The Total Eclipse of the Sun, September 21, 1922.

By Dr. WILLIAM J. S. LOCKYER.

SOME time ago an account was given in these columns (December 29, 1921, vol. 108, p. 570) of the probable expeditions which would go out, and the stations that would be occupied, for the observation of the total eclipse of the sun in September of last year. This programme was very nearly followed, excepting that Mr. Evershed's party from South India, instead of occupying one of the islands of the Maldive group, went to a station, Wallal, on the north-west coast of Australia, thus joining up with other expeditions located there.

The eclipse track, it may be remembered, passed over the Maldive Islands, Christmas Island, and Australia, leaving that continent on its eastern coast.

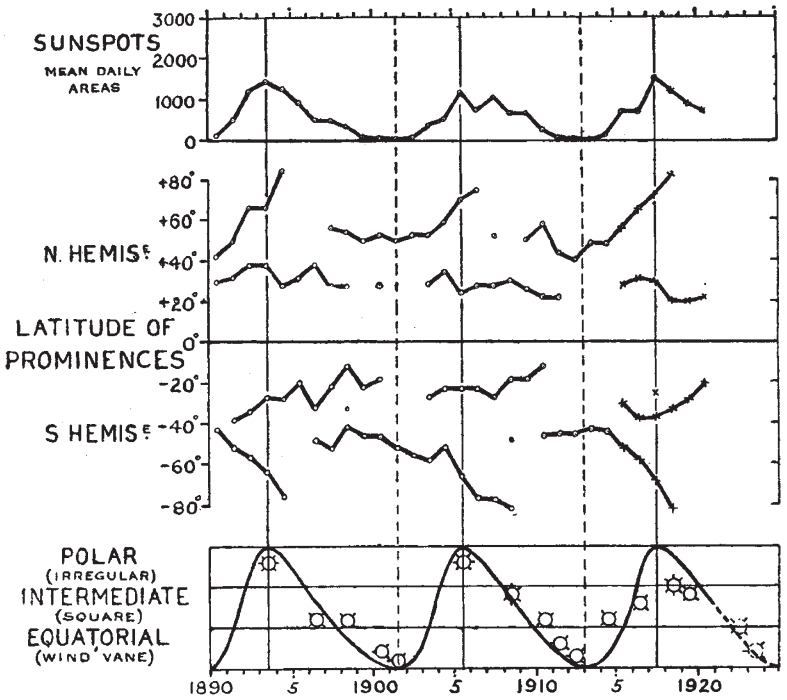

FIG. 1.—Comparison between prominence zones and forms of the corona. From Monthly Notices R.A.S., April 1922, vol. 82, No. 6, p. 324. By permission of the Royal Astronomical Society.

The Maldive Islands seem to have been unoccupied on this occasion, and the British and German expeditions to Christmas Island were so clouded out that no observations could be made. All the stations in Australia were favoured with fine weather, so a valuable series of records may be expected in due course.

The success of the Crocker Eclipse Expedition, which occupied Wallal, is shown by Dr. W. W. Campbell's account of the expedition which appears in the Publications of the Astronomical Society of the Pacific (vol. 35, p. 11). In the first instance, this expedition was organised on a modest scale, owing to the probable great difficulties of transport, etc., at this remote and somewhat inaccessible station in Australia. The generosity of the Australian Government in providing transport from Fremantle, and assistance both in personnel and material, altered the whole aspect of affairs. A much enlarged programme was, therefore, decided upon and was eventually carried out successfully.

The main programme was as follows:

A pair of cameras of 5 inches aperture and 15 feet focal length for application to the Einstein eclipse problem: the Shaeberle camera, aperture 5 inches and focal length 40 feet, for the photography of the solar corona: two cameras of 4-inch quadruplet lenses and 5 feet focus for the Einstein effect and other possible results of the sun's surroundings: several spectrographs for the photography of the coronal spectrum: and a camera of 5-inches aperture and 66 inches focal length for the photography of the form of the corona.

Dr. Campbell's account describes very fully the many and varied experiences of the trip to the station, the landing, the erection of the instruments, and the procedure to prevent the great amount of dust from affecting the mechanisms of the instruments. He pays great tribute to the valuable assistance rendered by Mr. H. A. Hunt, the Government meteorologist, charged with the general organisation of all the expeditions, and to the officers and men of the Royal Australian Navy detailed to accompany the expeditions to Wallal and provide for their needs at transfer points and at Wallal itself. The camp was quite up-to-date, receiving wireless time signals and a weekly aeroplane mail service.

Eclipse day proved ideal and the whole programme was followed successfully.

Owing to the irregularity of the moon's motion, the times of the eclipse were not exactly as forecasted. On this occasion the duration of the total phase for Wallal, assigned by the "Nautical Almanac," was five minutes nineteen seconds. At Wallal the beginning of totality came about sixteen seconds earlier than the predicted time, and the end occurred about twenty seconds earlier. Thus, mid-totality was eighteen seconds early and the whole total duration lasted five minutes fifteen and a half seconds.

The corona appeared visually small and relatively faint, and no large prominences were visible. It is stated that the form of the corona corresponded to that generally associated with sunspot minimum. This verifies the forecast I made in the article in this journal mentioned above, where it was stated that "the corona will most probably be of the 'wind-vane' type, in which the coronal streamers are restricted to the lower solar latitudes, while the regions of both poles will be conspicuous by the presence of the well-known polar rifts." The illustration which accompanies Dr. Campbell's paper indicates a typical form of "wind-vane" corona. (See Fig. 1.)

Dr. Campbell seems to have made supreme efforts to measure, on the spot, some of his plates for the Einstein effect, having previously succeeded in his arrangements for securing night comparison plates in the island of Tahiti. He wished at least to make a preliminary statement concerning the contribution of the expedition to the solution of the Einstein eclipse

problem before he left Perth on his homeward journey. In his own words, " it was a severe disappointment to me, that the many delays, wholly beyond our control . . . prevented me from carrying out this plan." (The plates have since been measured, and, as was announced in *Nature* of April 21, p. 541, the results confirm Einstein's prediction.)

It was intended that the large-scale photographs of the corona obtained at Wallal, and by the Adelaide expedition at Cordillo Hills, should be compared for evidence of motion within the coronal streamers, during the interval of 35 minutes between the times of totality at the two stations. The very quiescent solar conditions at the time did not hold out very good prospects, as Dr. Campbell states, but probably the high quality of the negatives will on closer examination lead to positive results.

All the spectroscopic results of the corona indicated also a low activity of the sun, the coronal lines being very much fainter than those recorded in the eclipse of 1918.

The absence of prominences, the smallness of the corona and its faintness, all tended to make the eclipse a dark one, thus favouring ideal conditions for the Einstein plates to secure as many star images as possible.

There is little doubt that when the complete results of the Crocker Eclipse Expedition come to be published they will contain a valuable record of the work accomplished during the brief interval of five minutes fifteen and a half seconds.

Perhaps one may be permitted to take this opportunity of congratulating Dr. Campbell not only on the success of this expedition which he so ably led, but also on his election in January last to the presidency of the University of California. While this position will involve great responsibilities and absorb much of his time, he will still, fortunately, retain his directorship of the Lick Observatory and his residence on Mount Hamilton, and he will return there on all available occasions.

Alloys Resistant to Corrosion.

A GENERAL discussion on the subject of alloys presenting a high resistance to corrosion was held on April 13 at the University of Sheffield, the meeting being arranged jointly by the Faraday Society, the Sheffield Section of the Institute of Metals, and the Manchester Metallurgical Society. Sir Robert Robertson, president of the Faraday Society, occupied the chair. In his opening remarks the chairman referred to the economic loss involved in the corrosion of steel, and to the great step in advance represented by the introduction of stainless steel. In the chemical industry, the use of high-silicon irons had proved to be of great value. It was important to remember that the order of resistance of materials might be quite different towards different reagents, so that in nitration, for example, while iron and steel would resist the action of the concentrated acids, the same solutions after being deprived of their nitric acid would cause attack. The time was ripe for a general survey of the subject.

Prof. C. H. Desch, while noting that no theoretical paper was to be presented at the meeting, remarked that the study of corrosion had undergone a profound change in recent years. Formerly, the usual method of experiment was the determination of loss of weight of specimens under more or less arbitrary conditions, coupled sometimes with measurements of electrolytic potential. The first method gave purely empirical results, whilst the second was difficult to interpret, and the resistance of different metals and alloys often appeared to be quite incompatible with their positions in the electrochemical series. Gradually, investigators had become convinced that the physical character of the products of corrosion was a most important factor in the process. A metal which from its electrochemical position might be expected to corrode rapidly might in the early stages become coated with a protective film, after which the action was negligible. It was not only films of perceptible thickness that exerted such an influence. Recent work had shown the importance of films of oxygen and other substances, one atom or one molecule thick, to which no definite formula could be assigned, but they altered entirely the chemical character of the surface. It is still impossible to predict the composition of highly resistant alloys, and we have to be content with empirical trials, such as have led to the discovery of the alloys to be described. The theory of the subject is still imperfect, and he urged that more attention should be given to the fundamental work of Faraday, the neglect of whose teaching was responsible for much confusion of thought on the subject of corrosion.

Three main classes of alloys were dealt with by the readers of papers, namely, the stainless steels, the alloys of nickel with chromium, and the alloy known as Monel metal. Dr. W. H. Hatfield gave an account of the extensive series of laboratory tests made in the Brown-Firth Laboratory, in which many specimens were exposed to the action of simple and mixed electrolytes, the results being recorded numerically and by means of colour photography. The high resistance of the alloys of iron with chromium and varying amounts of carbon, known as stainless steels, was very evident from these experiments. This class of steels was described in detail by Mr. J. H. G. Monypenny. The greatest resistance to corrosion in these steels is obtained by quenching in such a way as to obtain a homogeneous martensite, while the attack by reagents is greatest when the steels are annealed so as to bring about the greatest separation of the carbide and the ferrite. This is in accordance with the known effects of galvanic action. Tempering at such a temperature that the internal stresses are relieved, but coalescence of the carbide is avoided, does not lessen the resistance. With a very low carbon content, nearly all the chromium is in solid solution, so that the steels are resistant even in the unhardened state, and this property has led to many new uses for the metal. The retarding effect of colloidal substances on corrosion is shown by the fact that while a properly hardened stainless steel is not attacked by vinegar or lemon juice, pure acetic or citric acid of the same concentration produces a marked attack. The same alloys are highly resistant to the action of air at high temperatures or of superheated steam.

It is for their resistance to these agents that the next series of alloys, those containing nickel and chromium as their principal constituents, are specially valued, and these alloys were described by Mr. J. F. Kayser. The technical alloys contain iron, and the useful compositions are limited to a comparatively small area on the ternary equilibrium diagram, although some experiments have been made with alloys outside that range. Copper is occasionally added when resistance to acids is required, but is detrimental when high temperatures are involved. Aluminium has a remarkable hardening effect, owing to the formation of the very hard and infusible compound NiAl. Wires for electric furnaces, case-hardening boxes, and reaction vessels for ammonia synthesis, are among the uses to which this group of alloys has been put. The corroding action of furnace gases containing sulphur compounds is due to the