Presidential Address.

LADIES AND GENTLEMEN,

I rise once more to inflict upon you a President's address and in doing so I propose to keep the usual form, and firstly to speak about the Society itself, secondly to make a few remarks about the Astronomy of the year under report, and thirdly to deal shortly with a subject of my own.

First as to the Society. I am sure we have all listened with gratification to the Council's report both in regard to the membership of the Society and its finances. I think we may now safely assume that the falling of dead leaves to which I referred in previous addresses has ceased, and that we have now begun to attract those whose interest in the science is lasting and practical. The upward rise in membership is very satisfactory. We have unhappily to record the loss of a valuable member in Mr. R. J. Pocock regarding whom we have just had to pass a resolution. A notice of his services both to us and Astronomy generally will appear in the Journal shortly. Not less satisfactory than the increase of members is the state of our finances. In spite of a heavy expenditure on a really practical instrument and house for it, we have at our credit a substantial balance which should enable us to expand our work in the coming year. The Journal of the Society has been greatly improved owing to the efforts of our Editor, Mr. Weston, and if as we hope, members will undertake next year practical work with the $8\frac{1}{2}''$ reflector and also extend their private work, we ought to have additional original material for Mr. Weston to include in his future numbers. The list of our exchanges in the matter of publications continues and we have received many valuable contributions from the various Societies. Notable among them are copies of the volumes of the Astrographic Chart issued by the Oxford University Observatory and by H. E. H. the Nizam's Observatory at Hyderabad. We wish this year to carry our observational work much further than we have been able to do hitherto. It has made a start, and last year more was done than the year before, but it is still very small. One or two members did well and we have to congratulate Mrs. Murray on having picked up the new star in Aquila and secured the third observation in India. The appearance of the Nova and her observation of it, are I think a sufficient answer to those who are sceptical about the value of the naked

eye work, and it is exactly to secure results such as these that the sky search was introduced among workers. Of course, some may say, "well, but Nova do not appear every year!" This is quite true, but other objects do, and it was only the year before that an interesting comet was discovered with the naked eye. This year in addition to naked eye work we shall have a powerful telescope for members in Calcutta to use and I hope they will do so.

I come now to the second portion of my address.

Undoubtedly the most sensational event of the year was the advent of Nova Aquila. A history of the star will shortly appear in our Journal. It seems to have become visible as a brilliant object some time between the night of the 7th and that of the 8th of June. In a recent notice, I see that the star was noticed by an observer on the night of the 6th, while working on variable stars in the region and it attracted his attention as a strange small star. On the 7th he saw it again, and this time he thought it of sufficient interest to make a rough sketch of its position with the idea of examining a chart. This he did on the morning of the 8th, and that evening on looking again he at once saw the object now as a brilliant star. The probability is that when he saw it on the 7th it was rising in magnitude. This is also borne out by photographers. Many other observers in England and elsewhere saw the star on the 8th of June, and after that it came under general observation. The star rapidly declined in brilliance and is now very small. Before leaving the subject of novæ, it is interesting to find that a search among old negatives at Mt. Wilson has resulted in the discovery of several of these objects associated with spiral nebulæ. The search was suggested by the discovery of a nova in the spiral nebula H. IV-76 Cephei and has led to the discovery of about a dozen new ones—all of course small but more or less interesting. Members will remember the sensation made by a star known as Barnard's runaway star which was found to have an exceptionally large proper motion, thus indicating its nearness to the Earth. Several values have been now determined for the parallax of this star, and the mean of these gives a distance of the star from the Earth of 6·27 light years.

It is therefore the second nearest known star.

There have been two comets, namely, Wolf's comet and Encke's comet. The latter is a periodic comet and was re-discovered in December last. It became an easy object in the spring and had the Society's telescope been erected, we might have had observations of it.

Photographs of Jupiter have been continued by Mr. Reynolds at Birmingham. Mr. Reynolds has a 28-inch reflector there and has devoted it to planetary photography in which he has had very striking success. This class of work is yet in its infancy and Mr. Reynolds is a pioneer. The photographs he has obtained are a great advance on previous efforts. The work of most observations has suffered greatly owing to the war. Many astronomers have either engaged in actual fighting or taken up war work. Consequently astronomical work suffered and many instruments are in disuse.

It was with much pleasure I am sure that we read the announcement that Mr. Evershed of Kodaikanal, who is one of our Vice-Presidents, had received the Gold Medal of the Royal Astronomical Society for his work on the Sun.

I come now to the third part of my address in which it is usual to treat of some subject which the retiring President has selected. I have chosen the Bright Rays on the Moon on which to say a few words this evening, because it is one about which I have said very little to members, though they have been the objects of my personal research for about 20 years. I speak of them now because I hope that in a short time I shall be able to continue investigations on these features of the lunar surface with an adequate instrument and on new lines.

The Bright Rays.

The Bright Rays on the Moon are those peculiar white markings which can be seen even with small instruments surrounding some of the lunar craters. There are about 21 of them altogether, and the two largest and most important are those round Tycho and Copernicus. The highest of these, however, is in the neighbourhood of Aristarchus. In most cases the marking radiate from the crater in their centre in all directions and some of the rays extend to very great distances, one of them from Tycho reaching about 1,000 miles from that formation. The rays, as far as one can see, are purely surface markings and are generally dazzling white in colour. Those round Copernicus are, however, an exception and are slightly yellow especially in certain lights. A peculiarity of the rays is that they traverse every thing on the surface with which they happen to meet in their path. For instance, if a ray comes to a ravine it can be seen going down one side, across the floor

and up the other and then on as before. Similarly with a hill ; the ray will go up and over and on its course entirely undisturbed and can be traced along its whole path. These rays have been very systematically and carefully observed with a view to detecting the details of their structure and physical constitution.

Important features are the tiny craterlets which are to be found at intervals along most of the rays. These lead to the inference that the rays are of volcanic origin or at any rate lie along lines of weakness which are themselves probably volcanic or due to sub-surface forces on the Moon such as the faults and fissures on the Earth. A peculiarity of the rays is that they are not usually apparent at sunrise, but they begin to appear after an interval of about 24 hours. From this it was supposed that the rays were due to some solar action on the Moon's surface. Another supposition was that they are snow lying in shallow crevices which can only be seen when the Sun is high enough for the light to penetrate to them. It is now pretty certain, however, that the cause of their late appearance and early disappearance is simply due to the angle of light on them, and that when the Sun is low their whiteness is not reflected sufficiently to us here on the Earth to be contrasted with the rest of the soil. The effect has been experimentally reproduced by me on the Earth and the result is pretty conclusive. That the rays are not the product of the solar action is also proved from the fact that they can often be seen on the Earth-lit portion of the lunar surface at the time of young Moon. It is evident, therefore, that they are on the surface during the lunar night and cannot, therefore, be any result of the Sun shining on it.

I have just said that the rays pass over obstacles in their path such as valleys or hills and are therefore probably surface markings. At the same time it does not follow that their origin is of purely surface origin. If this were the case it is not likely that there would be no visible fracture in them ; for unless they appeared after all changes in the surface had ceased, there would almost certainly be signs of interruption in the continuity of the rays visibly due to this cause. I have never been able, however, to detect anything of this kind, and it seems likely therefore that where changes have occurred the white material of the ray, whatever it is, has again appeared on the surface. This suggests that the rays must be due to some kind of crystalline substance which comes up through cracks or the pores of the ground. This view has been held by many selenographers, notably

by Carpenter and Naysmith, who considered that enormous cracks or faults occurred in the lunar surface owing to internal pressure as the Moon evolved, and that lava or some such material welled up from below through the cracks. The experiments conducted to show this are of great interest, but in my opinion it is difficult to suppose these enormous fractures, as they do not exist on the Earth, though, as I shall show, something analogous to the cracks is probable. I may here perhaps clear the ground by mentioning two other explanations of the rays. One of them is that at the time when volcanoes were very active on the Moon, the white material was emitted by them and carried by air currents in all directions. This explanation seems to me to be a poor one as there is nothing to show that such eruptions took place, or if they did take place that white material issued. Even granting this, however, it is not explained why the currents should have taken the stuff along narrow lines radial to the central formation. Another explanation is the one held by many that the rays are the result of a bombardment of the Moon by meteorites. The size required of such bodies seems to me to be against the theory, but supposing them even to have fallen, there are two ideas put forward, one of them is that the heat of the falling body on impact melted that part of the surface and splashed the material radially, the other is that the meteorite on impact broke up, and the pieces made grooves in the ground which now appear as white streaks. Apart from the fantastic nature of these speculations, it seems to me that they must be ruled out for at least three reasons among others. First, the meteoric theory does not account for the crater chains consisting of, say, half a dozen or more craterlets lying in a line and touching one another. A peculiarity of these chains is that the largest craterlet is always at one end of the chain and the craterlets get smaller as they occur down to the smallest at the other end of the chain. It is difficult to see how meteorites could have fallen in this peculiar order. Secondly, the idea of the grooving and splashing does not account for the craterlets along the rays at intervals in the manner I have just stated. Thirdly, many of the rays, if not most of them, lie along low ridges.

I think we must look in another direction for an explanation and preferably on the Earth in order to see if we can find anything in the nature of an analogy there. This I have been able to do. In Northern India, as many members may be aware, there are vast saline deposits, and those who have travelled over the country will have noticed

the tracts of alkali efflorescence that lie like snow for miles and miles on the ground. It occurred to me that we might have an explanation here of the lunar rays, and I, therefore, spent a considerable time in investigating the alkali tracts.

The Alkali Tracts of India.

They are purely surface features and are caused by evaporation of the water from the ground which sets up an upward current of moisture bringing the salt in solution to the surface. The water then evaporates leaving the white efflorescence on the surface. To begin with, therefore, it was necessary to ascertain whether these efflorescences existed in any particular formation or whether they lay over the ground at random. With the kind help of District Officers in the Punjab I obtained maps and information from all parts of the Province with the result that when the tracts in the district maps were pieced together, the result was the salt range as a centre and three distinct rays issuing from it about 20 miles wide and running in two of the cases to the borders of the Province. On pursuing the enquiries in the case of the ray running towards the Karnal district, I found that it then followed the watershed of the Jumna and Ganges and continued even further than this down to the Mirzapur district in the United Provinces, a distance of over 600 miles. The second ray goes across the North-West Frontier Province into Afghanistan and there very little information regarding it could be got, but through Persia there are saline tracts in the desert of the same kind, and as far as I could trace information about them in the libraries in London, the tract extends most of the way across Persia. The third ray runs towards Sindh and is lost in the desert there. I could not see that these rays lay on any elevated ridges except the watersheds of the rivers, but this suggested the examination of the problem on the assumption that the albedo of the rays is separate in origin from the ridges on which they appear. Considering the question of the elevations only then to begin with, they seem to be explainable by supposing some point of internal pressure, such, for instance, as a volcano or other sub-surface upward force which has pushed up the surface above it. It might have broken the surface and thus have been an active volcano, or it might simply have pushed up the soil without breaking it. In either case the result would be that the surface all round would be similarly raised more

or less as we depart from the centre. If later on the force expired or lessened as it would probably do having spent itself, there would be a subsidence of the surface, and the resulting formation would be one of a central elevation with ridges radiating from it in all directions. I have been able to obtain this result exactly by experiment on a small scale, and it occurs in every case of an elevation and subsidence, though the number and direction of the ridges vary. But this of course is also what we also find in nature.

The Universality of Sodium.

If now we consider the analogy on the Earth, we should suppose the salt range to have been pushed up with saline beds in and around it. This would cause elevated ridges in the way already described and these ridges in their turn would influence the flow of the rivers and become watersheds. Similarly on the Moon radiating ridges would occur, though they might be only slight or perhaps not visible on the surface at all. As on the Moon water does not exist, the question of the rivers and watersheds does not arise, but there is nothing against the ridges. Having now obtained a radial ridge system, let us consider the saline efflorescence. It might not be present at all in which case there would be no white rays. Suppose, however, that some deliquescent salt existed in the soil, and that when the ridge was pushed up this was brought into contact with surface moisture, then the salt would inevitably rise in solution to the surface and there be left as an efflorescence. The fact that such ridges exist on the Moon has been proved by observation and the craterlets along them indicate that they are lines of weakness, and that the sub-surface material has had access to the surface. Consequently if any deliquescent material existed in the soil, then it would come to the surface and it would lie along the ridges under the ordinary process of evaporation. Now on the Earth some of the most common substances met with are the salts of sodium, so much so in fact that they are in evidence in practically every thing we know of unless they are specially excluded. In nature sodium is to be found everywhere not only on the Earth, but in the Sun and stars. On the Earth the quantity is enormous, and as it it is highly probable that the Moon was at one time part of the Earth, it seems to me to be extremely unlikely that the Moon is an exception to the rule of the solar system and that sodium is absent there. It is not, therefore, a very violent speculation to assume that such

salts do exist in the lunar surface as in the case of the Earth, and if this is the case, any moisture would bring them to the surface.

The Rainless Moon.

We here meet the difficulty that as far as we can see no water exists on the Moon. Certainly no clouds are there nor any rain or free water now. But in the past history of the Moon it seems to me to be by no means so certain that water in some form did not exist. Many lunar features point to it, and there is no doubt that enormous internal forces of some kind must have played their part in the Moon's surface formation. On the Earth water is one of the chief of such forces and more than one astronomer thinks that snow, hoar-frost or ice do exist on the Moon even at the present day. All that the theory requires is that some moisture should at one time have existed in the soil and come in contact with the saline substance. No rain or clouds are wanted nor any free water. But what would be the result of such a state of affairs? On the Earth the salts are brought to the surface and stay there so long as the Earth is dry. But when rain falls they enter into solution again and disappear. No rain however or atmospheric moisture exists on the Moon, and consequently there would be nothing to affect the efflorescence when once it appeared on the surface except wind. But on the Moon there is very little atmosphere and consequently no winds: hence when once the salts appeared, they would remain *in situ*. Not only so, but as any moisture that exists at present must be in the soil itself and cannot return when once it has left the soil, any evaporation that now goes on would merely continue to bring more and more salt to the surface thus adding to the rays. I think, however, that such processes have long since ceased and we may imagine the events to have been somewhat as follows: The salts having come into contact with the moisture, rose to the surface as an efflorescence. If moisture existed at any time, they probably disappeared and appeared again as on the Earth, but as moisture vanished from the Moon, the variations grew less and less, until a condition of desert was reached when no downward currents could occur. From that time the salt rays come to stay, and though salts still came up as evaporation occurred this has now probably ended, and the salts are left as white rays of dry saline substance on the crests of the ridges in an arid and

desert country. That is the conclusion I have reached, and I hope shortly to be able to test it by series of photographs which I want to obtain with a view to seeing whether any changes in them occur. If these photographs can be obtained, they should add much to our knowledge of these wonderful rays.

Appreciation of the late Mr. R. J. Pocock, B.A., B.Sc., F.R.A.S.

Mr. and Mrs. Pocock visited the Kodaikanal Observatory in May and June of this year. Mr. Pocock having obtained a well-earned holiday from his work at the Nizamiah Observatory. While here Mr. Pocock impressed me by his remarkable keenness for astronomical research and by a most generous spirit of co-operation. He undertook an arduous series of measures of Sun and arc spectra to assist me in an investigation on the displacement of the cyanogen bands in the solar spectrum, and in addition he carried out an investigation on the distribution of sunspots east and west of the Sun's meridian. The appearance of Nova Aquila during his stay here naturally excited his keen interest, and it is due largely to his energy and resourcefulness in assisting me to construct and arrange the necessary apparatus that we were able to secure a very valuable series of spectrum photographs.

Mr. Pocock was a man of generous and sympathetic nature, and we all at the Observatory deplore his untimely death.

J. EVERSHED.

Professor H. H. Turner, at the Royal Astronomical Society, London (taken from "The Observatory").

I am very glad to have this opportunity of saying a few words about Mr. Pocock, the announcement of whose unexpected death was seen by some of us in the papers recently. I have received no further particulars as to the cause of his death beyond the fact that it was due to pneumonia,