accepted, the postulate of discrete or statistical space and electric or magnetic fields would also become highly probable.

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Chicago, Illinois, Dec. 20.

[1] "Nature of the Physical World", Cambridge University Press, 1928.
[2] "Symmetry of Time in Physics" (*Science*, June 6, 1930, p. 569).
[3] "The Growing Importance of Frequency" (NATURE, Mar. 22, 1930, p. 454).

Equipotentiality of the Amphibian Eye Primordia.

THE experiments referred to below are concerned with the problem of the regulative power of embryonic *anlage*, the study of which has been taken to prove the equipotentiality of the eye primordia in amphibian embryos in the stages following the closure of the medullary folds. In *Pleurodeles waltli* it has been shown [1] that two optic vesicles may fuse together when that of the donor is transplanted in the close proximity of the optic vesicle of the host, keeping the same orientation of the normal position in the implanted eye. The degree of fusion depends upon the size of the removed portion of the vesicle in the host, and varies from that of double eyes partially fused to single eyes of larger size than the normal, which have developed by complete fusion of the two optic vesicles, which regulate its size afterwards, provided that the lens is not double.

By transplanting the optic vesicle of the donor dorsally and ventrally, cranially and caudally, or in the outer portion of the vesicle in the host, it has been possible to show the morphogenetic equipotentiality of the eye primordia. This is further shown by the fact that the anterior, posterior, ventral, dorsal, or medial halves of the vesicle may regulate and give rise to a normal but smaller eye. Such results have been extended by myself in further experiments on *Triton*, *Axolotl*, *Rana esculenta*, later by Detwiler [2] in *Rana fusca*. More recently, in some experiments on lens induction in *Rana catesbiana*, I repeated my own experiments on the fusion with the same results.

The chief results concerning the extent of fusion of two optic primordia in the experiments already described, together with the regenerative power of the optic vesicle or its compensatory regulation, have been dealt with. Our experiments have shown that the easiest way to get complete fusion is to remove a certain amount of the exterior part of the host vesicle, transplanting in its place the vesicle of the donor; with the same kind of operation, it has been possible to get the clearest cases of regulation in the medial half of the vesicle. In this way the potentiality of the optic vesicle's constituents has been analysed, controlling each half of the vesicle delimited by the transversal, frontal, and sagittal planes.

It has been found also, in my fusion experiments, that there exists a very close relation between the behaviour of the lens and the fused eye. Examples of such are cases in which the lens ectoderm was not transplanted with the optic vesicle and the double eye arose with a normal size lens; cases of transplantation of the optic vesicle with the overlying ectoderm which gave rise to double eyes with double lenses; or cases of a single lens produced by the fusion of two lens primordia. In the first case the regulatory reduction of the size in the double eyes seems to be accelerated, the same occurring in eyes with single fused lens; in the latter case the presence of two lenses causes less regulation of the form and size of the eye, and in some cases this regulation does not occur at all. A point of particular interest which has been investigated more carefully is the reaction of nerve centres to the double eye (resulting from complete fusion of two optic vesicles), in which case the number of nerve fibres growing in the thicker nerve has been increased by the implantation of an additional optic vesicle. There is always a very clear hyperplasia of the central nervous system, and the amount of the grey matter in the wall of the mid-brain on the side opposite to the double eye increases because of the greater number of the ingrowing nerve fibres.

A similar reaction has been shown for a single eye transplanted in the ear region by May and Detwiler [3] in *Amblystoma*, by May [4] in *Rana temporaria* and *Bufo vulgaris*, but in this new condition established by a double nerve which belongs to a larger sense organ, this reaction has a particular significance for its quantitative nature. These effects are closely similar to the hyperplasia found by Burr [5] in *Amblystoma* following the fusion of two nasal pits, and to the hyperplasia described by Twitty [6] when a large *Amblystoma tigrinum* eye is transplanted in its normal position in *A. punctatum* embryos.

In my experiments the size of the larger eye, sometimes double that of the normal and originating by complete fusion of the two eye primordia, the normal and the grafted one, and the consequent disturbance of the number of ganglionic cells in the double retina, causes also a real shifting of the grey matter cells in the brain toward the ingrowth of the supernumerary nerve fibres. My new experiments in *Axolotl* [7] have shown the possibility of such an increase of the amount of the grey matter as a result of the transplantation of a supernumerary single eye in a different region of the head; in other words, with abnormal connexions with the brain in the olfactory