SCIENCE

VOL. LX — OCTOBER 31, 1924 — NO. 1557

CONTENTS

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

THE SCIENCE PRESS

Lancaster, Pa. — Garrison, N. Y.

New York City: Grand Central Terminal.

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.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

PRELIMINARY MEASUREMENT OF THE VELOCITY OF LIGHT[1]

THE velocity of light is one of the most fundamental of the constants of nature, and this alone would justify the attempt to measure its value with the highest possible precision. But in addition to its scientific importance it may prove to have a practical value if the result of such a measurement can be obtained with sufficient accuracy.

The mean of the various measurements thus far attempted is 186,330 miles per second, with an uncertainty of 20 or 30 miles. If this uncertainty can be reduced to one mile, the result could be utilized to obtain distances between stations from 50 to 100 miles apart far more expeditiously and with an order of accuracy at least as great as that obtainable by the usual method of triangulation. Indeed, there are possibilities of utilizing the velocity of light in cases where triangulation would be difficult or impossible.

An invitation tendered by Dr. G. E. Hale, then director of the Mt. Wilson Observatory, and supported by Dr. J. C. Merriam, director of the Carnegie Institution, made it possible to install the necessary apparatus on Mt. Wilson, with Mt. San Antonio 22 miles away as the distant station, during the summer of 1923; but smoke and haze from burning oil and from forest fires made it impossible even to test the feasibility of the method at so great a distance.

This was accomplished during the past summer with very promising results. The set-up of apparatus involved several important changes in the arrangement employed in previous investigations, the most important of these consisting in the substitution of an octagonal revolving mirror instead of a plane-parallel, together with a system of reflectors which eliminated all direct and diffuse extraneous light. Finally, a simple method for returning the light from the distant station back to the source was substituted for the plane mirror used for this purpose in previous work, and this functioned so well that no readjustment was required during the entire two months of the work.

The advantage of the octagonal revolving mirror, in addition to the higher speed obtainable, lies in the possibility of receiving the return light on a succeeding face, thus eliminating the measurement of the angular deflection of the returned beam; or rather

[1] Presented at the Centenary Celebration of the Franklin Institute, Philadelphia, September 17–19, 1924.

transferring this measurement to the construction of the octagon, the angles of which were tested and found to be equal with an uncertainty of only one part in a million.

The determination of the velocity of light is thus reduced to the measurement of the distance between the stations and of the speed of rotation of the mirror. The former operation was carried out by the U. S. Coast and Geodetic Survey with the result 35,426.3 meters (about 22 miles) with an uncertainty of the order only two parts in a million.

The errors in the measurement of the speed of the revolving mirror were much greater, as no very effective means were employed to insure its constancy. (This defect will be eliminated in the continuation of the work next summer.)

Notwithstanding the inconstancy of the speed of the mirror, by choosing the most favorable moment, when the speed was that corresponding to the frequency of a control tuning fork, the resulting uncertainty of the measurements was of the order of one ten thousandth part, which is about that of the mean of all the previous measurements.

It is hoped that next year's work will furnish results four or five times more accurate.

The result of eight independent observations in the present preliminary work is, for the velocity of light in vacuo, 299,820 kilometers per second.

Following is a table of results of the more important investigations to date with an estimate of the weight which should be assigned to each:

Investigator	Method	Distance	Wt.	Velocity
Cornu	Toothed Wheel	23.0 Kilom.	1	299950
Perrotin	" "	12.0 "	1	299900
Michelson	Revolving Mirror	0.6 "	2	299895
Newcomb	" "	6.5 "	3	299860
Michelson	" "	35.4 "	3	299820

A. A. MICHELSON

UNIVERSITY OF CHICAGO

A NEW TYPE OF ELECTRIC DISCHARGE: THE STREAMER DISCHARGE[1]

IN connection with a detailed study of the mechanism of electric discharges in argon we have observed some phenomena of remarkable beauty which may prove to be of theoretical interest.

A single loop tungsten filament of large diameter (0.5 mm) is mounted at one end of a cylindrical pyrex glass bulb 10 cm in diameter and 15 cm long with its axis horizontal. Rising vertically from this bulb is a tube 3 cm in diameter and 50 cm long which contains at its upper end a disk shaped anode. The tube is exhausted for an hour at 450° C., and the electrodes are freed from gas by induction heating and the tube is filled with extremely pure argon at a pressure of preferably 2 to 4 mm of Hg. The cathode is heated to about 2500° K and +250 volts is applied to the anode through a resistance. By approaching one terminal of a high frequency coil to the middle of the glass tube an arc of about one ampere is started through the tube, and the voltage difference between anode and cathode falls to about 25 volts.

The arc then fills the tube with a uniform pale reddish glow showing only lines of the red argon spectrum. A transverse magnetic field, from a hand horseshoe magnet with poles 4 cm apart, has practically no effect on the appearance of the arc.

The *streamer discharge* may now be started by opening the cathode heating circuit for *one half second,* allowing the current to return immediately to its former value. This lowers the cathode temperature momentarily and by decreasing the electron emission causes the voltage across the arc to rise from 25 to 100 volts or more for perhaps a second. The cathode drop sputters tungsten from the cathode in an amount which is estimated to lie between 10^{-6} and 10^{-7} grams.

This small dose of tungsten vapor has a profound effect on the arc. There are at first brilliant blue flashes of light from the lower end of the tube which show the tungsten spark spectrum. Simultaneously the arc begins to detach itself from the glass walls, starting at the lower end and gradually, in 5 to 15 seconds, extending up to the anode.

After 30 seconds or so the blue tungsten spectrum disappears and the arc quiets down but remains detached from the walls for its entire length. At first the arc is 1 to 1.5 cm in diameter and is bounded by a sharply defined luminous skin which emits a dull yellow light showing a continuous spectrum. The interior of the arc is reddish (argon spectrum), but is separated from the yellow skin by a dark space 1 or 2 mm thick.

Sometimes just inside this dark region there is a transient bluish white skin of considerable brilliancy which seems to show a mixture of continuous spectrum with the tungsten spectrum.

After perhaps 1 minute the yellow skin has disappeared and the arc has increased so much in cross-section that it seems at first as if it had returned to its original condition.

[1] Abstract of an address by Irving Langmuir at the Centenary of the Franklin Institute, Philadelphia, September 18, 1924.