A very fine example of the value of knowing the correlation of host and symbiont was demonstrated when studying the disputed *Mesotrichia aestuans* and *M. confusa* of India. *M. aestuans* is a recognized north African form, and within its pouch there is a characteristic African mite belonging to the *braunsi* group which I have named *Dinogamasus inflatus* because of certain swollen hairs on the legs. There has been more or less uncertainty whether the *confusa* of the Orient is the same as the African *aestuans*. Pérez recognized the two forms, using the margin of the clypeus, the clypeal keel and the frontal keel as the main distinguishing features. It has been recently claimed that these species are not distinct.

It was interesting to find that two specimens of these disputed bees which I had from northern India had the African *Dinogamasus inflatus* in the pouch, and that another bee labeled from Sikkim, India (from the Bingham collection, Berlin Museum), as well as other specimens of *confusa* from other Oriental localities, had mites belonging to the Oriental group.

Dr. T. D. A. Cockerell examined the hosts and upon comparison with an African *aestuans*, taken at Suez, he found that the specimens from northern India (Chikar Kot, N. W. Prov., and Jammu, Kashmir; Frank Benton collector, National Museum specimens) are the genuine *aestuans*, thus evidently belonging to the Palearctic fauna which extends over from northern Africa. The other form of carpenter-bee he determined as the true *confusa*, and this, belonging to the Oriental region, naturally should harbor a distinctly Oriental species of mite.

Another case of the mites helping to distinguish between slightly differing hosts may be cited. Two specimens labeled *confusa*, one from Singapore and one from Trang, Siam, yielded closely related but nevertheless distinctly different species of mites. Examination of the hosts showed that the one from Trang was *M. confusa* var. *viridissima*. It is conceded now that this form should be considered a valid species *M. viridissima*.

NORMA LEVEQUE

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PROFESSOR EINSTEIN'S ADDRESS AT THE UNIVERSITY OF NOTTINGHAM[1]

PROFESSOR EINSTEIN does not wish you to accept his remarks on credit, but wishes to explain in the clearest way possible what he considers to be the trend of modern physics. What he has to say is his purely subjective opinion and it is by no means generally recognized. He thinks that he can give you at least some outline of what his view is of the future of the subject, but he does not want his remarks to be regarded as assertions. He wants them to be regarded rather as humble expressions of his opinion.

He will now concentrate our attention on the fundamental conceptions which lay at the beginnings of the foundations of physics. Professor Einstein makes clear what the prescientific view was and explains that the primitive concept was that of a rigid body and that relationships in the positions of rigid bodies preceded all ideas of space; that space was not a primary conception and that it was only through dealing with the position and relationships of bodies that the idea of space later emerged.

These ideas of space were due, of course, to contact relationships between bodies, and it is interesting to know that the classical science of the Greeks did not operate with space but exclusively with bodies. A rigid body is at the bottom of all the conceptions of geometrical space in Euclid.

The idea of a space continuum entered into science only when analytical geometry was invented by Descartes. How did the idea of space originally arise? The Greeks approached position in geometry by considering the position of bodies with regard to each other. This, of course, suggests a body of reference. We are familiar with coordinate systems in geography in the way in which they were used, for instance, in maps of geography.

Space appears expressed in body-like form by means of these axes of reference. This is really the way in which space as such entered into geography in the first place, and there was no physical basis for it. Relative motion occurs only with reference to one or more bodies. The great change took place in that view when Newton propounded his mechanics.

The fundamental idea of Newton's mechanics was the introduction of the idea of force—that is to say, acceleration. Acceleration can be imagined only in reference to a really rigid body. It is a wonderful tribute to Newton's genius that he could go so far as to give space a definite physical reality.

He included it among the other realities. This is an aspect of his theory which has not been understood or has been neglected or misunderstood by some of his followers. Professor Einstein is very anxious

[1] The address given in German on June 7 was translated by Dr. I. H. Brose. A stenographic report of Dr. Brose's translation was cabled to *The New York Times* and permission has been given for publication in SCIENCE.

that this particular point be emphasized—that space entered as a definite physical reality. It was a point which was missed even by the philosopher Kant.

A remark should be added about the physical idea of space. There are two aspects. In one of them space is to be regarded as the quintessence of positional possibilities of bodies, and, secondly, as a definite dynamic system of reference.

Professor Einstein emphasizes that Newton's space is to be regarded as absolute in the sense that positional possibilities of rigid bodies are to be considered as quite independent of outside forces, although he does not take temperature into consideration. This space is independent of all physical causes and is something which is absolute in itself.

In Professor Einstein's opinion a definite change in the view of nature after the time of Newton occurred when the idea of the electro-magnetic field was introduced by Faraday and Maxwell. The only real things at that time were bodies, space and time. Those were constructive elements from the physical viewpoint of the times. There were no others.

Faraday introduced the idea of "a field," and his contemporaries were bound to that method of introducing the idea of a state owing to the manner of thought of their time.

They, therefore, introduced a new body called the ether—or at least a new idea which they called ether—to represent a physical state. The introduction of ether was necessary in order to allow electro-magnetic phenomena to occur in space. This view received considerable strengthening at the hands of a Dutchman named Lorentz, who showed that in the electro-magnetic theory of states all ponderable bodies were those of ether and not of material bodies themselves.

Looking back now we might ask why ether as such was introduced. Why not have called it "state of ether or state of space"? The reason was they had not yet got to realize the connection or lack of connection between geometry and space, and so they felt constrained to add to space a variable brother, as it were, which could be a carrier for all electromagnetic phenomena.

The next change in the idea of space was comparatively small. It was due to a special theory of relativity sometimes called the "restrictive" theory of relativity. Classical physicists had two separate continua which were to be regarded as a performing stage for continua. Those were space and time. Altogether, they formed four dimensional continua, three being in space and one in time.

But it had to be subdivided into two blocks due to the fact that there were a before and an after and to satisfy the requirements of simultaneity. It was found, however, that to satisfy the demands of the constancy of propagation of light the subdimensions of space and time could not in this way be preserved or carried out.

The space-time phenomenon of the special theory of relativity was something absolute in itself, inasmuch as it was independent of the particular state of motions considered in that theory.

A definite change in our ideas about the rôle and constitution of space was due to the enunciation of the general theory of relativity, for which the ground had been prepared by the special theory of relativity. The law of inertia—we called it Newton's first law of motion—has shown a gap in its logic because we were not able to tell when coordinate systems were in acceleration or in rotation. We had no definite means of establishing it.

This is what is known in the general theory of relativity as "the principle of equivalents." It implies that an accelerated, coordinate system can be regarded in a certain sense as equivalent to what was known as the "inertial system." Watches and measuring rods were not found to operate in the same way for accelerated systems as for coordinate systems of the special theory of relativity.

To preserve the theory of relativity for the accelerated motions as well as for the uniform regular motions of the special theory of relativity, Euclidian geometry, having been found to be too restrictive, had to be rejected and a new geometry of space found. In order to preserve position possibilities of space we were compelled to regard them as no longer independent of positions of other bodies.

In other words, the privileged position of geometry had to be given up and the viewpoint of covariants, as it is known to mathematicians, has been gained. This means that for a description of physical phenomena we must regard all generalized coordinates as of equal validity.

What, as general theory, has relativity then actually achieved? Professor Einstein does not want to enter into the question of the three experimental tests, which have all conformed to his suspicions, but the main achievement of the general theory of relativity is that it has advanced a uniformity of view of the physical world structure. The metrics of space can be derived directly from the full equation and it reduces a number of hypotheses which were originally thought necessary to account for physical phenomena. It has built, so to speak, a bridge between geometry and physics.

The next question is—What are the weaknesses of the general theory of relativity? Taking as a basis the Rummbey-Riff structure of space, we find that geometry and gravitation were completely represented by this structure, but what was to be done with the electro-magnetic phenomena which play an exceedingly important part in the world of physics?

In order to introduce these phenomena and to take them up in the general scheme of relativity it was found necessary to add to or impose upon the metric structure or Rummbey-Riff structure further terms which could account for electro-magnetic phenomena. Logically this structure had nothing to do with that which had been deduced from the elementary law of propagation of light. This duality in the geometrical structure of space leaves us in a rather indistinct state.

Professor Einstein feels that it should be possible to get a further form of this metrical space which will at one stroke comprise all phenomena in one set of equations, so that we shall not have a double metric structure of geometry and gravitation, on the one hand, and electro-magnetics on the other.

We want a system of equations which will take in all physical phenomena. This would be an enormous gain in the picture of the uniformity of physical nature.

As to the way in which the problem may be solved Professor Einstein says that it is a very difficult question to answer, and it has not yet been finished. His colleagues regard his view as a particular craze and do not support it. Nevertheless, he has faith in the path along which he is proceeding, and although the theory is not yet quite finished, he has evidence that so far as he can judge the end is very near.

He says that there is a metrical structure of space, but that a full-time structure has yet to be determined. Then he wishes to find what conditions have to be made in the older structure or what modifications in electro-magnetic phenomena may be included. He emphasizes that he is in no way taking notice of the results of quantum calculation because he believes that by dealing with microscopic phenomena these will come out quite by themselves. Otherwise he would not support the theory.

Then he says that a new idea which has occurred to him and on which he has been working is that the two elements in space should also be compared with direction. So far we have compared them only as regards size. This idea may give a clue. It occurred to him suddenly during a severe illness two years ago that by introducing the idea of direction he would be able to get the additional terms that are required in regard to space to allow electro-magnetic phenomena to be included with those of gravitation and geometry.

Professor Einstein's object now is to get mathematical conditions which will satisfy all his expressions and will comprise electro-magnetic equations as well. The problem is nearly solved, and to the first approximations he gets laws of gravitation and electro-magnetics. He does not, however, regard this as sufficient, though those laws may come out. He still wants to have motions of ordinary particles come out quite naturally.

This does not finish the program by a long way. It has been solved for what he calls "quasi-statical motions," but he also wants to derive elements of matter (electrons and protons) out of the metric structure of space. No doubt much work will have to be done before this is achieved. Professor Einstein thinks, however, that the way in which he has sketched the evolution of physical ideas is the only possible one—at least to him.

The strange conclusion to which we have come is this—that now it appears that space will have to be regarded as a primary thing and that matter is derived from it, so to speak, as a secondary result. Space is now turning around and eating up matter. We have always regarded matter as a primary thing and space as a secondary result. Space is now having its revenge, so to speak, and is eating up matter. But that is still a pious wish.

THE IOWA ACADEMY OF SCIENCE

THE forty-fourth annual meeting of the Iowa Academy of Science was held at Iowa State College at Ames on May 2 and 3, with 330 members and visitors in registered attendance.

The president's address, "The Ether Concept in Modern Physics," was given by Professor L. B. Spinney. The academy address, "Methods of Space Determination," was presented by Dr. C. C. Crump, professor of astronomy at the University of Minnesota. Professor Crump took the place of Dr. R. A. Gortner, of the University of Minnesota, who was detained on account of the serious illness of his son. Dr. Crump also acted as the American Association representative at this meeting. Other papers of the general meeting were: "A Statistical Test of Experimental Technique," G. W. Snedecor; "X-ray Diffraction in Water 2° to 98° C.: The Nature of Molecular Association," G. W. Stewart; "A Note on the Trans-neptunian Planet," D. W. Morehouse; "Some Recent Modifications of the Geological Map of Iowa," A. O. Thomas, and "Soil Bacteriology as a Science," P. E. Brown.

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[1] The academy research fund is made possible by the refund of the American Association for the Advancement