can be converted into an energy, E, but that an object of mass m contains simultaneously an energy, E.

In nuclear reactions there is never any actual change in the total mass content of the universe. For example, the fission of a nucleus of mass M into two equal fragments, each of rest mass m_0, sets free an energy of

$$E = (M - 2m_0)c^2 \quad (1)$$

which gives a velocity, v, to each fission fragment. The kinetic energy of each fragment at this velocity is given by the Lorentz equations as

$$\tfrac{1}{2}E = m_0c^2\left(\frac{1}{\sqrt{1 - v^2/c^2}} - 1\right). \quad (2)$$

Now the mass of a particle at velocity v is

$$m = \frac{m_0}{\sqrt{1 - v^2/c^2}}. \quad (3)$$

Therefore, equation (2) becomes

$$\tfrac{1}{2}E = mc^2 - m_0c^2. \quad (4)$$

Combining equations (1) and (4) gives:

$$(M - 2m_0)c^2 = 2mc^2 - 2m_0c^2, \quad (5)$$

from which, by cancellation of terms,

$$M = 2m. \quad (6)$$

The final total mass is thus exactly equal to the initial mass. The system does not lose any mass until collisions with other particles gradually remove kinetic energy and mass from the fission fragments, and then the mass gained by the other particles is exactly equal to the mass lost by the fission fragments. Mass is not detroyed but merely dispersed, just as the potential energy originally contained in the fissionable nucleus is dispersed as kinetic energy of the particles struck by the fission fragments.

In the preceding derivation, M is the mass of the fissionable nucleus plus the neutron added to trigger it off. Also, it was assumed that M is essentially at rest, that two exactly equal fission fragments are produced, and that no extra neutrons are released. If it is assumed that both the fissionable nucleus and its triggering neutron are originally in motion, that unequal fission fragments are produced, and that several neutrons are liberated at high velocities, the equations are more involved, but the same result is obtained, namely, that the sum of all masses before the reaction is exactly equal to the sum of all masses after the reaction. In calculating the kinetic energy released or consumed by nuclear reactions from the formula, $E = (\Delta m)c^2$, the rest masses and not the actual masses must be used in computing Δm.

Likewise, in the "annihilation" of a positron and electron, it can be shown (remembering that the mass of a photon is $h\nu/c^2$) that the total mass of the photon or photons produced is exactly equal to the combined mass of the electron and positron "annihilated."

The law of conservation of mass still holds.

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Book Reviews

Scientific, medical and technical books published in the United States of America, 1930–1944: a selected list of titles in print with annotations. **R. R. Hawkins. (Ed.) (Prepared under the direction of the National Research Council's Committee on Bibliography of American Scientific and Technical Books.) Washington, D. C.: 1946. Pp. xv + 1114. $20.00. (Distributed by R. R. Bowker Co., 62 West 45th Street, New York City 19.)**

In 1943 the American publisher's mission to South America brought to the attention of the State Department the need for a comprehensive selected bibliography of recent American publications in science, medicine, and technology. In 1944 the National Research Council appointed a committe to direct the project and R. R. Hawkins, chief of the Science and Technology Room, New York Public Library, was chosen as editor. This book is the result of the committee's work.

The bibliography is designed as a list not of best books but rather of important and useful books, with primary emphasis on availability. Titles of 5,193 books published between 1930 and January 1945 by citizens of the United States and Canada and still in print at the time of publication of the list are included. Thus, this bibliography will be of value not only to librarians and scholars abroad, especially those in war-devastated areas charged with the task of reconstructing libraries, but also to those in this country who may wish reliable and accurate information on American scientific, medical, and technical books of the past 15 years.

The titles are classified in broad categories with appropriate subdivisions. Thus, the first section is headed "Science" and carries the following subheads: general, dictionaries, history, methodology, popular works, textbooks, tables, annuals, and scientific expeditions. Mathematics, astronomy, physics, meteorology, chemistry, geology, oceanography, natural history, biology, botany, zoology, etc. are similarly classified, in many cases with more detailed subheads. The price of each item is included together with the table of contents and a descriptive note. These notes are especially useful, since they indicate the character of the book, give special information about its contents not obvious from the title, and suggest the type of reader for whom the book is intended. An appendix provides a directory of state agencies in the United States issuing publications in geology, engineering, and agriculture. There is also a useful directory of publishers. Finally, there is an author index, with certain title entries included, and a detailed subject index.

The social sciences in general have been omitted, as were also trade publications and elementary and high

school texts. In some instances important works otherwise qualified were left out because they were temporarily out of print due to wartime paper shortages. Despite these omissions, some of which were unavoidable, this bulky volume stands as an impressive record of American scholarship in the fields represented.

MORRIS C. LEIKIND

Library of Congress, Washington, D. C.

An introduction to the study of eclipsing variables. **Zdenek Kopal. Cambridge, Mass.: Harvard Univ. Press, 1946. Pp. x + 220. $4.00.**

The title of this book (No. 6 of the Harvard Observatory Monographs) reads like that of an elementary textbook, but it is neither a text nor elementary. It is a scholarly treatise and an introduction to the interpretation of the light variations of eclipsing stars, evidently written for the investigator who expects to devote an appreciable fraction of his career to research on eclipsing binaries.

The book opens appropriately with a brief foreword by Prof. Henry Norris Russell, of Princeton, who developed the first general method of computing orbital elements of these stars. The first chapter gives a brief history of the subject and delimits the field of the book. It is here that the reader finds that the book does not purport to tell "all about" eclipsing variables, for all aspects of the subject other than the light curve and its interpretation are outside its scope.

The second chapter, "Nature of the Eclipses," treats the geometrical relations that determine the light curve and includes a discussion of the theory of darkening at the limbs of stellar disks. The third chapter, "Determination of the Elements," considers the reverse problem: given the light curve, to find the geometrical elements of the system. In this earlier portion of the book the mainstay is the original Russell method and others of similar nature which are still the most practical way of beginning the computation. The fourth chapter, "Improvement of Preliminary Elements and Determination of Limb-Darkening," completes the discussion of the simpler problem of spherical stars moving in circular orbits.

The next chapter discusses the complications that arise from eccentricity of orbits. This is followed by a chapter on the theory of tidal distortion of stars and that of "gravity-darkening" or nonuniformity of surface brightness of distorted stars. The effects upon the light curve of ellipticity of the stars and of reflection or absorption and reradiation of the light of each body by the other form the subject of the seventh chapter. The eighth and ninth chapters embody all these complications and correspond, respectively, to the two aspects of the simpler case covered in the second and third chapters. In this latter part of the book the treatment leans heavily upon the important original contributions by the author himself.

The book is well organized and well written. The treatment throughout is strictly mathematical, but with adequate descriptive paragraphs. If it has a defect, it is in the lack of diagrams (only one is given). The practical computer may be disappointed at finding no illustrations of processes. On the other hand, there are numerous suggestions that the computer will find invaluable, for, in spite of recent progress, the solution of every individual orbit is a unique problem and in the last analysis must depend upon trial and error.

The reviewer was a little disappointed to find the scope of the book deliberately limited. A chapter or appendix of less than 20 pages could have covered in outline the contributions of spectroscopy in determining absolute dimensions and the extent of atmospheres. The special problem of stars with diffuse limbs is likewise omitted.

This is the only comprehensive treatment of the subject in any language. It will undoubtedly prove to be a stimulus to further research in the field, which is in a state of rapid flux. It should be in the library not only of every student of binary stars but of everyone interested in the astronomical applications of mathematics.

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A future for preventive medicine. **Edward J. Stieglitz. New York: Commonwealth Fund, 1945. Pp. xviii + 77. $1.00.**

This monograph is one in a series issued under the auspices of the Committee on Medicine and the Changing Order of the New York Academy of Medicine and published by the Commonwealth Fund.

Dr. Stieglitz interprets preventive medicine as meaning more than the prevention of disease. It is rather the attainment of optimum health and well-being by the individual. With this viewpoint most of the teachers in the field of preventive medicine and many of the advanced men in medicine will agree. The author argues that the full achievement of preventive medicine requires the cooperation of the physician, the collective public, and the individual. On pages 16–18 we are given the change in the age structure of the population that has come about in the United States over the last eight decades. This change in grouping makes all the more important this emphasis on the individual preventive medicine rather than the preventive medicine of the past, which had largely to do with the prevention of communicable diseases. He rightly calls attention to the fact that, up to the present, individualized health guidance has been developed entirely in the fields of pediatrics and obstetrics. The health problems of middle and old age must come to the fore if the public is to have maximum health, usefulness, and happiness. It is not so much longer living as it is a better and fuller living.

Dr. Stieglitz holds out for a very detailed examination which will mount up considerably in cost and be beyond the reach of many that should have this type of health service. While the reviewer agrees with this idea, it must not be forgotten that there are a few essential laboratory tests, together with a rather complete but in-