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President's Address

R. J. Baldwin

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PRESIDENT'S ADDRESS.

BY HON. R. J. BALDWIN.

That subtile influence, which, with the dawn of the morning, shines about us, bathing the mountain peaks with splendor, and penetrating to the dark valleys, reveals all the hidden labyrinths of forest, stream and glen; which discloses to the eye the starry depths of the heavens, and the gorgeous scenery of the earth, flashing from the surface of lake and fountain, and glittering in the varied colors reflected from leaf and flower, rock and sky—we call light. Since the creation it has streamed upon the earth, a flood of glory, furnishing to man the means of exerting his best activities, and revealing the countless forms of nature, yet, so far as its nature is concerned, as little known as "when the morning stars sang together." Permeating all space, penetrating the substance of the chrystal diamond, it has neither appreciable weight or force, and is known to man, after centuries of study and experiment, only by its effects. How shall we define this most familiar and most useful gift of a beneficent Creator? We can not call it matter. We can not prove it substance. Scientific accuracy will hardly permit it to be called an influence. We know not that it is an element. We can only affirm it to be that in nature which enables man to exercise the faculty of vision.

The chief source of light to the earth is the sun. The fixed stars, meteors and comets also emit light. Various terrestial bodies in a state of incandescence and phosphores-

cence likewise give forth light. What a wondrous object of creative power is the sun! Drifting through space with its enormous bulk, holding in their prescribed and exact orbits the distant planets, and pouring upon earth through 96,000,000 miles, its flood of light, and by its warmth dissolving the frosts of winter, and quickening into life the leaf of spring and bloom of summer—not only—but flashing onward through space illumines the remotest planet.

Homer among poets thus describes:

"The sacred sun, above the waters raised,
"Through heaven's eternal, brazen portals blazed;
"And wide o'er earth diffused his charming ray,
"To gods and men to give the golden day."

And Milton apostrophises:

"Hail, holy Light, offspring of Heaven first born!"

Moore makes the Gheber chief thus greet his God:

"And see—the Sun himself!—on wings
"Of glory up to the East he springs.
"Angel of light! who from the time
"Those heavens began their march sublime,
"Hath first of all the starry choir,
"Trod in his Maker's steps of fire!"

Light, whether emanating from celestial or terrestial sources, permeates all space. It moves, if motion can be predicated of it, in straight lines. It has an appreciative velocity, greater indeed than that of any other force of nature whose properties it resembles—quicker even than thought.

Observations upon the occultation of the satellites of Jupiter, corroborated by a series of the most delicate measurements with instruments, show the velocity of the sun's light to be 192,500 miles per second of time. It would move round the earth in the eighth part of a second, and fly from sun to earth in eight minutes.

Light has the property of being reflected from some surfaces, and absorbed by others, giving rise to all the varied colors of nature.

It posseses likewise the quality of refraction, by virtue of which we are able to separate a beam of light into its primary elements, to eliminate its heat giving qualities, as well as those which produce chemical effects, and thus observe many of its subtlest properties. By virtue of this quality the solar spectrum is produced, the analysis of which reveals to us the composition of the sun's atmosphere, as well as the constituent elements of the planets, fixed stars, and nebulæ of the heavens.

Rays of light are also shown to possess polarization, like magnetism and electricity, and to influence one another in a peculiar way, which has been termed "interference."

In all these aspects, light obeys fixed laws, the particulars of which have been the subject of the most critical study, and which are formulated in the exactest methods of mathematical calculation and statement.

The investigation of the laws and properties of light constitutes the science of optics, and the application of these laws and properties to the uses of man, furnish occasion for some of the most useful industries and elegant arts of civilized life. By the former we learn the laws and conditions of vision, and the constituents and combinations of color. Among the latter will be at once recognized the telescope, by which the vast depths of etheral space are explored; and the microscope, which reveals the minute in nature, so that fluid drops are shown to be spheres swarming with animal life, and the very dust of the ground instinct with vital forms.

And then painting so essential among the useful and so exalted among æsthetic arts, that we think of the brush of Raphael as dipped in celestial colors.

But no painter, however inspired with the divine afflatus, can rival the pictures which the sun himself paints upon the canvass of the camera, and etches with touches more delicate than the graver's hand upon the sensitive plate prepared by photographic art.

The chief pleasure which man derives from external nature is due to the effects of light. The broad landscape emerges from the night, bright with verdure, waving with the undulations of ripening grain, flashing with mirror surface of lake and river, and glinting with the waterfall. The delicate tinting of bird and butterfly, of flower and blushing fruit, the flashing of diamond and ruby, and all the arcana of precious gems, please the eye only when the sun pours his wealth of light upon them, or when the "lamps shine o'er fair women and brave men." How much of the pleasure of life is received through the eye! How dark and sad this life to him whose eyes are closed to the light of day! How Milton's lament touches the tenderest chord of sympathy in the human heart!

"Thus with the year
Seasons return, but not to me returns
Day, or the sweet approach of even or morn,
Or sight of vernal bloom, or summer's rose,
Or flocks, or herds, or human face divine;
But cloud instead, and ever-during dark
Surrounds me, from the cheerful ways of men
Cut off, and for the book of knowledge fair
Presented with a universal blank
Of nature's works to me expunged and rased,
And wisdom at one entrance quite shut out."

We have already said that we remain ignorant of the nature of light, and the mode of its action. Nevertheless modern science has proposed two different theories.

The more ancient originating with Descartes, but reduced to systematic theory by the laborious research and delicate calculations of Newton, regards light as composed of particles or corpuscles of matter of extreme tenuity, emitted from the luminous body, and penetrating all space, and entering into the substance of the most compact bodies. Upon this hypothesis all the various phenomena of light which had been observed in Newton's day, including reflection and refraction, were accounted for. Later and more accurate observations

have brought to light other properties of light which the Newtonian hypothesis fails to account for.

The theory universally accepted by physicists of the present, regards light as propagated by undulations in an all pervading and extremely tenuous ether. The vibrations of this elastic fluid furnish a very plausible and apparently satisfactory explanation of the phenomena of light. This theory was first suggested by the Dutch philosopher Huyghens, about the year 1660. At the beginning of the present century Fresnel showed by the most brilliant discoveries the superiority of this theory, and shortly after Arago confirmed him in his demonstrations, and their conclusions have stood unchallenged to the present day. Experiments recently made have tended to raise some questions respecting the truth of this theory. An instrument discovered by Mr. Crooke F. R. S , and first exhibited by him at the soiree of the Royal Society, April 7, 1875, proves that light is capable of imparting motion, and seems to demonstrate that it possesses dynamic force. It is called Crooke's Radiometer. By the courtesy of A. C. Rand, Esq., I am able to exhibit this instrument, and to show its operation.*

It has been found, by throwing the pure rays of the spectrum one after the other upon the apparatus, that the actual rays which cause this action could be ascertained. Taking the maximum at 100, the following are the mechanical values of the different colors of the spectrum: ultra red, 100; extreme red, 85; red, 73; orange, 66; yellow, 57; green, 41; blue, 22, indigo, 8½; violet, 6; ultra violet, 5.

A comparison of these figures, says the inventor, is a sufficient proof that the mechanical action of radiation is as much a function of the luminous rays as it is of the dark heat rays.

*(This instrument consists of four circular discs of thin metal, bright upon one side and blackened upon the reverse, fastened to the extremities of two tranverse arms, and moving freely upon a central pivot within an exhausted glass receiver. Light from any luminous body falling upon the discs, causes them to revolve in the direction of the blackened surfaces.)

A consideration of the phenomena of light would be incomplete and unsatisfactory which did not include the spectrum, and the wonderful results which its analysis yields. A beam of light admitted to a dark room through an aperture, and falling upon a prism is decomposed, owing to the different refrangibility of its rays, and when received upon a screen, reveals a succession of brilliant colors. These colors were distinguished by Newton, and have ever since been recognized as violet, indigo, blue, green, yellow, orange and red. These are not distinctly marked, but merge into one another by imperceptible degrees, so that it is impossible to tell where one color ends and another begins. In point of fact, instead of seven distinct colors the spectrum shows an infinite number of shades, from the violet upon the left to red upon the right. Beyond these luminous rays are others which yield calorific and chemical effects. An instrument called the spectroscope has been constructed for producing and exhibiting the spectrum from all the various sources of light.

A century and a quarter after the observations of Newton, Dr. Wollaston, by using a slit instead of a round aperture, discovered that the lengthened spectrum was broken by a succession of fine black lines. About 1814, a German optician, Fraunhofer, mapped out these lines to the number of about six hundred. Since his time, from two to three thousand of these lines have been distinguished.

Radiation produces bright lines across the spectrum. Absorption produces dark lines. These lines are found to be always constant for the same substance. Thus the condition, composition, and quality of the body giving out light, are determined by the handwriting which they make in the spectrum. By it we are enabled to analyze all luminous bodies, and detect the smallest quantity of metallic, vaporous or gaseous substance in their composition.

The uses which the spectroscope serves are almost infinite. By it the atmosphere of the most distant planet, yea the remotest

star may be penetrated, its density determined, and its elements identified; and descending to terrestial and trivial concerns, we may detect our grocer in the adulteration of his goods, and reveal the minutest blood stain upon the washed and renovated garments of the assassin.

Time fails to pursue this interesting subject further. Among the sublime and wonderful results of the study of nature, not the least absorbing and pleasurable will be found the phenomena of light.

REPORT OF THE COMMITTEE ON BOTANY.

THE MYCOLOGICAL FLORA OF MINNESOTA.

BY A. E. JOHNSON, M. D.

Mr. President:

Ever since "The Minnesota Academy of Natural Sciences" was organized, four years ago, it has had a standing committee on botany, composed of three members, myself being one for at least three years, and until now we have not had a report on this branch of the natural history of Minnesota.

At the close of the April meeting of the Academy, the Committee on Botany held a short conference, in which I believe it was agreed, that as I had given some attention to the Mycological flora of this locality, I should, if I chose to do so, pursue this branch of botany, and report the results of my investigations; and it was also understood that the other members of the committee were to collect, determine and list as far as possible the Phænogamous plants of the State, and report the results of their investigations in that branch