

# SCIENCE

VOL. LXVII

JUNE 29, 1928

No. 1748

## THE PAST TWENTY YEARS OF PHYSICAL ASTRONOMY<sup>1</sup>

### CONTENTS

<i>The Past Twenty Years of Physical Astronomy:</i>	
DR. WALTER S. ADAMS .....	637
<i>Charles Henry Gilbert: DR. DAVID STARR JORDAN</i> .....	644
<i>Scientific Events:</i>	
<i>The International Dairy Congress; The Upper Klamath Wild-life Refuge; A Foundation for the Study of Children's Diseases; The American Executive Committee of the World Engineering Congress</i> .....	645
<i>Scientific Notes and News</i> .....	647
<i>University and Educational Notes</i> .....	650
<i>Discussion and Correspondence:</i>	
<i>An Old Experiment on Collisions of the Second Kind: DR. J. RUD NIELSEN. Another Wild Life Preserve near Ithaca: PROFESSOR P. W. CLAASSEN. Angström in English: E. F. B. FRIES. Embryonless Seeds in Cereals: MILDRED E. LYON. The Host of the Broad Tapeworm: DR. THOMAS B. MAGATH</i> .....	651
<i>Scientific Books:</i>	
<i>Goldschmidt and Gordon's Crystallographic Tables for the Determination of Minerals: DR. ALFRED C. HAWKINS</i> .....	653
<i>Scientific Apparatus and Laboratory Methods:</i>	
<i>An Efficient Dehydrating Apparatus for General Use: WILBUR D. COURTNEY. Immobilization of Paramecium: J. C. BOLAND. A Burette Cleaner: F. H. FISH</i> .....	653
<i>Special Articles:</i>	
<i>The Photo-mechanical Changes in the Retina of Mammals: GORDON L. WALLS. Egg Laying of Izodiphagus Caucurtei du Buysson in Larval Ticks: PROFESSOR R. A. COOLEY and GLEN M. KOHLS</i> .....	655
<i>Science News</i> .....	x

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa.

Garrison, N. Y.

Annual Subscription, \$6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

A COMPLETE survey of the progress of physical astronomy during recent years would be so formidable an undertaking that to attempt to cover the entire field would require a whole series of lectures rather than a single evening. So I shall limit myself to the attempt to trace for you the development of only one or two of the more recent conceptions and methods of modern astrophysics and to show how greatly they have enlarged the views which we held, even as recently as the first ten years of this century. From the standpoint both of the results accomplished and the outlook toward the larger problems of astronomy there probably has never been a period quite comparable to that of the past twenty years.

The underlying cause of this remarkable progress has been the intimate relationship which has developed between physics and astronomy, so that important discoveries in the one science have reacted immediately upon the other and found far-reaching applications almost at once. A quarter of a century ago an immense amount of observational material had been collected in our physical laboratories and observatories to the interpretation of which the key was almost entirely lacking. We could hardly hope to understand the behavior of matter in the distant stars when the mechanism of the light given out by a candle flame was still quite unknown to us. So in astronomy, as in physics, a great new field was opened up by the fundamental discoveries of Rutherford, Bohr and many others on the structure of matter and the nature of radiation.

It is a commonplace to say that all our primary knowledge of stars is derived from the light which they give out, where the term *light* is used in a general way to include both visible light and invisible radiation, such as heat or X-rays. From a star's light we can measure its position, its slow movement across the sky, its brightness and its distance, but we can do a great deal more. By analyzing its light we can study its individuality, which is defined almost as uniquely by the faint rays of light which reach us as is the personality of a friend by the actions of his daily life. The main problem of physical astronomy,

<sup>1</sup> Address given in San Francisco on April 16, on the occasion of the presentation of the Bruce medal by the Astronomical Society of the Pacific.

## Marine Biological Laboratory Woods Hole, Mass.

### INVESTIGATION

#### Entire Year

Facilities for research in Zoology, Embryology, Physiology, and Botany. Fifty-two private laboratories \$100 each and ninety-four private laboratories \$200 each for not over three months. Fifty-six tables are available for beginners in research who desire to work under the direction of members of the staff. The fee for such a table is \$50.00.

### INSTRUCTION

June 27 to August  
7, 1928

Courses of laboratory instruction with lectures are offered in Invertebrate Zoology, Protozoology, Embryology, Physiology, and Morphology and Taxonomy of the algae. Each course requires the full time of the student. Fee, \$75.00.

The annual announcement will be sent on application to The Director, Marine Biological Laboratory, Woods Hole, Mass.

**SUPPLY  
DEPARTMENT**  
Open the Entire  
Year



### Biological Supplies

For the classroom, museum or collector.

Look for the sign of the Limulus. As the Limulus represents the test of time, we feel from the business growth that our supplies have also stood the test of years.

*Send for Catalogue*

No. I. Zoological and Embryological material. Life Histories and Habitat Groups.

No. II. Botanical material.  
No. III. Microscopic Slides.

Address all correspondence regarding material and catalogue to:

Supply Department

**GEO. M. GRAY,**  
Curator, Woods Hole, Mass.

Ready July 1

## BIOLOGICAL REVIEWS

AND BIOLOGICAL PROCEEDINGS OF  
THE CAMBRIDGE PHILOSOPHICAL  
SOCIETY

Edited by H. MUNRO FOX

**Biological Reviews** embodies critical summaries of recent work in special branches of biological science, addressed to biological readers.

Vol. III. No. 3. July, 1928. \$3.00.

### CONTENTS

- (1) Les données expérimentales relatives au mécanisme de la division cellulaire, par ALBERT DALCQ.
- (2) The physiology of ovarian activity, by A. S. PARKES.
- (3) The influence of ultra-violet light on plants, by E. MARION DELF.

CAMBRIDGE UNIVERSITY PRESS

Fetter Lane, London, E.C.4

## JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE

The School of Medicine is an Integral Part of the University and is in the Closest Affiliation with the Johns Hopkins Hospital.

### ADMISSION

Candidates for admission must be graduates of approved colleges or scientific schools with two years' instruction, including laboratory work, in chemistry, and one year each in physics and biology, together with evidence of a reading knowledge of French and German.

Each class is limited to a maximum of 75 students, men and women being admitted on the same terms. Applications may be sent any time during the academic year but not later than June 15th.

If vacancies occur, students from other institutions desiring advanced standing may be admitted to the second or third year provided they fulfill the requirements and present exceptional qualifications.

### INSTRUCTION

The academic year begins the Tuesday nearest October 1, and closes the second Tuesday in June. The course of instruction occupies four years and especial emphasis is laid upon practical work in the laboratories, in the wards of the Hospital and in the dispensary.

### TUITION

The charge for tuition is \$400 per annum, payable in two installments. There are no extra fees except for certain expensive supplies, and laboratory breakage.

Inquiries should be addressed to the Executive Secretary of the School of Medicine, Johns Hopkins University, Washington and Monument Sts., Baltimore, Md.

Graduates in Medicine who satisfy the requirements of the heads of the departments in which they desire to work are accepted as students for a period not less than three quarters. Tuition charge is \$50 a quarter.

## The Wistar Institute Bibliographic Service

Is of invaluable assistance to

Librarians—Investigators—Teachers

It brings to them, in AUTHORS' ABSTRACT form, a brief review of all original papers on Biological Subjects which appear in the following journals:

**Journal of Morphology and Physiology**  
**The Journal of Comparative Neurology**  
**The American Journal of Anatomy**  
**The Anatomical Record**  
**The Journal of Experimental Zoology**  
**American Journal of Physical Anthropology**  
**The American Anatomical Memoirs**  
**The Biological Bulletin (M. B. L., Woods Hole, Mass.)**  
**Folia Anatomica Japonica (Tokio, Japan)**  
**The Journal of Parasitology (Urbana, Ill.)**  
**The Australian Journal of Experimental Biology and Medical Science (Adelaide, South Australia)**  
**Stain Technology (Geneva, N. Y.)**  
**Physiological Zoology (Chicago, Ill.)**

### Advance Abstract Sheets

Issued every few days, bearing Authors' Abstracts without bibliographic references, offer a practical means of making research immediately available in abstract form and of purchasing articles of special interest in reprint form without the necessity of subscribing to all the journals. Subscription, \$3.00 per year.

### Bibliographic Service Cards

with complete bibliographic references, printed on Standard Library-catalogue cards, are of value and assistance to Librarians and Investigators. Subscription, \$5.00 per year.

### Abstracts in Book Form

referred to above, are brought together periodically, with Authors' and Analytical Subject Indices. Price \$5.00 per volume.

*Subscriptions to the Bibliographic Service and orders for reprints should be sent to*

**The Wistar Institute of Anatomy and Biology**  
Thirty-sixth St. and Woodland Ave. Philadelphia, Pa.



## JENA GLASS FILTER APPARATUS

Filter discs of sintered glass fused into transparent Glass containers

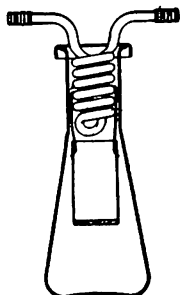
**SAVE YOUR TIME**

*Watch your work in transparent glass*

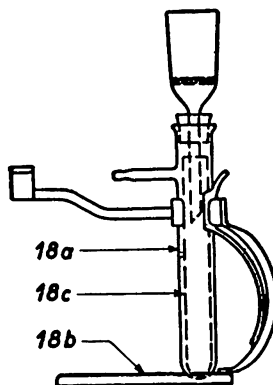
*Keep your chemicals pure*



Crucibles



Extraction apparatus

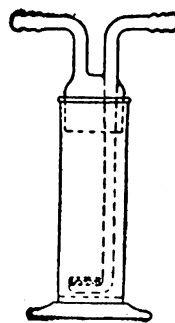


Apparatus for qualitative Analysis

*Order through your Dealer from Stock*

Ask for price list 4041E and pamphlet 4078E

U. S. factory representative: J. E. BIEBER, 1438 E. 18th St., Brooklyn, N. Y.



Gas Washers



Buechner  
Funnels

### THE SCIENTIFIC MONTHLY

An illustrated magazine, devoted to the diffusion of science.

Annual Subscription, \$5.00.

Single number, 50 cents.

### THE AMERICAN NATURALIST

A bi-monthly journal, devoted to the biological sciences.

Annual Subscription, \$5.00.

Single numbers, \$1.00.

### SCHOOL AND SOCIETY

A weekly journal covering the field of education in relation to the problems of American democracy.

\$5.00 a Year

15 Cents a Copy

### THE SCIENCE PRESS

Grand Central Terminal,

New York City



### LAMOTTE SOIL TESKIT

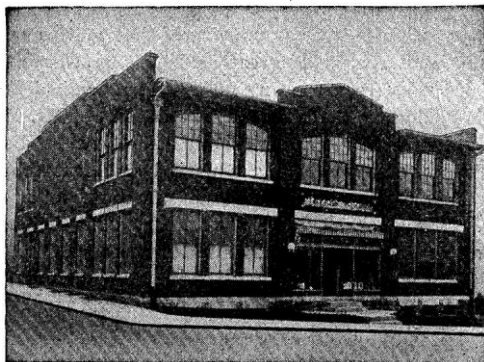
A simple and complete scientific outfit for determining the acidity or alkalinity of soils. The Handbook contains an extensive list of plants with their soil preferences as well as other valuable data on soils and plant growth.

Price complete, \$1.50, postpaid

LaMotte Chemical Products Co.

418 Light Street

Baltimore, Md., U. S. A.



### THE SCIENCE PRESS PRINTING COMPANY

The Science Press Printing Company has been established and equipped for printing scientific literature in the best way, with compositors, pressmen and proof-readers trained for technical work. It is a business corporation but it has been founded to provide facilities essential for the advancement of science.

The corporation owns its building at Lancaster, Pennsylvania, over 14,000 square feet of floor space lighted on all sides, with space for printing a hundred scientific journals. It has the best obtainable presses, composing machinery and binding equipment. What is more important, it has the most competent pressmen and compositors in a city which since "Science" was first printed there in 1894 has become a center for fine scientific printing. The costs are only about three fourths as much as in the large cities.

Those authors who have read proofs will know the correctness of the composition, including the technical scientific terminology. A distinguished scientific man wrote recently to the editor of "Science": "I corrected my first proof a year before you were born and the one I returned yesterday was the first one in my long experience that needed no correction."

The press prints "The Scientific Monthly," "Science," "School and Society," "The American Naturalist" and some twenty other scientific journals and publications. The typography and presswork of these journals will bear comparison with any weekly or monthly publication, although, for example, "Science" must be printed mostly in one day in an edition of over 13,000. The new edition of "The Biographical Directory of American Men of Science" is an example of the work of the press. It can to special advantage print scientific monographs and doctorate dissertations.

Correspondence should be addressed to the secretary, Jaques Cattell, The Science Press Printing Company, Lancaster, Pa.

## THE MICROSCOPE

By SIMON H. GAGE, of Cornell University

Revised, Dark-field Edition (1927) now Available.  
The Old and the New in Microscopy, with a special chapter  
on Dark-Field Methods and their Application.

Postpaid, \$3.50

COMSTOCK PUBLISHING CO., ITHACA, N. Y.

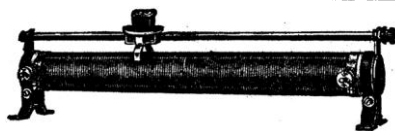


### Hy-Speed Mixers

Clamp to any tank, operate from light circuit, mix all kinds of liquids. Also used for even temperature baths. Thousands in use.

All Sizes  
from  
1/10 H. P.  
\$37.50 up

Write for circular.  
ALSOP ENGINEERING CO.  
47 W. 63rd St., New York



By means of sliding-contacts the resistance value of

### JAGABI RHEOSTATS

can be varied from zero to full rating in exceedingly small steps.

They are eminently suited for, and are largely used in Educational, Research and Industrial Laboratories.

Write for illustrated Bulletin 1140-S

JAMES G. BIDDLE, PHILADELPHIA  
1211-13 ARCH STREET

### The Biological Laboratory Cold Spring Harbor, Long Island, N. Y.

Now open the entire year for  
Research

In any branch of Biology

Fundulus and other marine material abundant for embryological and physiological investigation.

Special Equipment for mammalian work.

Fee for private laboratory \$75, table \$50.

#### Instruction

Six weeks, June 27th to August 8th. Courses in Field Zoology, Physiology, Surgical Methods in Experimental Biology, Endocrinology, Field Botany and Plant Ecology. Tuition, \$75.

A marine littoral location, in rolling, forested country, with close proximity to brackish and fresh water collecting grounds, yet only an hour from the center of New York City, with access to its splendid museums, institutions and libraries.

### LIVING BULLFROGS

Safe delivery guaranteed

Teach Biology with live specimens where practicable

We have the only complete live materials establishment in America. Live plants and animals representing all types are kept on hand under semi-natural conditions at all seasons.

Also headquarters for preserved specimens of all types, microscopic slides, life histories, demonstrations, osteological preparations, insect collections. We specialize in many important southern species not obtainable elsewhere.

All material guaranteed without reservations.

SOUTHERN BIOLOGICAL SUPPLY CO., INC.,  
Natural History Building, New Orleans, La.