for the purpose of trade, but as a rule are immediately after consecration deposited in shrines or springs, they are rather difficult to obtain, yet the collection numbers over 150 specimens of these interesting objects, representing nearly every form of baho known to the Hopi.

The figurines produced by the Hopi men and given by the mothers to the children during the *Niman*, or Farwell ceremony, and known as *tihus*, are objects found in all Hopi collections, but as a matter of fact these *tihus*, which represent certain mythological personages called *Katcinas*, are only reproduced for a limited number of characters. Owing to the unusual zeal shown by Mr. Voth toward the collection of this class of objects, the collection, with the recent addition of specimens brought home by Mr. Owen, numbers not less than 275, comprising over two hundred distinct varieties, a great many of which were reproduced for Mr. Voth only after earnest endeavor on his part. Inasmuch as these *tihus* represent *Katcinas* and as these *Katcinas* play a very important part in the religious life of the Hopi the importance of a collection of this magnitude, carefully arranged and labelled, can not be overestimated. Even more difficult than these *tihus* to obtain are the masks which are worn by the Hopi as they personate deities in the *Katcina* dances. The Hopi regard these masks with considerable reverence and do not willingly part with them, yet the collection numbers one hundred and thirty specimens, many of them being made of elk or buffalo hide.

But more important than these collections, however valuable and interesting, are the altars and sand mosaics, which are faithful, painstaking reproductions of altars which are erected year after year in the underground *kivas* of the Hopi. There may come a time when the actual altars themselves may be obtained, but up to the present, so highly are they revered by the Hopi that no sum of money, however great, would induce them to part with a single slab from a single altar. The altars reproduced by Mr. Voth number nine, namely—the Antelope, Snake, Flute, Powamu, Powalawu, Katcina, Soyal, Marau and Oöquol. These altars are such as are erected by the Hopi during the great nine-day ceremonies, and while they do not exhaust the subject for even a single Hopi village, they are by far the most important altars and comprise within their number all those which contain images or fetishes. In most of the ceremonies represented by these altars, during the years when initiations are performed, sand mosaics are added to the altar, and comprised within the altars which have been reproduced are all those which contain this additional feature of interest. Mr. Voth also reproduced the great Ballülukon screen which is erected in the *kiva* during one of the ceremonies, and which is manipulated by means of concealed wires, to the intense delight of priests and the great mystification of the novitiates present.

The work which has been accomplished by the McCormick expeditions up to the present time has, I believe, been thorough and in every sense worthy the generosity of the patron. It must be admitted, however, that much yet remains to be done of equal value and importance among the Hopi of to-day and among the ruins of the past.

George A. Dorsey.
Field Columbian Museum.

SCIENTIFIC BOOKS.

An Atlas of Representative Stellar Spectra from λ 4870 to λ 3300, together with a Discussion of the Evolutional Order of the Stars, and the Interpretation of their Spectra, preceded by a Short History of the Observatory and its Work. By Sir William Huggins and Lady Huggins. London, William Wesley & Son.

This sumptuous volume of 165 folio pages worthily represents a part of the work which has been quietly in progress during the past forty years at the little private observatory at Upper Tulse Hill, London, one of the most important outposts at the frontier of astrophysical science. The additional title, 'Publications of Sir William Huggins's Observatory, Vol. I.,' leads us to hope that this introductory volume may soon be followed by others which shall give in similar manner the results which have been gained from the minute study of the large store of photographs which have been secured by the talented authors during many years of patient experiment and observation.

The first chapter gives a brief 'history of the observatory, and of the work done therein.' At the present day, when a photograph of the spectrum of a bright star may be obtained with an exposure of but a few minutes,—or even seconds, we are likely to fail to appreciate the difficulties and discouragements of the pioneers in these delicate researches, and we may forget how our present large and rigid instruments have slowly evolved from the first combinations of spectroscopes and telescopes. It was soon after the establishment of the private observatory that Mr. Huggins learned of the discovery by Kirchhoff and Bunsen of the true nature of the dark lines of the solar spectrum, which had been unexplained for more than half a century after their discovery. It at once suggested a wide field of research, and, as the author states, 'then it was that an astronomical observatory began, for the first time, to take on the appearance of a physical laboratory.' With the collaboration of Professor W. A. Miller, the spectra of forty stars and of Jupiter and Mars had been observed at the end of 1862. The news of the similar work of Mr. W. M. Rutherfurd in America arrived on the day the preliminary paper was to be read at the Royal Society.

The photography of stellar spectra was attempted in 1863, the wet process, of course, being employed, but the dark lines were not shown on the plates until the attempt was resumed in 1875. Meanwhile the chemical origin of a number of the lines in stellar spectra was established, and in 1864 Mr. Huggins made his famous observation on the spectrum of a nebula, demonstrating its gaseous constitution. In 1866 a temporary star, *Nova Coronæ*, was first observed spectroscopically; and in the same year was begun the construction of a spectroscope for determining the velocity of stars in the line of sight, the results of the use of which were published in the *Philosophical Transactions* in 1868. Later, attention was given to the spectra of comets, and to attempts at the spectroscopic observation of the red prominences previously only seen during solar eclipses. Although the principle underlying their visibility in the spectroscope was clearly stated by Mr. Huggins early in 1868, he did not actually succeed in detecting them until after their discovery by Lockyer and Janssen later in that year.

Larger instruments and the dry-plate process permitted much progress in the work on stellar spectra after 1875, which is recorded in numerous papers read before the Royal Society in the subsequent years. The titles of eighty-two papers on work done at the observatory are given in the second chapter of the work. Chapters III. to V. describe the instruments and methods of obtaining the spectra, and of broadening them, the descriptions being largely quoted from the journals in which they were originally printed.

Chapter VI. occupies one quarter of the volume, and is entitled 'Discussion of the Evolutional Order of the Stars and the Interpretation of their Spectra,' with sections on (1) the types of stellar spectra, (2) original differences of stellar constitution, (3) classification of stellar spectra, and (4) physical and chemical interpretation of stellar spectra by means of terrestrial spectra observed in the laboratory.

In addition to its absorbing interest to students of astronomy, this chapter can hardly fail to be attractive to the general reader of scientific topics. The author quotes freely from his published addresses bearing upon this subject, and brings into discussion the work of other astronomers and physicists, although drawing his observational data chiefly from his own work. In the matter of classification of stellar spectra the author follows in the main the scheme suggested by H. C. Vogel in 1874.

The white stars are considered to be in a more diffuse state than our Sun, and hence in an earlier stage of development. The subdivision represented by Bellatrix, which has a characteristic spectrum of the 'Orion type,' is placed first in the order of stellar evolution. Considerable space is devoted to the question of which class of spectrum corresponds to the highest temperature of the radiating photosphere, and numerous lines of evidence are adduced to support the view that this is found in case of the stars with spectra of the solar type. The argument based upon the relative extension of the continuous spectrum into the ultra-violet region, the extension of the solar type being regarded by the authors as the greatest, is not wholly convincing, as the difficulty of securing identical conditions of exposure, atmospheric absorption, etc., in the case of different stars of different types, is very great. But emphasis is well placed upon the importance of taking into account more fully than has hitherto been done the large diminution in the star's effective radiation from the integrated effect of the selective absorption of its atmosphere; that is, from the absorption represented by the very numerous dark lines in spectra of the solar type.

Attention is drawn to the important effect of the convection currents in stellar atmospheres, and their increasing activity in the region where the dark lines originate, as the stars advance in age. This increase is assigned as a possible cause of the diminished prominence of the hydrogen lines in the spectra of the second and later types.

The reasons for the presence of certain particular lines of certain particular elements in the spectra of stars at different stages are considered by the authors to lie in the conditions of the absorbing region, as to density and composition, particularly the mixing of various vapors. The absence of the metallic lines from the spectra of the first type is attributed in part to the slight convectional effects in the very diffuse atmospheres of these stars, so that as a result of diffusion hydrogen and the lighter elements preponderate in the region where absorption occurs; and in part to a slow temperature gradient, so that the vapors just above the photosphere might differ in temperature too little from the photosphere for their lines to be seen as dark on the continuous spectrum.

The effect of density of the vapor is quite fully considered, particularly in connection with the laboratory experiments of the authors on the behavior of the calcium lines.

The twelve half-tone plates which illustrate the volume are admirably done, and represent extended and skilful work by the authors in their arrangement. Plate II. contains reproductions of numerous 'historical spectra,' as they are well named, obtained by the authors between 1876 and 1895. These are fully described in Chapter VII. The remaining plates receive a 'preliminary discussion' in Chapter VIII.

The treatment of the subject as a whole is qualitative rather than quantitative, and is not mathematical, so that the general reader can follow the clear and philosophical reasoning of the authors without the necessity of a previous familiarity with technical symbols.

Artistic head pieces and initials appropriate to the subject, the hand work of Lady Huggins, complete the adornment of the volume. The work has received the Actonian prize of the Royal Society, and the election of Sir William Huggins to the presidency of the Royal Society at this time will be recognized as highly appropriate.

Edwin B. Frost.

Annual Report of the Chief of the Bureau of Steam Engineering of the U. S. Navy Department, 1900. Washington, Government Printing Office. 1900. 8vo. Pp. 128, pl. 17, folded.

This report, apart from its importance as detailing the work in applied science of one of the most important bureaus of the U. S. Government, has a peculiar interest at the moment to all who have become aware of the tendency illustrated, for example, in the operation of the National Observatory and of the Coast Survey, toward amateurism in all branches of the Government service. The Engineer-in-Chief of the Navy, Admiral Melville, is one of the most competent expert professionals in the Navy, or outside it, in his department, and his report, while giving an admirably condensed account