HARVARD UNIVERSITY.

The following record of original work in progress at Harvard University, forms part of an interesting article by J. R. W. Hitchcock, A. B.:

In the last publication of the American Academy of Arts and Sciences, in which, by the way, seven of the eight papers are by Harvard investigators, appear the following "Propositions in Cosmical Physics," by Professor Benjamin Peirce:

1. All stellar light emanates from superheated gas. Hence the sun and stars are gaseous bodies.

2. Gaseous bodies, in the process of radiating light and heat, condense and become hotter throughout their mass.

3. It is probable that their surface would become colder if there were not an external supply of heat from the collision of meteors.

4. Large celestial bodies are constantly deriving superficial heat from the collision of meteors, till at length the surface becomes superheated gas, which constitution must finally extend through the mass.

5. Small celestial bodies are constantly cooling till they become invisible solid meteors.

6. The heat of space consists of two parts: first, that of radiation principally from the stars, which is small, except in the immediate vicinity of the stars; the second portion is derived from the velocity with which the meteors strike the planet at which the observation is taken; and this velocity partly depends upon the mass of the star by which the orbit of the planet is defined, and partly upon the mass of the planet itself.

7. If the planets were originally formed by the collision of meteors, it is difficult to account for an initial heat sufficient to liquefy them, and, at the same time, to account for their subsequent cooling without a great change in the number and nature of the meteors; and any such hypothesis seems to invalidate the meteoric theory.

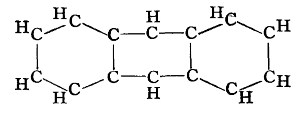
8. If the planets were not originally formed by the collision of meteors, their common direction of rotation becomes difficult of explanation.

Professor J. M. Peirce has recently published a set of "Mathematical Tables," in which the part relating to "Hyperbolic Functions" is entirely original. Other work in this department is represented by Professor Byerly's "Differential Calculus" and Mr. Wheeler's "Elementary Plane and Spherical Trigonometry."

The forbidding granite building called "Boylston Hall" conceals scenes of strange activity. Unwonted odors irritate the inexperienced nose of the visitor, and in the laboratories spectral shapes flit backward and forward behind clouds of vapor, occasionally lit up by lurid flames. These are the students; but in their private laboratories the professors pursue their own researches. Professor Cooke has been dealing with that unprincipled element, antimony, which has obdurately persisted in claiming two atomic weights, until he has successfully limited it to one. In connection with his laboratory-work, Professor Cooke is preparing a new edition of his "Chemical Philosophy." The results of his inorganic work have appeared from time to time in the publications of the Academy of Arts and Sciences.

Since the "Organic Laboratory" was established, in 1875, Professors Hill and Jackson have published twenty-five papers giving the results of their work, and have discovered one hundred new compounds. The discovery of new compounds, however, possesses as a rule no special importance, and is rather incidental to, than the result of, the main work. Two examples will indicate somewhat the character and object of organic investigations. The *composition* of uric acid has been long known to be $C_5H_4N_4O_3$, but its *constitution*—the exact arrangement of the atoms—has been uncertain. Chemists all over the world had endeavored to settle the question, but their failures resulted in eleven different formulæ for this one substance. Professor Hill, taking this uric acid $C_5H_4N_4O_3$, marked one part by replacing H by CH_3 (methyl); then treating the acid so as to split it up, he determined to which part the methyl was attached, and, by continuing his treatment, was enabled to reduce the possible formulæ from eleven to three, with strong probabilities in favor of one. This possesses a practical value, inasmuch as it will lead to a knowledge of the method of formation of uric acid in the animal body. Professor Hill's work on "Fur ferrol," found in the products of the distillation of wood, is interesting, as chlorophyll can probably be obtained from it.

An example of the curious subtleties of science is afforded by Professor Jackson's investigations of anthracene, which is obtained from coal-tar, and yields alizarine (madder-dye), used in dyeing pink and purple calicoes, Turkey reds, etc. Anthracene was known to consist of two hexagons of carbon with hydrogen atoms attached, united by two other carbon-atoms. Professor Jackson proved, by making anthracene artificially, that these two carbon-atoms are united to adjacent corners in each hexagon, thus:



These are but stray examples of the researches that are constantly being made by Professors Hill, Jackson, and their assistants. Brom-benzylbromides, parachlorbenzyls, and benzaldehyds, however fascinating they may be to chemists, would offer few charms to the general reader.

Since 1841 Dr. Asa Gray has devoted such leisure as he could command to his great work "The Flora of North America," a labor the magnitude of which only an experienced botanist can appreciate. Mr. Watson, Curator of the Herbarium, is assisting Professor Gray, and at present is classifying the flora of California. The new series of botanical text-books, edited by Dr. Gray, will shortly be completed. The titles will be as follows:

1. "Structure and Morphological Botany of Phænogamous Plants," by Dr. Gray.

2. "Physiological Botany" (Vegetable Histology and Physiology), by Dr. Goodale.

3. "Introduction to Cryptogamous Botany," by Professor Farlow.

4. "Natural Orders of Phænogamous Plants and their Special Morphological Classification, Distribution, Products," by Dr. Gray.

One of the most recent of Dr. Gray's botanical contributions to the Academy of Arts and Sciences was a paper on the "Characters of some New Species of Compositæ in the Mexican Collection, made by C. C. Parry and Edward Palmer," and a notice of "Some New North American Genera, Species, etc."

Professor Farlow's work in cryptogamic botany is doubly interesting on account of its direct practical application. At the Bussey Institution Professor Farlow has been investigating the diseases of plants, and latterly has been engaged upon algæ and fungi. Among his recent work is a paper on algæ for the United States Fish Commission, an examination of the causes of onion-smut and the diseases of trees for the Board of Agriculture, and an investigation of the algæ producing disagreeable tastes and smells in water, for the State Board of Health. His work resolves itself, speaking generally, into two kinds—one, the abstract descriptions and arrangements in families of algæ and fungi, and the other the detection of fungi in disease. As an example of the first, there is a European species of alga which constitutes the green scum on stagnant water. Several different varieties may be found in different places, but they have all been discovered to belong to the same family. To illustrate the second, there is a certain kind of fungus on cedar trees, but this has been ascertained to be only a first stage, and the fungus in its second stage is found upon several members of the apple family.

Professor Wolcott Gibbs has been carrying on researches on complex inorganic acids, and Professors Lovering and Trowbridge have been conducting purely physical investigations. Professor Trowbridge has introduced a method of instruction that necessitates a large amount of original research on the part of his students. This consists of lectures, given by the students instead of by the instructor, to the class. Although all the work at the Observatory really comes under the head of original investigation, the observations constantly taken in connection with the Observatory Time Service resolve themselves into mere routine work. An immediate and practical benefit is conferred by this Time Service, the signals of which reach Bangor, Lennoxville, in Canada, Albany, and New York, as well as different points in Massachusetts. The copper time-ball, held by a powerful electro-magnet at the top of the mast on the Equitable Life Assurance Building, Boston, is released at noon by the clock at Cambridge. During 1879 accidents caused a small error in its fall on two days only, and on three days it has been dropped at 12h. 5 m. os.

The great equatorial of fifteen inches' aperture and the meridian circle whose telescope has an aperture of eight inches have been kept actively in use for the last three years. The former instrument has been devoted almost entirely to photometric work. The problem of astronomical photometry, roughly stated, is to determine the brightness of all the heavenly bodies, so that all may be compared with a single standard. Previous to the beginning of this work at the Harvard Observatory. photometric measurements had been made almost entirely upon the planets and brighter stars, and there was no definite knowledge of the amount of light emitted by the satellites and fainter stars. At the outset of the work several hundred measurements were taken of the brightness of the outer and inner satellites of Mars, which measures have been taken accurately nowhere else. The satellites of Jupiter and Saturn, including Hyperion, the faintest of Saturn's satellites, were similarly measured. In addition to measuring their brightness, a large number of determinations of the positions of the satellites were made. A comparison was also begun of the light of the sun and stars, with the idea of reducing all photometric measurements to a common standard—the light of the sun. This photometric work has been continued until the light of all the known satellites, except the two inner satellites of Uranus. has been measured.

One of the most important series of equatorial observations has been in connection with the eclipses of Jupiter's satellites. These phenomena have proved exceedingly valuable as a means not only of determining the orbits of the satellites themselves. but of measuring the distance of the sun or the velocity of light, and of obtaining terrestrial longitudes.

The observations of the mere appearance or disappearance of a satellite, however, can not be rendered sufficiently exact, and, to lessen the errors, photometric observations have been made of the satellites as they gradually enter or emerge from the shadow of Jupiter, using the planet itself or another sate lite as a standard.

In order to furnish means for the comparison of the scales of stellar magnitude, employed by different astronomers in their estimate of the brightness of faint stars, a number of faint stars in the immediate neighborhood of the north pole were selected for photometric measurement. and a circular was distributed among astronomers requesting estimates of magnitudes of the same stars for comparison with such other, and with the results of the measurements made here. A series of measurements of all the planetary nebulæ has also been undertaken. This work with the great equatorial has necessitated the invention of a number of new photometric instruments, which have been devised by Professor Pickering and his assistants.

For nearly eight years Professor Rogers has been engaged upon one of the largest astronomical undertakings that has been successfully completed in this country. This is the observation with the meridian circle of the zone of eight thousand stars, between fifty and fifty-five degrees north, undertaken by this Observatory as its share in the determination of the position of the stars of the northern hemisphere. The observations were finished about a year ago, but some years will be required to complete the reduction and publication of this work.

The total number of observations for 1879 with the meridian circle, including about six hundred for the Coast Survey, was nearly three thousand. The scientists at the Observatory are now engaged in the task of determining the light of all the stars visible to the naked eye in the latitude of Cambridge. The meridian is used in observations like a transit instrument in connection with a new and elaborately designed photometer.

At the Museum of Comparative Zoology the staff of specialists is almost entirely occupied in the classification and arrangement of different collections and the publication of the results of their researches. The most important accessions during 1878 and 1879 are the extensive collections of the Blake dredging expedition, and the collections of birds, mammals, reptiles, and fishes, made by Mr. Garman at St. Kitts, Dominica, Grenada, Trinidad, St. Thomas, and Porto Rico, after he left the Blake. The Blake collections and specimens from the entomological, conchological, and ornithological departments are in the hands of well-known specialists for final investigation. Of the extensive work in progress it is impossible to give any details. The results are embodied in the extensive publications of the museum. Five volumes of bulletins have been published, averaging about a dozen papers each. The quarto publications will hereafter be issued as memoirs. The catalogues thus far published have been collected into Volumes I.–IV. of the memoirs. Five volumes of memoirs and the first part of the sixth have already appeared. The second part of the sixth and Vol. VII. are now in course of preparation or in press. Vol. VI. contains the great work upon which Professor Whitney is now engaged, "The Auriferous Gravels of the Sierra Nevada of California." The Sturgis Hooper Professorship of Geology, held by Professor Whitney, is noticeable as being founded solely for original research.

The dredging operations of the Coast Survey steamer Blake have not only aided zoological science by the information obtained in regard to echini, corals, crinoids, ophiurians, worms, hydroids, and others. but have added to geographical knowledge of the Caribbean Sea by showing the changes in form and distribution of lands along various groups of islands, and in the form of the land beneath the water. Professor Agassiz considers the deep-sea collections of the Blake the largest and most important ever made on this coast, and, when combined with the results of other expeditions sent out under the auspices of the Coast Survey, they make the collections at the museum but little inferior to those of the Challenger. During the coming summer Professor Agassiz will probably undertake another dredging trip in the Blake, following the course of the Gulf Stream to the north of the Bahamas, and dredging from the 100 to the 2,500 fathom line off the coast of the United States, so as to connect the isolated district with the deep-water fauna proper of the Atlantic.

Professor N. S. Shaler, Professor of Paleontology, in addition to his work at the museum, and as an instructor, has, since 1873, had charge of the Kentucky State Survey. Four volumes of reports and one of memoirs have been already completed, and one volume of memoirs and nine of reports are now in press. The recent writings of Professor Shaler are "The Origin and Nature of Intellectual Property," and several articles in the "Proceedings of the Boston Natural History Society," "The Atlantic Monthly," and "The International Review." The article by Professor Shaler in the latter magazine is entitled "Sleep and Dreams."

Scientific publications, based entirely or in part upon the entomological collection of the museum, are the new edition of the "Catalogue of the Diptera of the United States," by Osten-Sacken, published by the Smithsonian Institution, Part VIII. of the "Monographic Revision of the European Trichoptera," by R. McLachlan, published in London, and several papers by Dr. H. A. Hagen, the head of the department.

At the medical school the largest amount of original investigation is carried on in the physiological and chemical laboratories. In the former a number of new forms of apparatus are in use, which have been designed by Professor Bowditch and his assistants. Among these are an apparatus for keeping animals alive by artificial respiration; a dog-holder, canulæ for observations on the vocal cords of animals, without interfering with their natural respiration; unpolarizable electrodes used in studying certain problems in the physiology of the nervous system; a new form of apparatus for barometric measurements; and a novel plan for measuring the volume of air inspired and expelled in respiration. A new form of plethysmograph has been devised by Dr. Bowditch. This is an instrument for measing the changes in the size of organs, either hollow or solid, which are produced by variations in the conditions to which they are subjected. The essential part of Dr. Bowditch's invention is a contrivance by which fluid is allowed to flow freely to and from the organ to be measured without changing its absolute level in the receptacle into which it flows, while at the same time a record is made of the volume of the fluid thus displaced.

The more important work going on in the laboratory at the time of my visit consisted of experiments in regard to respiration, with special reference to the functions of the glottis and epiglottis, and trials of disinfectants with a view to ascertaining the temperature necessary to kill germs. A series of experiments was also in progress for testing the porosity of various stones used in building.

The results of the original work performed here have been recently published, together with an account of the physical apparatus in use at the school. Accounts of the most important investigations carried on during the last year are contained in the following papers: "Growth as a Function of Cells: Preliminary Notice of Certain Laws of Histological Differentiation," by C. G. Minot; "Effects of the Respiratory Movements on the Pulmonary Circulation," by H. P. Bowditch, M. D., and G. M. Garland, M. D.; "Pharyngeal Respiration," by G. M. Garland, M. D.; "Functions of the Epiglottis in Deglutition and Phonation," by G. L. Walton. This paper shows that the removal of the epiglottis does not seriously affect deglutition, and therefore it is not necessary for that process. The epiglottis, however, plays an important part in forming and modifying the voice, taking different positions during vocalization, changes of pitch, quality, and intensity.

In the chemical laboratory I found that Professor Wood had been examining the water-supply of Cambridge; and was then engaged in the investigation of the extent to which arsenic is being used in the manufacture or ornamentation of articles in general use, such as wall-paper, confectionery, playthings, etc. The results of this work will be published in the next report of the State Board of Health. Professor Wood is also writing the addition to "Ziemssen's Cyclopædia" on the subject of toxicology.

Dr. William B. Hills was engaged upon a special investigation in regard to the localization of arsenic in the animal economy.

The most important feature of original work at the school of late years has been Dr. Bigelow's introduction of the new operation of litholapaxy.

A number of interesting papers have been recently written by members of the faculty, some of which contain new discoveries of considerable scientific importance. I cite two: "Effects of Certain Drugs in increasing or diminishing Red Blood-Corpuscles," by Dr. Cutter; and "Alterations in Spinal Cord in Hydrophobia," by Dr. Fitz.

The School of Agriculture and Horticulture, called "The Bussey Institution," is located on the sunny slopes of Forest Hills, about five miles southwest from Boston. The labors of the professors connected with this institution have been even more in the line of original research than of instruction, though of late the lack of a sufficient endowment has interfered with the quality of work and the publication of the results.

A number of exceedingly interesting and valuable papers, however, have appeared in the "Bussey Bulletin," the titles of which give some indication of the character of the work. I give a few of the more important: "Hybridiza- of Lilies," by Professor Parkman; "Diseases caused by Fungi"—Professor Farlow; Examinations of Fodders," "Trials of Fertilizers," "Prominence of Carbonate of Lime in Soil-Water," "Importance as Plant-Food of the Nitrogen in Vegetable Mold"—Professor F. H. Storer; "The Potato-Rot," and "The Black Knot" (of plum and cherry-trees)—Professor Farlow.—*Popular Science Monthly.*

ON THE EFFECTS PRODUCED BY MIXING WHITE WITH COLORED LIGHT.

It was noticed several years ago that when white light was mixed by the method of rotating discs with light of an ultramarine (artificial) hue, the result was not what one would naturally have expected, viz.: instead of obtaining a lighter or paler tint of violet-blue the color inclined decidedly toward violet, passing, when much white was added, into a pale violet hue. Two attempts have been made to account for this curious fact: Brücke supposes that the light which we call white is really to a considerable extent red, and that the mixture of this reddish white light with the blue causes it to change to violet. Aubert, on the other hand, following a suggestion of Helmholtz, reaches the conclusion that violet is really only a lighter shade of ultramarine-blue. He starts with the assumption that we obtain our idea of blue mixed with white from the sky, which, according to him, is of a greenish-blue color. We then apply, as he thinks, this idea to the case of a blue which is not greenish, namely, to ultramarine-blue, and are surprised to find that the result is different.

It will be shown in the present paper that these explanations are hardly correct, since they fail to account for the changes, which, according to my experiments, are produced in other colors by an admixture of white. I prepared a set of brilliantly colored circular discs which represented all the principal colors of the spectrum and also purple; these discs were then successively combined in various proportions with a white disc and the effects of rapid rotation noted, a smaller duplicate colored disc uncombined with white being used for comparison. Under these circumstances it was found that the addition of white produced the changes indicated in the following table:

Vermilion became somewhat purplish.
Orange became more red.
Yellow became more orange.
Greenish yellow was unchanged.
Yellowish green became more green.
Green became more blue-green.
Cyan-blue became less greenish, more bluish.
Cobalt-blue became more of a violet blue.
Ultramarine (artificial) became more violet.
Purple became less red, more violet.

Exactly these same effects can be produced by mixing violet with the above mentioned colors. These experiments serve to explain the singular circumstance that when complementary colors are produced by the aid of polarized light, it is difficult or impossible to obtain a red which is entirely free from a purplish hue, a quantity of white light being always necessarily mingled with the colored light. In the case of the red, orange, yellow, ultramarine, and purple discs, I succeeded in measuring the amount of violet light which different proportions of the white disc virtually added to the mixture, and found that it is not directly proportional to the amount of white light added, but increased in a slower ratio, which at present has not been accurately determined.

For the explanation of the above mentioned phenomena, Brücke's suggestion that white light contains a certain amount of un-neutralized red light is evidently inapplicable, since the effects are such as would be produced by adding a quantity not of red but of *violet* light, and for the present I am not disposed to assume that white light contains an excess of violet light. The explanation offered by Aubert does not undertake to account for the changes produced in colors other than ultramarine, and even in this case seems to me arbitrary; neither have I succeeded in framing any explanation in accordance with the theory of Young and Helmholtz which seems plausible.—PROF. O. N. ROOD, *American Journal of Science*

BERNARDINITE: ITS NATURE AND ORIGIN.

BY J. M. STILLMAN.

In a previous number of this Journal[1] I published the results of a chemical investigation of a resinous substance from San Bernardino, sent to me by Hon. B. B. Redding, which was said to occur in the form of vein in detached masses, and the vein to be traceable for three miles. The finders (farmers or "ranchers" of that vicinity) sent at the same time pieces of rock as vein-stuff which contained this peculiar resinous substance in the crevices. Some months later

[1] III, vol. xviii, p. 57.