frittering away of large resources upon schemes of research that are unwisely planned or prematurely undertaken or imperfectly coordinated with other activities of advancing science. And if it failed it would at least put the responsibility of justifying these expenditures of wealth, where it really belongs, upon American science as a whole.

With such a scheme of apportioning benefactions in the aid of pure science, the commercial utilities of research might safely be left to take care of themselves; for the large majority of the members of our scientific associations are themselves college professors, and would know well enough what scientific problems needed the support of benefaction and what could be wisely left for solution to the selfish interests of commercial organizations.

MARK H. LIDDELL
PURDUE UNIVERSITY

A TEST FOR ECLIPSE PLATES

THE mere fact that photographs taken during a total solar eclipse show a bending of light rays does not, of itself, prove the Einstein theory. Such bending may be due to the Einstein effect, or may be due to one of several perfectly natural causes: refraction of light through the masses of matter surrounding the sun, or abnormal refractions in the atmosphere of the earth. Until the possible effects of these natural causes have been completely eliminated, the observed light deflections during an eclipse cannot be taken as proof of relativity.

The effects of abnormal refraction in the earth's atmosphere may be very similar in character to the so-called Einstein effect. The higher the sun in the heavens at the time of the eclipse, the more nearly will the effects of abnormal refraction approach the Einstein effect. In fact, in the ideal case the two effects (abnormal refraction and Einstein) follow practically the same law. If, at the time of the eclipse, the sun be in the zenith of the observer and the atmosphere be perfectly quiet, then the shadow of the moon would cause a funnel of cool air to form, coolest along the vertical axis of the shadow. A ray of light from a star would, therefore, pass from warmer air to the cooler air of the shadow axis in reaching the photographic plate, and such ray would be refracted, or would show a bending; and the amount of such refraction would depend upon the distance of the star from the axis of the shadow. The law by which the amount of such refraction would decrease with the distance of the star from the center of the shadow would be the same as that for the so-called Einstein effect. A difference in temperature of only a very few degrees between the air at the axis of the shadow and that at the edges would cause a bending of the rays fully as large as that called for by Einstein. This abnormal effect might be larger than and completely mask the ordinary refraction.

There is rather a simple way of testing an eclipse plate for the presence of such abnormal refraction. Such a plate shows not only the images of the stars, but also the image of the moon. Various points on the edge of the moon might be measured in identically the same way as the star images. Such moon measures could be reduced in a manner entirely similar to that used for the stars, applying the same corrections for orientation, scale value, differential refraction, etc. From these measures could thus be obtained the values for various diameters of the moon and such measured diameters could be compared with that calculated from the lunar tables.

Such an operation ought to give a very good check on other measurements on the plates, it ought to show up any plate distortions, instrumental errors or atmospheric abnormal refractions. If the various diameters of the moon, so measured, show no distortion and agree with the calculated value, then this check would be fairly conclusive evidence that any star deflections obtained are caused by some cosmic action, are due to some cause or causes at a distance farther from the earth than the moon. On the other hand, if the moon diameters show distortions, or a value different from the calculated value, it would be good evidence that any other observed deflections are also of terrestrial origin, either instrumental or atmospheric.

On a plate of very long exposure the motion of the moon during the interval might cause complications, but on a plate exposed for only a few seconds such motion ought to be negligible.

Unless this, or a similar test can be made, the possibility that the observed bending of the light rays from the stars may be due to ter-

restrial causes will always remain, and the eclipse plates, whatever their results, can not be cited as proof of the Einstein theory.

CHAS. LANE POOR

DECEMBER, 1922

CHANGE OF FREQUENCY ON SCATTERING

A. H. COMPTON in a lately received bulletin of the National Research Council has reported some recent results obtained by him showing an increase in wave length of X-rays on scattering by graphite of the Molybdenum Kα line amounting to .022Å. U. A. Sommerfeld in his recent lectures, and Compton in *Phys. Rev.*, February, 1923, page 207, have shown that from the quantum theory the shift should be independent of the wave length of the primary beam and of magnitude $\Delta\lambda = \frac{2h}{mc} \sin^2 \frac{\theta}{2}$ where θ is the angle between the incident and scattered beam, h is Planck's constant, m the mass of an electron and c the velocity of light. At $\theta = 90°$ the value of $\Delta\lambda$ is .0242 Å.U $= \frac{h}{mc}$.

Compton states that according to his "absorption measurements, over the range of primary rays from .7 to .025 Å.U. the wave length of the secondary X-rays at 90° with the incident beam is roughly .03 Å.U. greater than that of the primary beam which excites it."

Such a shift, if it exists in visible light, should be detectable by interference methods. The writer has looked for such a shift with negative results. A Lummer-Gehrcke plate of resolving power 360,000 was used and the scattered beam compared with the direct beam using the green mercury line as well as various helium lines. The scattering substance was a block of paraffin and scattering was observed at nearly 180°, so that the shift should have been about .048 Å.U., while the plate should resolve to .015 Å.

Multiple reflections to the number of 16 at nearly 180° between silvered glass surfaces were also tried. All results were negative.

P. A. Ross

STANFORD UNIVERSITY

WHAT IS A PLANT?

THE discussions which have appeared in SCIENCE during the past weeks indicate that botanists are unable to agree as to a definition for a plant. In such a situation a chemist may perhaps be pardoned for offering a suggestion. The presence or absence of chlorophyll is obviously no criterion, for certain plants, *e.g.*, the "Indian pipe," *Monotropa uniflora,* are devoid of pigments. There is, however, one essential *chemical* difference between plants and animals. In *animals* the principal structural material is *protein* or some form of protein, whereas in plants *carbohydrates* predominate. Could not one, therefore, define a plant as "*a living organism whose cell walls consist predominately of carbohydrate materials?*" This would include the bacteria whose cell walls are composed of chitin, a nitrogenous carbohydrate. The fact that chitin forms the shell structure of certain invertebrates, such as the lobster, does not invalidate the definition, for the cell walls of such animals are composed predominately of protein.

R. A. GORTNER

UNIVERSITY OF MINNESOTA

SCIENTIFIC BOOKS

The Anatomy and Physiology of Capillaries, The Silliman Lectures for 1922 at Yale University, by AUGUST KROGH, Ph.D., LL.D., Professor of Zoo-Physiology, Copenhagen University. Yale University Press, 1922.

IN the circulation of the blood "the organs of propulsion, distribution and carrying back are all subservient to the function of exchange carried out in the capillaries and though, of course, each of the great organs is absolutely necessary for the functioning of the whole, it will be difficult to challenge the proposition that the capillaries constitute the most essential part of the whole circulatory system." Thus Professor Krogh early in the first lecture of this series emphasizes the broad importance of his topic. It is a conception which looks upon the particular topic, not as an isolated phenomenon, not merely as a "fragment of an animal," but in its bearing and function in the economy of the whole organism. This standpoint is noteworthy for its similarity to that adopted in two other masterpieces of physiological literature contributed by two previous Silliman lecturers. Krogh, like Sherrington in the "Integrative action of the nervous system" and Hal-