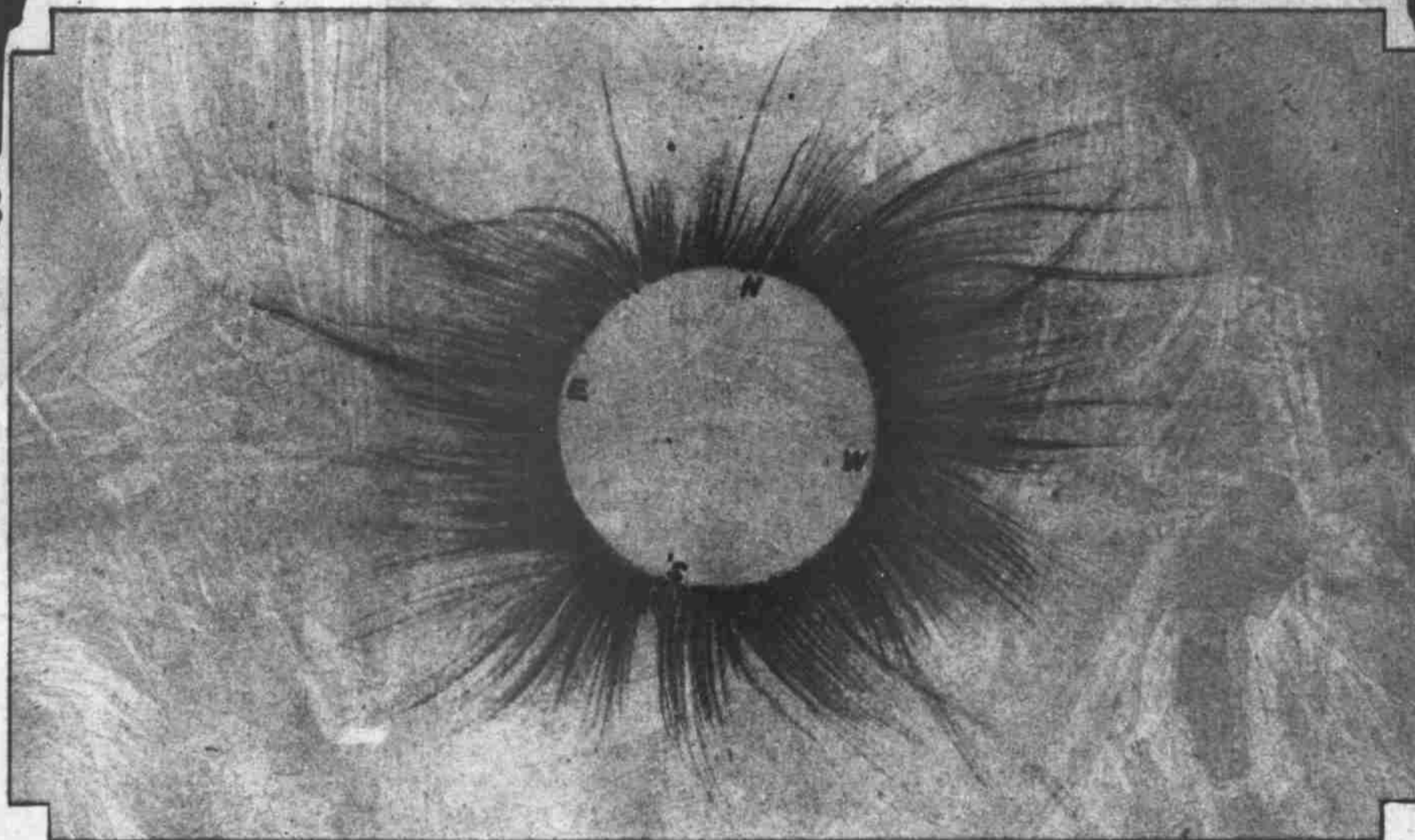
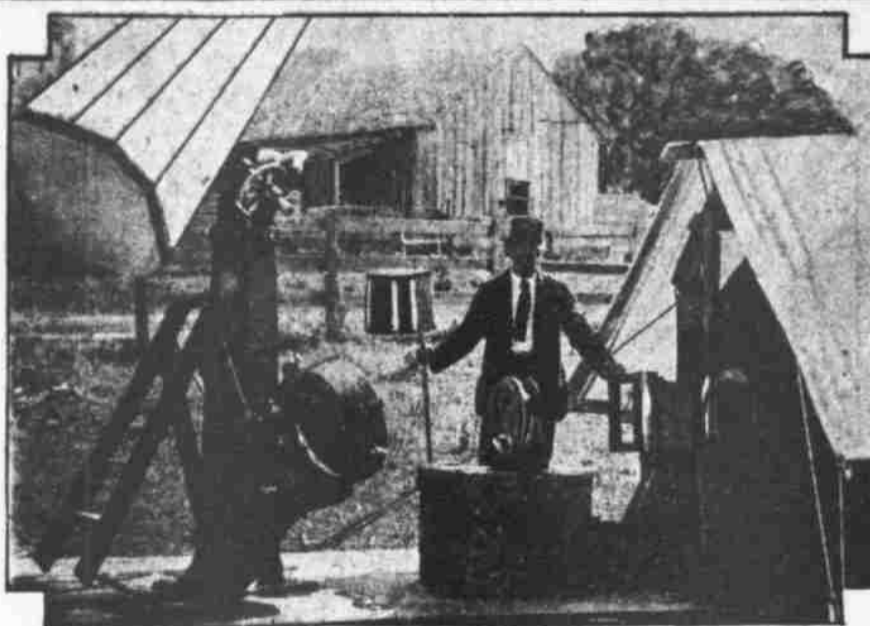


What Science Discovered from the Great Eclipse

New Facts About the Element Coronium, the Blood-Red Streamers $2\frac{1}{2}$ Million Miles Long, the Coronal Arches and Other Wonders of the Sun's Corona Observed at the Last Total Eclipse



Drawing of the Corona Made from Photographs Taken at Matheson, Colorado, Showing the Complicated Structure of the Corona. By Edison Pettit



Astronomical Photographer Throwing an Image of the Sun into a Camera 100 Feet in Length.

The Sun's Corona, Showing Eruptive Prominences, Photographed During the Total Eclipse of June 8, 1918, at Green River, Wyoming, by the Expedition of the Yerkes Observatory

average height. The two most conspicuous were apparently between fifty thousand and sixty thousand miles in height, though their actual height may have been somewhat greater owing to the effect of fore-shortening. One of these is most peculiar in form, resembling the skeleton of some monstrous prehistoric creature, so huge that two or three planets the size of the earth could be lodged in his skull. Spectroscopic records show considerable distortion of the images of this prominence. It was, therefore, extremely active. Such eruptive prominences frequently possess velocities greater than one hundred miles per second, and undergo radical change of form within a very few minutes.

The accompanying photograph of the eclipse, taken by the Yerkes Observatory expedition at Green River, Wyoming, shows this peculiar prominence very clearly. The eruptive varieties of prominence are always extremely short-lived, coming and going as the result of some mysterious form of solar activity that undergoes a periodic cycle of change and regulates not only the frequency of these outbursts of incandescent gases from the sun's interior, but also the frequency of sunspots and many allied phenomena, such as the form of the corona and the general magnetic field of the sun. Discoveries bearing upon the cause of any one of these phenomena may unravel the secret of the others, for all are different manifestations of some great underlying force that pulsates periodically through the sun's interior.

It is still early to consider the complete results of the June eclipse, since most of the astronomers who observed it are now busily occupied with astronomical work connected with the war, and have had, in many instances, no opportunity to examine extensively the records obtained. Some of the photographs and spectrograms have not yet been developed and a number of observers have made only preliminary reports.

The total phase of the eclipse was observed with great success by the Lick Observatory expedition at Goldendale, Wash. According to Professor W. W. Campbell, director of the Lick Observatory, the observations are the most valuable obtained by any expedition that has ever been sent out from the Lick Observatory.

The United States Naval Observatory was granted an appropriation of three thousand dollars by Congress in 1916 for the observation of this eclipse, and obtained valuable results at Baker, Oregon. The Yerkes Observatory was interested in three stations, one at Green River, Wyo.; a second at Denver, Col., and the third at Matheson, Col. Observations of great value were made at Matheson, where a number of expeditions from college and State observatories were also stationed. Unfortunately, no observations were possible at Denver, Col., where extensive plans had been made to observe the eclipse. Failure was due to the presence of dense clouds that persisted throughout the entire eclipse period.

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OBSERVATIONS of the total eclipse of the sun that was visible in the United States on the eighth of last June have yielded results that will be of great value to science. A large number of excellent photographic and spectroscopic records of the solar corona, that is visible only during the brief moments of a total eclipse of the sun, were obtained by nearly all of the eclipse expeditions that were stationed along the path of totality in the western States from Washington to Kansas.

It is expected that the information derived from careful future examinations of these records will materially assist in advancing our knowledge of the nature of the solar radiations and the connections existing between the sun spot cycle of solar activity and all the attendant, complicated phenomena of the upper solar atmosphere, as well as the resulting changes in the earth's magnetism and weather conditions.

On nearly every clear day for several weeks preceding the eventful day of the eclipse sun spot groups were to be seen on the surface of the sun. The period of maximum solar activity for this cycle was passed only a year or so ago, and as the decline toward the period of minimum activity several years hence is very gradual it was predicted that the light of that mysterious halo of the sun, the corona, would be unusually brilliant. This prediction was fulfilled, for the corona, visible during the eclipse of June 8, will go down into eclipse history as one of the most brilliant and interesting in its complicated structure of any of the eclipses of recent years.

Prints from original negatives unfortunately fail utterly to convey to us any idea of the magnificence of the coronal structure, while the exquisite pearly radiance of its light, described by observers of this eclipse as bluish-white, is but a cherished memory to those who were fortunate enough to observe it. To appreciate how complex and intricate is the structure of the corona one must go either to the original negatives that are full of detail, to photographic copies on glass or drawings from the original negatives. No adequate method for reproducing the coronal structure on prints has yet been devised. The accompanying drawing of the corona made by Edison Pettit from negatives obtained at Matheson, Col., gives us what the photographic prints cannot give—an excellent idea of the complicated structure of the corona.

It must be left to the painter to convey to the mind the superb coloring, the contrasting effect of the blood-red prominences, that were so conspicuous in this eclipse, with the grayish tinged disk of the occulting moon, the orange-tinged chromosphere and the pearly light of the coronal streamers interlaced to form the petals of some flowers gorgeous beyond description or curved into a series of gothic arches enveloping the most conspicuous prominences and towering to a height of more than two hundred thousand miles above the surface of the sun.

The corona of the June eclipse was very unsymmetrical, resembling a huge triangle in form, with the base to the west of the sun and the apex to the east. It is of the mixed type, in which the more evenly developed streamers to the west represent the type associated with maximum sunspot activity and the longer equatorial streamers to the east the sunspot minimum type, showing that the decline toward minimum solar activity for this cycle has already begun.

The longest coronal streamers, those to the east of the sun, it has been estimated, extend to a distance of fully three solar diameters, or over two and one-half million miles. This distance is not unusual. In fact, during certain eclipses streamers eight or nine million miles in extent have been observed. The petal formation so noticeable in this eclipse has also been noted in certain past eclipses, particularly in the Indian eclipse of 1898. Most of the petal-forming streamers seem to originate near the limits of the sunspot zone, while those over the solar poles are straight.

The arching of the coronal rays over all the most important prominences is considered to be very significant. It has also been observed in several past eclipses, and there seems little doubt now that the same forces in the sun that produced the eruptive prominences were also responsible for the arches above them. It is probable that the coronal streamers are largely electrical in their origin, just as the auroral streamers of the earth's upper atmosphere are electrical phenomena.

Evidence is also forthcoming from the June eclipse to strengthen the view that condensed metallic vapors are projected to distances of several million miles from the solar surface far beyond the limits reached by the prominences whose average height is from fifty thousand to one hundred thousand miles, though heights of over three hundred thousand miles have been attained by certain spectacular prominences.

The light of the inner corona, it has

been found from a preliminary study of the spectrograms taken on June 8, consists chiefly of intense continuous radiations. That the light of the inner corona is not due to reflected sunlight to any great extent is shown from the fact that the dark absorption lines of the normal solar spectrum were absent. Five bright lines were seen clearly, and their wave lengths have been measured, including the important green line of the unknown element coronium.

The existence of seven additional bright lines was suspected, but these were extremely faint. The corona has shown in several recent eclipses as many as fourteen bright lines very plainly. The comparative faintness of the lines in the corona observed in June is believed to be due to the fact that the solar activity was very great at this time. As a result, more than the usual amount of solar matter was being ejected from the surface of the sun into the inner corona as well as into the chromosphere, the lower solar atmosphere. This produced the unusual general bril-

liancy of the corona and the relative faintness of the true coronal lines. Though the characteristic lines of the corona were below the average in number and intensity, scores of bright lines belonging to the gases of the prominences were recorded.

It will be possible to obtain from the observations of this eclipse very accurate measurements of the green line of coronium. Preliminary measurements of this line place it at wave length 5303 instead of 5317, the value that was held for so many years, and therefore confirms the results obtained by Professor W. W. Campbell and others in more recent years. The location of this line in the spectrum is of the greatest importance. It is useless to expect to identify the element coronium until it wave length is known with a high degree of accuracy. It is one of the first laws of spectrum analysis that every chemical element has its own characteristic line or group of lines in the spectrum. The green line of the spectrum at wave length 5303, so far seen only during total

eclipse, belongs to the unknown element coronium.

It is strongly suspected that this is not the only line of this element, though it is the most intense one. It is believed that there are at least two or three fainter lines belonging to this element in the violet end of the spectrum.

It is also believed that there may be two of three more unknown elements that are true coronal elements, occurring, however, less generally than coronium. It is not likely that all of the fourteen or more bright lines of unknown origin that have been observed in the corona belong to the element coronium. It is believed by certain scientists that the coronal lines represent some form of matter electrically excited. Knowing the accurate wave length of coronium, it may be possible to identify it by laboratory experiments with some element existing on the earth, just as Ramsay, in 1895, discovered helium in the mineral clefts long after it had been discovered in the atmosphere of the sun.

According to spectroscopic observations recorded on June 8, showing the distribution of coronium around the sun, as well as several of the most characteristic gases of the prominences, this element is very irregularly distributed in the solar atmosphere. It occurred in greatest abundance in the sunspot zone, was observed to a considerable extent in the vicinity of the south solar pole, but was entirely absent in the neighborhood of the north pole of the sun. Moreover, its distribution was entirely independent of the elements belonging to the prominences, thus showing that there is no necessary connection between the solar prominences and the element coronium.

A most spectacular feature of the eclipse was the magnificent solar prominences, capped with sharply curved coronal arches. To the astronomer observations of the prominences during totality are not now considered of great importance, since it has been possible for some time to study these products of the ceaseless solar activity on any clear day by means of suitable spectroscopic instruments.

Their association with the coronal arches in this eclipse, as well as in certain previous eclipses, is important, since it may lead to a better understanding of the nature and underlying causes of the peculiar coronal streamers. The prominences observed in this eclipse were of