cially their language. I may not live very long, nor do I wish to do so; but I fear that unless these data can be properly elaborated and published there would be lost with me to science a good deal that could not be replaced. My monthly salary is 48 rubles. In order properly to work up my data I would need about 250 rubles (approximately $125) a month for one year. The result would be a book of about 500 pages on the Yenisei Ostiaks. For the illustrations I have more than 100 photographs and 10 drawings, besides 40 *aquarelles* made under my direction by a Russian artist. These *aquarelles* alone would be a valuable acquisition for any museum.

It is to be hoped that Professor Anučin will find the help of which he is in need.

A. HRDLIČKA

U. S. NATIONAL MUSEUM

SCIENTIFIC BOOKS

A Handbook of Solar Eclipses. By ISABEL M. LEWIS. XI + 118 pp. Duffield & Co., New York. Price, $1.25.

THIS little book was undoubtedly one of the best sellers in New England and New York just before and after the eclipse of January 24.

It is intended to enable the layman to make the most of the few precious seconds of a total eclipse of the sun. It explains in non-technical language the cause of eclipses and describes clearly what to look for during an eclipse. There are chapters on the shadow bands, Baily's beads, the chromosphere, prominences and corona and general instructions for viewing a total eclipse. Herein are answers to most of the questions with which astronomers are bombarded before every eclipse.

There are also chapters of a somewhat more technical nature on the prediction of eclipses, the flash spectrum, the astronomer's eclipse program and the scientific importance of eclipses. A bit of history dealing with the noted eclipses of the past and a chapter on the total solar eclipses of the near future conclude the book. Special attention is given to the eclipses of January 24, 1925, January 14, 1926, and June 29, 1927. The path of the 1927 eclipse crosses northern England. It will be the first total eclipse of the sun to occur in the British Isles since 1724.

The book is well illustrated by reproductions of photographs of the eclipses of 1918, 1922 and 1923.

Mrs. Lewis has rendered a real service by putting this rather difficult subject into clear and simple language. A second edition with illustrations of the 1925 eclipse will undoubtedly be as popular in England in 1927 as the first edition has been here this year.

FREDERICK SLOCUM

WESLEYAN UNIVERSITY

LABORATORY APPARATUS AND METHODS

A METHOD OF DEMONSTRATING MESONEPHRIC TUBULES

IT is often of considerable advantage to the teacher of embryology or histology to be able to show the contour and extent of the structures being studied in sections. The method described here gives an excellent outline of mesonephric tubules and the preparation may be made in a very short time. A somewhat similar technique was employed in the study of the elimination of iron by the mesonephros of Necturus.[1] The essential feature of the method is the precipitation of the iron as Prussian blue in the lumina of the kidney tubules.

Chase[2] has shown that in the pelvic (secretory) portion of the mesonephros, there are two sets of tubules (primary and secondary) which have direct connections with the body cavity by way of outer segments (peritoneal canals) and nephrostomes. Substances placed in the body cavity accordingly find their way into the primary and secondary tubules by this route and are eventually eliminated, in part at least, through the Wolffian duct.

A balanced mixture of sodium ferrocyanide and ammonium ferric citrate, made by adding 10 parts by volume of a 3 per cent. solution of the former to 7 parts by volume of a 4 per cent. solution of the latter[3] was kept as a stock solution. A quantity of this was diluted 10 times and a sufficient amount injected into the body cavity to produce a mild distention. The animals were left from two to six hours and then killed by immersion in an aqueous solution of chloretone. Sufficient time should elapse before killing to allow the iron salts to at least reach the Wolffian duct. The time needed for this is variable. The mesonephroi are dissected free and fixed in a solution sufficiently acid to produce the Prussian blue reaction. Acid-formalin or Gilson's fluid is satisfactory. The kidneys may be kept in alcohol and studied as opaque objects or may be cleared. If cleared, benzol or toluol is preferred, as they remove some of the pigment present. Later the tissue may be transferred to some less volatile fluid as oil of wintergreen.

On the ventral surface of the preparation, the neck, distal to its junction with the peritoneal canal, the proximal convoluted portion, the narrow straight part and the distal convoluted portion of a tubule can be readily followed by means of the dense blue deposit in the lumen. On the dorsal surface, the short junctional portions, collecting tubules and the Wolffian

[1] Dawson, A. B., 1925, *Am. Jour. Physiol.*, in press.

[2] Chase, S. W., 1923, *Jour. Morphol.*, Vol. 37, p. 457.

[3] Collip, J. B., 1920, Univ. Toronto Studies, Physiol. Series, No. 35.

duct can be easily seen. The primary and secondary tubules are so isolated that little overlapping occurs and a clear conception of the form and extent of an individual tubule is obtained. In this respect the preparation made by intraperitoneal injection is much more instructive than one made by injections through the Wolffian duct in which every tubule contains more or less color mass.

ALDEN B. DAWSON

LOYOLA UNIVERSITY
SCHOOL OF MEDICINE

SPECIAL ARTICLES

WAVE-LENGTH SHIFTS IN THE SCATTERING OF LIGHT[1]

BOHR[2] has called attention to a remarkable prediction made by Smekal[3] and by Kramers and Heisenberg (unpublished), to the effect that when monochromatic light falls on a multiply periodic electromagnetic system, the scattered radiation may contain not only the incident frequency, but also combinations of this frequency with those characteristic of the scatterer. The purpose of this note is to direct attention to a conclusion pointed out by one of the writers some two years ago that the wave-length shift may be very large in certain favorably chosen cases of the scattering of ordinary light. It appears that a part of this frequency shift is the quantum analogue of the phenomenon predicted by Kramers and Heisenberg. In general, the wave-length change is due to three influences—the Doppler shift caused by the initial motion of the atom, the Compton shift due to the recoil of the atom or the ejected electron, and the shift due to alteration in the internal energy of the atom. To a first approximation these are additive.

A. H. Compton's original theory[4] of the wave-length shift of scattered radiation was based on the assumption that each unidirectional quantum of incident radiation is deflected by a single electron, which recoils from the momentum of the quantum. For scattering at angle φ with the primary beam the increase in wave length (in centimeters) should be

$$\Delta\lambda = \frac{2h}{mc}\sin^2\frac{\varphi}{2} \qquad (1)$$

where h, m and c are Planck's constant, the mass of the electron, and the velocity of light, respectively. In Ångstrom units the shift is

$$\Delta\lambda = .0484\sin^2\frac{\varphi}{2}$$

Ross[5] attempted, without success, to observe this shift in the visible spectrum by scattering the light of the mercury line 5461 A from paraffin, and by multiple reflections from silvered glass.

We shall not attempt to discuss the latter experiment, but there are at least two possible reasons why no shift of the order of .02 A was observed in the case of paraffin. First, it seems improbable that there are "free" electrons in paraffin, and presumably light of wave length 5461 A is unable to eject electrons from atoms of this substance. Under such conditions the scattering must be attributed to the atom as a whole (or even to larger aggregates) and the shift is inappreciably small. Second, even if electrons were ejected, the shift should not be given by the equation (1); for in its derivation both the work required to separate the scattering electron from its parent atom, and the final momentum of the atom, were neglected. Compton[6] has taken these influences into account in a revised theory. There are not enough equations to determine all the unknowns in this problem. For example, the recoiling atom and electron as well as the scattered quantum will in general possess angular momentum with respect to the center of gravity of the system. The distribution of this angular momentum can not be specified unless we know the dynamics of the collision. The result is that the momentum of the atom and the direction cosines of its trajectory, which are unknown, appear in the formula for $\Delta\lambda$. In all probability these quantities are dependent on the relative phases of the incident quantum and the internal motions of the atom, so that $\Delta\lambda$ is not a constant for a given frequency, angle of scattering and material. This circumstance is probably contributory to the fact that the shifted peak is wider than the unshifted one. At any rate, the formula shows that $\Delta\lambda$ lies between infinity and $\lambda^2/(\lambda-\lambda_s)$, where hc/λ_s is the ionization potential for the atomic energy level from which the scattering electron is ejected. That is, $\Delta\nu$ lies between $-\nu$ and $-\nu_s$. In unpublished calculations of Ruark and Ellett these results are still further extended, though the numerical result is not changed appreciably. A formula is derived for the frequency ν_2 obtained when a needle quantum of frequency ν_0 falls on an atom and is scattered without ejecting an electron. Let E_0 be the rest-energy of the atom and let it have a velocity $v_0=\beta_0 c$, making an angle ϑ_0 with the direction of the quantum. E_2, β_2 and ϑ_2 denote the corresponding quantities for the final state of the

[1] Published by permission of the Director of the Bureau of Standards, U. S. Department of Commerce.

[2] *Naturwissenschaften* 12, 1115, 1924.

[3] *Naturwissenschaften* 11, 873, 1923.

[4] *Bull.* Nat. Research Council, Vol. 4, No. 20, 1922.

[5] *Proc. Nat. Acad. Sci.*, 9, 246, 1923.

[6] Compton, *Phys. Rev.*, 24, 168, 1924.