when it has been disturbed, and finally, the narrowing limits of adaptation imposed by age." The book, of course, is a classic and is already one of the most influential in the development of fundamental theory of modern physiology. That its popular presentation is appreciated widely enough to require a revised second edition, is clear testimony to the skill and clarity with which Professor Cannon has developed his idea.

In his introduction to Professor Haggard's volume, Professor Yandell Henderson, brilliant and blunt as always, says it is designed "for employers and engineers in charge of labor," as "a text-book for college students," and that "every educated man should see it." It clearly and convincingly develops the thesis that modern medicine is almost entirely a matter of applied physiology. As a text-book, it could be considerably improved by the inclusion of references to significant articles or reviews. It might also be improved by some degree of personalization, that is, by indicating who some of the scientists have been who have contributed to the gathering of the information which Professor Haggard reports so impersonally.

Dr. Kermack and Dr. Eggleton's book is the first to make a consistent effort to interpret biochemistry to the public. It is admirably designed and clearly developed. These Edinburgh scientists begin by placing living things in proper proportion to the rest of the universe. They next discuss the limitations of the scientific method and go on to explain how the complex molecules of living things are built up from a relatively small variety of atomic bricks. The discussion of foodstuffs is from the standpoint of "the biological motor car." In connection with growth, repair, reproduction and special functional adaptations, the authors make illuminating observations on such matters as the economics of forced labor, the proper design of bicycles and Olympic champions. Vitamins, enzymes and hormones are entertainingly discussed. Even the no-man's-land where what is living is not to be clearly distinguished from what is not living, is bravely probed. It is in every way a beautiful work. It could, however, be improved by judicious bibliographical references to readily available original sources.

Dr. Heiser's program for personal health is a remarkable combination of clever organization, hard horse sense born of much wisdom and experience and entertaining personal anecdotes. As in the case of "An American Doctor's Odyssey," Dr. Heiser's "You're the Doctor" gives evidence of professional journalistic organization. These are some of the chapter titles: "The All-devouring Gut," "Brother Rat," "Diet and Health with Key to the Vitamins," "How Now, Brown Cow," "A Little Poison Now and Then," and "Wher'er I Roam." The general point of the whole volume is summarized in the last chapter, headed "A Merry Heart Doeth Good Like a Medicine."

Frankly journalistic is Dr. Bauer's "Health, Hygiene and Hooey." To those familiar with the medical quackery exposés in *Hygeia* and the *Journal of the American Medical Association,* Dr. Bauer's technique is well known. The information is essentially sound, and its presentation is entertaining. Dr. Bauer wisely remarks: "The best safeguard against exploitation is a knowledge of principles. Individual exploiters come and go; nostrums rise, flourish and vanish; quackery is different every day and yet, fundamentally, the same. A person who understands the characteristics of charlatanism will not be fooled by the individual exploiter. Therefore, I have not chosen to 'name names,' but rather to set up principles. . . ." Some of the chapter headings illustrate his method: "Wim, Wigor and Witamins (pinpricks in the vitamin inflation)"; "Soft Soap and Skin Games (facts and nowhere-near facts about the skin you love to retouch)"; "A Fake for Every Ache (common symptoms pay dividends to the quack and charlatan)"; "Life Begins Before Birth (we will grow old—why not gracefully?)"; "Common Sense, Preferred (how to be happy though healthy)." The book contains much factual information, but again fails to document more readily available sources.

Popularization of modern science may become a socially beneficial procedure. The success of the effort depends largely upon its sincerity. Journalistic tricks are justifiable if they stimulate attention, provoke entertainment and supply the essential information. Science popularizers should write simply without condescension and clearly, without emphasizing the obvious. When prepared by a master in his own right, as in the case of Professor Cannon, the result is likely to become not only a classic in science, but in general literature as well.

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REPORTS

ASTRONOMICAL SYMPOSIUM ON GALACTIC AND EXTRAGALACTIC STRUCTURE

IN connection with the dedication on May 5 of the W. J. McDonald Observatory of the University of Texas—a joint project of the University of Texas and the University of Chicago—an astronomical symposium was held at the observatory. The purpose of this symposium was to bring together the leading experts in the various fields of astronomy directly or indirectly working on the general problem of galactic and extra-

galactic structure, and to present, in the form of a series of connected lectures and discussions, a unified picture of the present views concerning the structure of the universe. The symposium was sponsored by the Warner and Swasey Company—the builders of the 82-inch McDonald telescope—and through the generosity of this famous firm many astronomers from this country and from abroad were invited to participate in the symposium. The general character of the symposium may well be described by quoting the words of one of the participants, Dr. J. H. Oort, of the University Observatory, Leiden, Holland:

> The question of the general dimensions of the galactic system, which preoccupied astronomers around the beginning of this century and which stimulated Kapteyn, in 1906, to develop the plan of selected areas, can no longer be considered as one of the burning problems of to-day. We might venture to say that another group of problems, *viz.*, those connected with the spiral structure of stellar systems, is now generally coming to the foreground. The great majority of, and possibly all, stellar systems of great flattening show such a structure, and it is natural to conclude that the galactic system would exhibit similar structure if looked at from a suitable position. This is evidently an important problem, as it may well be expected that the study of possible spiral structure in the galactic system may help to elucidate the character of spiral structure in general.

In order to elucidate the spiral structure of galaxies, we must systematize our knowledge of the various units of which these galaxies are composed: the stars, the cosmic dust clouds and the gaseous nebulae. In the discussions frequent reference was made, especially by Professor H. N. Russell, of Princeton, to the possibility that an additional unit may ultimately be found in the form of "chunks," ranging in size from meteoric particles to Jupiter, but there is as yet no direct observational evidence of such "chunks" outside the solar system.

In order to estimate the mass of our galaxy we must know the masses of the individual stars. Professor Russell's paper was devoted to the problem of determining the masses of the stars from observations of binary motion. While, in principle, the problem is simple, there are many serious difficulties in practice, and a large part of the discussion was devoted to the elimination of accidental and systematic errors in the parallaxes, etc. The data obtained by Professor Russell yield a new expression for the mass-luminosity relation (in solar units):

$$\text{Log } L = 3.82 \log \overline{m} - 0.24$$

Professor G. P. Kuiper, of the Yerkes Observatory, discussed a little-known group of stars which are somewhat less luminous than ordinary dwarfs, but which can not be identified with the true white dwarfs. For these stars Dr. Kuiper suggests the name of subdwarfs. Two dozen of these stars were discovered by him during the first six weeks of regular use of the 82-inch McDonald reflector. In addition, Dr. Kuiper announced the discovery of two new white dwarfs.

The problem of stellar colors and stellar spectra is of particular importance for the interpretation of the structure of our galaxy, because only after we have determined the colors and the spectra can we estimate the effect of the absorbing dark clouds in interstellar space upon the apparent distribution of the stars in the Milky Way. This problem was discussed by Mrs. Cecilia Payne Gaposchkin, of Harvard Observatory. Of particular importance is her discussion of the systematic errors of the Potsdam system of spectral classification and the conclusion that "the negative density gradients for blue stars that have been derived by others for the area in Carina (S.A. 193) are partly a result of the systematic errors of spectral classification."

A powerful new method for the determination of star colors was outlined by Dr. W. W. Morgan, of the Yerkes Observatory. When these colors are combined with spectroscopically determined luminosities they serve to give us reliable values of selective interstellar absorption. Several excessively red B stars were discovered in this work, and it was pointed out that an excessively red star may be either of type N or of type B—the latter, of course, being reddened by interstellar absorption.

The problem of space reddening was discussed by Professor Joel Stebbins, of the Washburn Observatory, University of Wisconsin, who, together with Drs. Huffer and Whitford, has determined photoelectric colors of 1,300 B-type stars. The main conclusions of the paper are: ". . . the dark clouds of interstellar material are located close to the main plane of the Milky Way; they are irregularly distributed and do not make up a thin uniform layer. The absorption of light is much greater for stars toward the center than toward the anticenter of the galaxy, and even the brightest parts of the Milky Way are only half as bright as they would be if we could see them in the clear."

The effects of interstellar reddening are so conspicuous and there are so many excessively red stars of early spectral type that it is difficult to understand how the effect could have remained controversial until less than ten years ago. The profound influence of our recognition of interstellar absorption upon theories of galactic structure is one of the most significant advances of recent years.

Professor Harlow Shapley, of the Harvard Observatory, discussed the importance of variable stars in

the measurement of great distances. A large number of cluster-type Cepheids in high galactic latitudes has been used to determine the thickness of our galaxy and the law of galactic concentration for cluster-type Cepheids. Important applications of variable stars have also been made at Harvard to the determination of distances of external galaxies.

The problem of diffuse, reflecting matter in space was discussed by Dr. C. T. Elvey, of the McDonald Observatory. Elvey and Rudnick have discovered a new faint glow in the Milky Way which comes from star light that is reflected by large numbers of very small particles. The existence of this "galactic light" has recently been confirmed by Henyey and Greenstein at the Yerkes Observatory.

The composition of the interstellar gas was the topic of a paper by Dr. O. Struve, of the Yerkes and McDonald Observatories. The principal result is the very large abundance of hydrogen.

Dr. Bart J. Bok, of the Harvard Observatory, gave an account of important investigations which are now being carried on under his direction at Harvard. The work is based upon accurate star counts which are used to determine first the interstellar absorption and then the space distibution of the stars in our galaxy. The presence of considerable negative density gradients in stellar distribution was discovered for several Milky Way regions.

The importance of galactic clusters in problems of Milky Way structure was stressed in a paper by Dr. R. J. Trumpler, of the Lick Observatory of the University of California. "When the known galactic star clusters are projected on the galactic plane, their arrangement shows no relation to the generally accepted structure of the galactic system, but indicates a grouping with the sun near its center. . . . The possibility that star clusters are confined to outer regions of our stellar system and are missing in its central condensation is indicated by the examination of extragalactic nebulae. A large number of undiscovered distant clusters, however, should be expected in galactic longitudes 0°–70° and 220°–290°. In the former region the strong obscuration marking the dark division of the Milky Way is probably responsible for the scarcity of known clusters. It is suggested that the search for distant clusters should be made by photographs utilizing red light, as the latter has a greater penetration of absorbing (scattering) material."

Dr. J. H. Oort finds that the

star densities indicate a curious distribution: a region of relatively small density near the sun is found to be surrounded in all longitudes by extensive regions where the density is two or more times higher; this is a large-scale structure, showing equally on both sides of the galactic plane. The plausible comparison with spiral structure presents, however, a difficulty in the unexpected increase of density found when proceeding from the sun in the two opposite longitudes perpendicular to the direction of the center. This warns us not to accept these results without reserve. The principal assumption involved could, however, be verified to some extent by the color-excesses. One of the most urgent needs appears to be the further study of color-excesses, also in low latitudes, so that the density distribution may also be determined in regions near the galactic plane. An essential but difficult point is the determination of the relation between color-excesses and total absorption.

An accurate photometric study of the extragalactic system IC 1613, a member of the local group of galaxies, was presented by Dr. Walter Baade, of the Mount Wilson Observatory. Astronomers will especially welcome the extension of the photographic scale to magnitude 21.0. This has enabled Dr. Baade to determine accurate light curves of 20 Cepheid variables with periods between 146 days and 3 days and to determine a new period-luminosity curve from his data.

Dr. Harlow Shapley spoke on the distribution of external galaxies made at the various stations of the Harvard Observatory. Attention was called to the uneven distribution of the external galaxies in different regions. The structural features of extragalactic nebulae were reviewed by Dr. Edwin Hubble, of the Mount Wilson Observatory. The photographs secured by him with the large reflectors at Mount Wilson suggest "the segregation of material already distributed through the nebulae rather than the ejection of material into previously unoccupied regions. The patterns appear to develop inside the central lenses or within the surrounding envelopes. In early barred spirals (SBa), however, incipient spiral structure is generally found at the rims of the central lenses or of the surrounding envelopes. The further development of spiral structures progresses smoothly, along several closely parallel lines, to the familiar late type patterns (Sc and SBc)."

The theoretical interpretation of spiral structure was the subject of a paper by Dr. Bertil Lindblad, of the Stockholm Observatory (Sweden).

In the case of nebulae with thin spiral arms, as exemplified by the nebula M 81, the arms can be well represented by the asymptotic orbits extending from a spheroidal central mass. The tidal effects of ejected matter on the matter moving at the edge of the central system may lead to a successive dissection of the original central system and in favorable cases to a heavy spiral structure like that of M 51. From the point of view of this theory the abundance of spiral nebulae of a fairly uniform type concerning essential features like the form of the arms, the number of turns of the spiral whorls around the center, etc., seems possible to understand. The theory favors the opinion that the direction of rotation of the system agrees with the direction in which the

spiral arms wind around the center when followed outwards from the nucleus.

Dr. S. Chandrasekhar, of the Yerkes Observatory, presented a new theory of stellar motions which is applicable to various types of stellar systems, and which will doubtless revolutionize stellar dynamics.

Professor E. A. Milne, of the University of Oxford (England), gave a lecture on "Cosmological Theories," in which he begins,

> with a logical analysis of the large-scale universe of matter and motion as it appears to observation, avoiding any appeal to laws or concepts derived from smaller-scale phenomena. . . . Starting from the individual's awareness of the passage of time, it is possible to set up a system of congruent timekeeping in different places, to construct in turn a kinematics and a dynamics, hence to give a logical meaning to "uniform time," to give accounts of gravitation and electromagnetism, and finally to show how to identify the various logical constructs so encountered in the physically observed universe. . . . The stimulus for the development of this logical structure has arisen from the great American discoveries of the phenomena associated with the extragalactic nebulae. Such discoveries have justified us in formulating our deepest questionings, and have helped to separate questions which are genuine questions from those which have merely conventional answers.

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SPECIAL ARTICLES

LINKAGE OF PEA COMB AND BLUE EGG IN THE FOWL

RECENT studies in this laboratory show that the dominant gene causing blue shells on eggs of the domestic fowl is closely linked with that for pea comb. During the last two decades a number of fowls that lay blue eggs have been introduced into this country and to Europe from South America. These vary considerably in color of plumage and in structural characteristics. In most cases they resemble Dark Brown Leghorns in color but have pea combs. They are generally called "Araucanas" after that region in Chile in which they are most abundant.

Unlike the brown pigments of hens' eggs, which are applied on the surface only, the blue color is found all through the shell and is quite evident on the inside. When the blue is combined with varying shades of brown (as in egg-shells of Rhode Island Reds and other breeds) the result is a series of green and olive colors, varying with the intensity of the brown color. The ability to lay blue eggs results from a unifactorial dominant autosomal mutation.[1]

In February, 1938, the writers obtained a male Araucana descended from stock imported from South America and mated it with a number of females, including "testers" for two autosomal linkage groups. This male had a pea comb, and all but one of the females had single combs. Among 35 laying daughters from single-combed dams, the following combinations were found:

Parental combinations	
Single comb, white egg:	18
Pea comb, blue egg:	15
Cross-overs	
Single comb, blue egg:	0
Pea comb, white egg:	2
	35

[1] R. C. Punnett, *Jour. Genet.*, 27: 465–470, 1933.

Such a distribution could not occur by chance. The possibility that one gene is responsible for both type of comb and color of egg-shell seems very unlikely, because Brahmas, Sumatras and Cornish Indian Games, all pea-combed breeds, do not lay blue eggs. Evidently the Araucana male was heterozygous for pea comb and for blue egg, carried in the coupling phase. Since in 35 gametes only two cross-overs occurred, the amount of crossing over between the two genes is apparently not more than 6 per cent. Tests to measure this figure more exactly are in progress.

Hertwig[2] found 32.8 per cent. crossing over between pea comb and marbling (a pattern in the down of chicks) and 45.6 per cent. between marbling and naked neck. Confirmation of the latter association is desirable because of the long map distance involved. Though the gene for blue egg is now added to this group, its usefulness for further mapping of the chromosome is likely to be somewhat limited because it is manifested only in one sex and even there not until the birds lay. Moreover, its close linkage with pea comb would necessitate large numbers in any linkage test where these two genes were to be separated.

A tentative map[3] for chromosomes of the fowl, published in 1936, showed 18 genes in five linkage groups. Since then the "naked" gene has been added to the sex chromosome[4] and the addition of blue egg makes a total of 20 genes in the five groups. Some of these, as well as one or two other loose linkages that have been suggested, need further study.

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[2] P. Hertwig, *Verhandl. Deutschen Zoolog. Gesell.*, pp. 112–118, 1933.

[3] F. B. Hutt, *Neue Forschungen in Tierz. u. Abstammungslehre (Duerst Festschrift)*, Bern, pp. 105–112, 1936.

[4] F. B. Hutt and P. D. Sturkie, *Jour. Hered.*, 29: 370–379, 1938.