has occurred during a comparative calm on some occasions, whilst on others, though a strong gale has been setting inshore, I have not noticed any difference in the lake's level, so it would seem that this occurrence is not altogether attributable to the wind backing up the water. Another curious feature is the periodical rise and fall which, according to the natives, takes place every twenty-five years, and which is shown by the water-marks on the shores. At the time of my visit the lake was between eight and nine feet below high-water mark, and the people told me that certain lands then under cultivation would again be flooded in due season, and that the peninsula on which my camp was pitched would again become an island." Similar changes of level have been noticed, both in Lake Tanganyika and Lake Nyassa, and it is very desirable in the interests of geography as well as the development of the continent that continuous observations should be made, in order to discover what is the real character of these changes.

LETTERS TO THE EDITOR.

*** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

The Relative Hardness of Cut Diamonds.

WILL you allow me to add the result of my experience to the testimony of Mr. Kunz that the hardness of diamonds is not perceptibly reduced by cutting and polishing? In the earlier years of my experience in ruling upon glass I was accustomed to select a gem with a smoothly glazed surface, and, splitting the stone in a cleavage plane inclined at a rather sharp angle to the natural face selected, this split face was then ground and polished.

In this way I was able to obtain at several points short knife-edges, which gave superb results in ruling. It was soon found, however, that after ruling several thousand rather heavy lines the diamond was liable to lose its sharp cutting-edge, and this experience became so frequent that I was compelled to resort to the method now employed, that of grinding and polishing both faces to a knife-edge. I have one ruling diamond prepared in this way, which has been in constant use for four years, and its capacity for good work has not yet been reduced in the slightest degree.

A diamond prepared by Mr. Max Levy of Philadelphia has given even better results, and so far it shows no evidence of wear.

WM. A. ROGERS.

Colby University, Waterville, Me., June 6.

The Notion of Four-Fold Space.

IN a paper by Professor T. Proctor Hall, entitled "The Possibility of a Realization of Four-fold Space," a digest of which appeared in *Science* for May 13, the author, after making certain allusions, remarks "there is therefore nothing inherently absurd or improbable in the supposition that any of us may attain to a concept of four-fold space 'as clear as the designer and the draughtsman have of three-fold space.'" The word "therefore" refers to what immediately precedes, and here we read: "Perhaps most of us can remember times in the course of our education when new conceptions of quantity entered into our conscious life, conceptions which correspond in a general way with those of length, area, and volume, in that they enable us to find at once such relationships as are most frequently required for practical purposes by a general, synthetic, instinctive method . . . . The sense of propriety, the sense of honor, and numberless other 'inbred' or 'instinctive' concepts are examples of this mental tendency." There is no such connection, however, between this and the succeeding paragraph, quoted above, as to justify the assertion made with reference to the conception of four-fold space, and the utmost that can be properly inferred is, that, in the words of the following sentence, "such a conception would be of great value to all classes of scientists"—assuming always that it is a possible conception, that is, possible to us with our present mental constitution. I do not propose to enter into this question, but it seems to me that Professor Hall's argument is open to criticism in other respects.

For instance, he does not sufficiently meet the objection based on the fact that "our conception of three-fold space is derived directly from sensations in three-fold space, and that the conception of four-fold space cannot be derived in a similar way, nor yet from sensations in three-fold space." It may be admitted that from the sense of sight we get only a two-dimensional sensation, and that the existence of a third dimension is solely a matter of inference. Yet, this inference has a physiological basis, and is justified by universal experience in past and present generations, so that we know that it expresses the truth. The conditions relative to the conception of four-fold space are quite different. There are apparently no grounds on which a fourth dimension can be inferred, and so far from such an inference being in accordance with experience, this entirely opposes it. To render the truth of such an inference probable, it would have to be shown that the existence of a third dimension is inferred solely from that of two-dimensional space, and yet even then, as the conception of a three-fold dimension would be supported only by that of a two-fold dimension, it would hardly form a sufficient basis for the existence of a fourth. In fact this would ultimately, like the second, be based on the conception of two-fold space.

The conditions of the question are such that the hypothesis of a fourth dimension cannot be made as real to us as that of the existence of a third dimension; any more than Professor Hall's plane being, that is, a being who has no conception of volume, could understand a geometric solid. It is one thing for a person who knows all about three-dimensional space to explain how an imaginary plane being might be able to form such a conception, but a totally different thing for the plane being to perform the operation. The conduct of animals shows that they act according to the same view of space that we do, and yet none of them could form any idea of the relations of the faces of a cube, although propably some very clever dogs can be taught the number of its faces. How much less could any plane being form an idea of those relations. In suppositious cases of this kind, it is always assumed that the imaginary being would be limited only in his ideas of space, but surely this notion is erroneous. A being thus deficient would, by virtue of the law of organic correlation, be equally deficient in other respects, and would rank in an inferior grade of organic development. Such being the case, it is impossible to imagine a plane being acting as a three-dimensional philosopher, and constructing a theory of the evolution of circles, true or false.

It seems to me that those who endeavor to imagine the possibility of four-dimensional space look in the wrong direction. It is very questionable whether, as we are at present constituted, we can possibly form any such idea of space, but there is another view which is worthy of consideration. We know space only in relation to formed matter, and if such matter were to disappear, space would, as so related at least, disappear also. According to present conditions such a state of things would seem to be highly improbable, but we can nevertheless, from what we know of the past, conceive its possibility. If we trace the evolu ional stages of organic nature back through the higher animals from man we reach the worm, from which, according to Hæckel, they have all sprung. Going still further back we come to the primitive moneral ancestor of all organic existence on the earth. But we can retrace the path of evolution beyond the primordial slime, until we arrive at its beginning when, says Professor Crookes, "primitive matter was formed by the act of a generative force, throwing off at intervals of time atoms endowed with varying quantities of primitive forms of energy." Before this there existed, we are told, the formless fluid, from knots and voids in which the chemical elements were formed.

But what has had a beginning can come to an end, and we can imagine therefore all organic and inorganic forms being reduced to the primitive elements, and these elements themselves resolved into the formless fluid from which they were derived. Professor

Crookes says, indeed, "that the atoms are not eternal in existence, but share with all other created beings the attributes of decay and death." They cannot be dissolved into nothing, however, and the only condition they could assume would be that of the formless fluid from which they originally emerged. If this were to happen, matter as we know it would cease to exist, and material or three-dimensional space would with it disappear.

Such a change as is here supposed would be one of pure negation, that is, it would be the negation of all material existence. And yet it would not be absolute negation. It might be described as the absence of position. Every past stage of evolution is negative to that which immediately succeeds it, and yet it is positive to that which has gone before; so that if we go back to the beginning of evolution, the earliest negation is the most real of all existences, because it is that from which all other existence has been derived. Thus formed matter in ceasing to exist as such, and in being resolved again into the primitive formless fluid, would yet continue to exist in a negative state, that is, in its original formless condition, as to the nature of which we can frame no clear idea, beyond that it would be non-material and invisible. Probably we should be justified in considering it the same as the ether.

The existence of the ether is as real as that of formed matter, judging from the phenomena of light, and for that we know there may be ethereal existences which are not subject to the laws which affect that matter. It may be, moreover, that the ether furnishes the link which unites individuals so as to form "genetic or race relationships," and that it conceals the world of spirits, if such exists, from material gaze. The race unity which Professor Hall refers to may, indeed, be conceived of as consistent with, and as even requiring the continued existence of, individuals; just as the existence of a wire depends on that of its constituent molecules. Thus the death of an organism may include a change, unless it be simply a *return*, to a state of immateriality and, therefore, of invisibility. If so, such a negative existence may be the end of all things, material as well as organic; and, since complete change of form often, as in the case of destruction by fire, takes place rapidly, there may be conditions under which, instead of as Professor Hall imagines a plane being stepping out of our space and re-entering it again, matter may suddenly become invisible, that is, be reduced to a state of formless fluid, and again become visible. Under such a condition, all the phenomena which it is supposed the existence of four-fold space would render possible, could be equally well produced without it. The erratic nature of ghosts even would be explainable on the assumption that ethereal existences have the power, under special circumstances, of making use of the physical forces so as to render themselves visible. This is, however, beside the real question, which is the possibility of a state of relatively negative existence, which, although invisible to us, is as real as that on the material plane.

C. STANILAND WAKE,

349 North Clark St., Chicago, June 1.

The Possibility of a Realization of Four-Fold Space.

DR. HALL'S argument for this possibility (*Science*, May 13, 1892) turns upon two other possibilities: first, upon the possibility of building up the conception of this kind of space from that which we already know; and, second, on the possibility of making such a conception so perfect that it may fairly be said to be realized. In support of the first he instances the visual perception of space in which we are supposed to get three fold space by inference from a plane image. Many psychologists, however, contend that such a constructive inference is quite impossible, and others believe that it is only made possible in the case of vision by the aid of touch. Even those that admit a construction of the sort required, can hardly deny that it occurs in the very beginning of babyhood, a fact that points to a racial rather than an individual acquisition. It appears, therefore, to be extremely doubtful whether Dr. Hall could get a four fold space conception built up in a single generation, if at all; that is, if it is to be realized in anything like the degree in which we realize three-fold space.

If, however, by realization is meant only a tolerably complete knowledge about four-fold space,— such, for example, as a deaf physicist could get of sound,— it may be possible to realize it; and Dr. Hall has undoubtedly taken the right road. But knowledge about a thing seems to come somewhat short of realization of it. Some sensory element is also required, and especially verification by touch, which is the sense of last appeal in cases of doubtful reality. Dr. Hall's models would appear to this sense as unquestionably three-fold as a perspective drawing would appear plane.

In regard to the benefits of a full knowledge of four-fold space, Dr. Hall should not allow himself to hope too much. A really clever and elusive ghost would never stop at four-dimensions, but would surely lead him, Will o'-the-wisp fashion, through all the series of n dimensions.

EDMUND C. SANFORD.

Clark University, Worcester, Mass., June 6.

Eskimo Throwing-Sticks.

IN my pamphlet on the Eskimo Throwing-Sticks I drew attention to the fact that they are all right-handed save two from the Alaskan Peninsula and that neighborhood. I also mentioned two specimens afterwards described by Ensign Niblack from the T'lingit area in south-eastern Alaska. I neglected to mention that they are ambidextrous, and so is a beautiful specimen from the Vancouver collection, figured by Mr. Charles H. Read in the *Journal of the Anthropological Institute* (Vol. XXI., pl. xi.), bilaterally symmetrical and, doubtless, ambidextrous. In British Columbia and Washington the long-handled fish-spear is ambidextrous, and has two finger-notches on the end, answering to, if not derived from, the form further south. Mr. Read's specimen from Santa Barbara, Cal., is an abbreviated specimen of like form to one lately recovered from Lake Patzcuaro, Mex., by Captain John G. Bourke, U.S.A., suitable for either hand. Looking over the interesting pamphlets of Mrs. Nuttall and Messieurs Stolpe, Uhle, Bahnson, Seler, and de Mortellet, I find most of the spear-throwers or throwing-sticks adapted to either hand. The ornamentation throws a considerable amount of uncertainty over the elaborate forms, but, omitting the Eskimo examples, all other spear-throwers appear to be ambidextrous. Indeed, I should like to inquire whether outside of the Eskimo area any American aborigines had apparatus that would not fit either hand.

Hasty conclusions are dangerous, but we may be allowed to say that the development of a purely right handed implement points to a southern origin for the original invention. At any rate, the atlatl is assuming an enviable importance in comparative technography. While upon the subject I should like to draw attention to the Mexican artist's fashion of pulling certain parts of a solid body into the foreground, as in the heart-shaped finger-pocket or grip on the bottom of the atlatl, always exhibited on the side. Notice is also called to the fashion of shortening objects to get them into a picture; for example, in many cases a harpoon with a shaft ten feet long is represented with all its parts in as many inches.

O. T. MASON.

Washington, D.C., June 7.

AMONG THE PUBLISHERS.

THE Scientific Publishing Company, 27 Park Place, New York, have in press Dr. Endlich's "Manual of Qualitative Blowpipe Analysis."

— William R. Jenkins, New York, has just issued "Parasites and Parasitic Diseases of the Domesticated Animals," by L. G. Neumann, professor at the National Veterinary School of Toulouse, translated and edited by George Fleming.

— Harper & Brothers have nearly ready a book which doubtless will provoke no little discussion and controversy. In is entitled "The Puritan in Holland, England, and America," by Douglas Campbell, who claims that the last word regarding the Puritan settlers of New England has not yet been written, and that many of the prevalent ideas concerning the earlier influences upon the political, social, and religious life of the American people are susceptible of revision.