Astronomers Prepared for Eclipse

By James Stokley

If you should happen to be at Iloilo, second largest city of the Philippines, at 3:27 p. m., on next Thursday, May 9, you will not be able to see the sun in the sky for a few minutes. Perhaps it will be cloudy there at the time, but even if it is clear, the sun will disappear.

In the darkened sky, the planet Jupiter will shine brilliantly just above where the sun was when the light went out. Still higher, not quite so bright, is seldom-seen Mercury. Below, brightest of all, is Venus, brilliant evening star a few months ago. High in the eastern sky is Mars, inferior in brightness to its planetary brothers and sisters. The bright stars will flash out as well.

But most striking of all, to one fortunate enough to be over there next Thursday afternoon, is the appearance of the sun. Where the sun itself would be seen, is an intensely black disc. Shining out around it is a pearly white halo, irregular in shape, perhaps with several long streamers. Close to the black disc, there may appear several brilliant spots of red light.

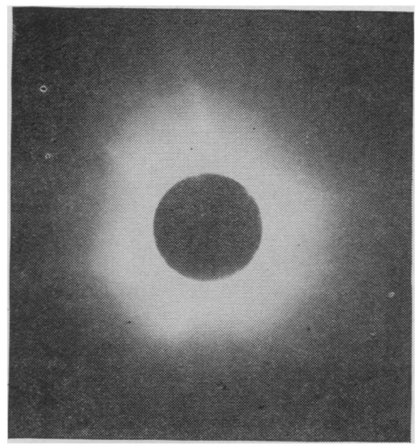
Not for long does the glorious spectacle continue. After three and a half minutes a brilliant spot of light of the sun reappears, and about an hour later the sun is gradually sinking in its accustomed manner into the west, as if nothing extraordinary had occurred.

If you happen to be on the Iloilo grounds of the Philippine railway at this time next Thursday, however, you will not find any astonishment at this remarkable occurrence. All around you will be a group of men with curious instruments, working with feverish activity during the three and a half minutes it lasts. All is quiet, except for the monotonous chant of one of the party, standing over a chronometer, as he counts seconds:

"One, two three, four, five, six, . . ."

and so on up to two hundred and twenty or so.

The cause of this activity is one of the rarest, grandest and most important of natural phenomena—a total eclipse of the sun. So important is it that astronomers are glad to travel half-way around the earth, if necessary, to see one—and to take a chance on the weather being cloudy at the crucial moment, and making the long months of preparation and travel all in vain.



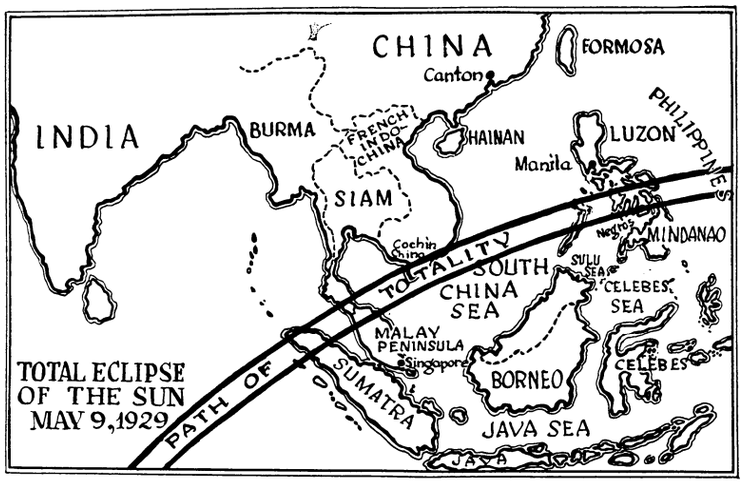
THE LAST ECLIPSE, on June 29, 1927, photographed at Jokkmokk, Lapland, by a party from the Hamburger Sternwarte, Germany

In many ways this coming eclipse will be one of the best in years. At Iloilo is a party of astronomers from the U. S. Naval Observatory in Washington. Nearby is a group from England. Farther west is a party from the great Hamburg Observatory in Germany. In Cochin-China, on the Malay Peninsula, in Siam, and in Sumatra, are other groups. One is from Swarthmore College, near Philadelphia. Another is from Harvard University. Several other parties from observatories in England, Germany and Holland, together with thousands of amateur star-gazers, or photographers turned star-gazers for the occasion, will be shooting away with their cameras to obtain a permanent record of the few minutes when the sun disappears.

All this because the moon happens to be of the size and at the distance that it is. If it were a little smaller, or a little nearer to us, we would never see an eclipse, and its glories would be unknown to us.

The moon, like the earth, and all the other planets in the solar system, is lighted by the sun. If the space between the planets were dusty, we could see a long shadow trailing out into space from the moon and each of the planets, always traveling along with the planet, and keeping pointed away from the sun. In one way, such a planetary shadow would differ from many of the shadows that we are used to. If you stand in a dark room, holding a candle, the shadow cast on the wall back of you is much larger than you are. This is because the source of light is much smaller than the object casting the shadow.

Suppose that the light is coming from a fixture with a large, round, translucent glass globe. Underneath it you hold your hand, and below your hand you hold a piece of white paper. When the paper is directly below your hand, the shadow is almost full size. As you move the paper farther away, the shadow becomes smaller and smaller, and finally you get to a point at which no clear shadow is seen. In other words, the light source is now larger (*Turn to next page*)



WHERE THE COMING ECIPSE WILL BE SEEN. Practically all of the land areas shown in the map as being crossed by the path of totality will have their quota of astronomers

Astronomers Ready for Eclipse—*Continued*

than the object casting the shadow, and so the shadow is a cone.

The sun is larger than any of the planets, so their shadows are all conical, with the tips of the cones pointing away from the sun. The shadow of the moon is about 232,000 miles long. The distance of the earth from the moon is just about the same figure. At least twice each year the shadow touches the earth. As the earth is always close to the tip of the conical shadow, it is never very large. But if the shadow strikes the earth obliquely, it may be spread out into an ellipse, which may be longer than this in one direction.

The moon travels on one trip of its orbit around the earth every twenty-eight days, but generally the shadow misses the earth. Twice every year at least, occasionally as often as five times, the shadow touches the earth, and sweeps across its surface at speeds as great as 5,000 miles an hour. The path traced by the shadow is usually about a hundred miles wide and many thousands of miles long.

To a person in this path, as the shadow approaches, the dark disc of the moon is seen gradually to encroach on the bright sun, so that after a few minutes it looks like a cookie out of which someone has taken a rather timid bite. The bitten-away part increases in size. Perhaps an hour after the first contact of moon and sun, the latter is completely swallowed up, and the beautiful corona flashes out for a brief period. Then a spot of the sun reappears, and the moon disgorges its solar cookie, in the reverse order from that in which it swallowed it.

Not every eclipse is a good one from the point of view of the astronomer. Sometimes the shadow strikes a part of the earth that is completely inaccessible. Sometimes the eclipse is so extremely brief that the astronomer does not feel that it is worth the trouble. Or sometimes the chances for clear skies at accessible places along the path may be so poor that he is unwilling to take a chance. Sometimes, also, the tip of the shadow does not quite reach the earth's surface and the result is an annular eclipse. Then the bright disc of the sun never completely disappears, but remains as a ring of light around the dark moon. Such an eclipse will occur later this year, on November 1, but it is of little scientific value, and no astronomer will go out of his way to get to Africa, where it will be visible.

Before this month, the last chance that astronomers had to observe an eclipse of the sun was on June 29, 1927. The path crossed England, Norway, Sweden and part of Siberia. At no point did the total phase last more than 50 seconds. Only two of the many groups of astronomers that went to observe it, one at Giggleswick, England, and the other at Jokkmokk, in northern Sweden, had clear weather.

Before that, there was another eclipse visible in the Indian Ocean and Sumatra, Borneo and Mindanao, on January 14, 1926. This was quite favorable. Fine weather was the order of the day, and a number of good photographs were made.

This eclipse was preceded, on January 24, 1925, by the famous New England eclipse, which was observed by an estimated total of 20,000,000 people. Along the Atlantic seaboard, where there seemed so little chance of clear weather in the early morning in January, the day dawned clear and cold, and most of the observing parties were successful.

There was no favorable eclipse in 1924, but on September 10, 1923, the path of one crossed southern California and Mexico. California's weather, as usual, was unusual, and cloudy weather prevented satisfactory observations. Farther south, in Mexico, the weather was clear, and observations there were successful.

September 21, 1922, brought a very favorable eclipse, visible in Australia, and a couple of small islands in the Indian Ocean.

On the 29th of May, 1919, there was a very famous eclipse visible in Brazil. It was at this eclipse that Prof. A. S. Eddington, of Cambridge University, England, first confirmed the deflection of star light near the sun, as predicted by Einstein's relativity theory, and so brought that theory into general prominence. The year before, on June 8, 1918, the path of an eclipse crossed the western United States.

With but seven total eclipses in the last ten years, visible only in widely scattered parts of the world, none lasting more than a few minutes and one lasting less than a minute, the rarity of the event can be realized. If an astronomer went to all the eclipses visible during his lifetime, and had clear weather at every one, he would only see the sun eclipsed for about half an hour, in spite of the hundred thousand or so miles that he would have to travel.

There are four prominent American eclipse observers, each having been to six or more eclipses. These are Prof. W. W. Campbell, of the University of California; Prof. H. D. Curtis, of the University of Pittsburgh; Prof. John A. Miller, of Swarthmore College, and Prof. S. A. Mitchell, of the University of Virginia. Campbell and Curtis each have been to eight eclipses and are tied for first place. Dr. Campbell is now President of the University of California and will not go to Sumatra, so that after this eclipse, Prof. Curtis will be ahead in the number attended. Prof. Mitchell ranks second with seven eclipses and Prof. Miller has six to his record.

However, the batting average of these observers has not all been 100 per cent. Only Prof. Miller has had clear weather at every eclipse he attended. Prof. Mitchell has had cloudy weather once, at the 1927 eclipse in Norway, when the sky was completely overcast. Thus, he has also seen six. Prof. Campbell has had cloudy weather twice and has seen six eclipses. Three eclipses that Prof. Curtis attended have been cloudy so he has seen only five, but should the one in Sumatra be successful, then he will have seen as many as Professors Campbell and Mitchell, but Prof. Miller will then advance to first place for having seen seven.

But why are the astronomers so anxious to see eclipses? Why have the numerous expeditions from some half-dozen countries traveled to Sumatra and the Philippines to see the eclipse next Thursday?

Of all the stars in the sky, the most important one to us is the sun. After all, the sun is a star, just like any other star in the sky. The only reason that it looks different to us is because it is so much closer than any other. Since it is the sun that is the source of all the energy that we use on the earth, the very energy that keeps the human race alive, it is essential that the sun be studied in every way possible. And further, as the sun is a typical star, and the only star of which we can get a closeup, its study helps us to learn of the behavior of the more distant stars that we cannot study so well.

The corona, outermost layer of the sun, extends for a million or more miles from the solar surface, and can only be adequately observed at the time of an eclipse. This is because its light is only about half as bright as that of the (*Turn to next page*)

Astronomers Ready for Eclipse—*Continued*

AT A COLDER ECLIPSE. Prof. Heber D. Curtis, of the Allegheny Observatory, Pittsburgh (left) and Prof. John A. Miller, of Swarthmore College, Pa., at the eclipse of Jan. 24, 1925, which they observed from New Haven, Connecticut, with the temperature around zero. The two astronomers are again together for an eclipse in a somewhat warmer clime.

full moon, and about a millionth as bright as the sun itself. Ordinarily, the glare of the sun in the surrounding atmosphere makes it invisible.

At the station of the Naval Observatory, on the Philippine Railway grounds at Iloilo, several important observations will be made. With a camera 65 feet long, photographs will be made of the inner layer of the corona. In Sumatra, Prof. J. A. Miller, of Swarthmore, will make similar photographs with an identical camera. The shadow of the moon sweeps across his station about an hour before it reaches Iloilo, so that comparison of the two pictures should reveal how rapidly the material in the corona is moving.

It is known that the corona consists mostly of scattered sunlight, scattered partly by fine particles, or dust, and partly by the molecules of gas. But nobody knows just how fast it is moving. Obviously it is moving, for eclipses at different times have coronas of greatly different shapes. When an eclipse occurs at the time of a large number of sunspots, a condition occurring every eleven years, the corona is nearly circular, extending out an equal distance on all sides of the sun. At the time of few or no sunspots, the corona shows long streamers extending out from the equator of the sun. The sunspot maximum came last year, and the sunspots are now definitely on the decline. Probably the corona will be nearly the same as that of the 1918 eclipse, for in that year also the sunspot maximum had gone by just a year before.

Another way of telling of the constitution of the corona is with the spectrograph, which analyses the light. Prof. Heber D. Curtis, of the Allegheny Observatory, who is with Prof. Miller, will make such spectrum photographs of the corona. He is not using the ordinary kind of spectrograph, however, but one which makes use of the interference of light and gives extremely accurate measurements of the speed of the moving material in the corona.

Within the corona, the outer part of the sun as we see it, is the chromosphere, a layer of glowing gases. Ordinarily, this makes itself evident only by absorbing part of the light from the inner parts of the sun, and causing the dark lines in the color spectrum. At the time of an eclipse, just before and just after the moon completely covers the sun, this layer shines by its own light. Its spectrum then is a series of bright, colored arcs of light, and by their measurement on the photographs it is possible to meas- (*Turn to next page*)

Prehistory Young Science

Archæology

The science of determining what went on in the world before men started the writing of history is just ninety-nine years old, Dr. George Grant MacCurdy, of Yale University, reminded the American Philosophical Society at its Philadelphia session.

The zero milestone of the science of prehistory was set by C. J. Thomsen of Copenhagen in 1830 when he established a system of chronology for prehistoric ages based on the development of human industry in stone, iron, and bronze.

The years 1857 to 1861 were important ones. The discovery of primitive human bones at Neandertal, Germany, was announced in 1857. The following year came the joint communication of Darwin and Wallace regarding the perpetuation of varieties and species by means of natural selection. In 1859 Darwin's "Origin of Species" was published. The same year scientists agreed that the crudely chipped stones found along the valley terraces of the Somme River must have been made by men of remote antiquity, and soon after that came the realization that a reindeer bone with pictures of wounded animals cut into it was really a specimen of the art of ancient men.

"Before the science of prehistory could be developed it had to await the prior development of geography and geology as well as comparative anatomy," Dr. MacCurdy stated. "It was a bit of great good fortune that the discovery of the human bones at Neandertal did not take place during the Middle Ages."

One of the big problems of prehistory is to gain an increase of knowledge regarding ancient man in Asia and Africa in order that Old-World prehistory as a whole may be correlated, Dr. MacCurdy stated. To this end, he said, the American School of Prehistoric Research has obtained permits and is already exploring and excavating jointly with the British in Iraq and Palestine. Another great problem is the correlation of human remains with the various phases of the Ice Age.

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Twenty-five years ago, the first flight in a heavier-than-air machine lasted 59 seconds.

Alaska has a herd of galyaks, which are hybrids of galloway cattle and the Tibetan yak.

Eclipse—*Continued*

ure the exact height of each of the gases in this solar atmosphere.

It was in the 1919 Brazilian eclipse that the deflection of the light of a distant star as it passes close to a body so massive as the sun was first shown. This had been predicted by Prof. Einstein, and when it was found his theory of relativity came into world-wide prominence, despite the fact that it was so technical. Prof. W. W. Campbell, of the University of California, also measured it, but some opponents of the theory of relativity have questioned both measurements, and it should be shown again. Prof. Miller will make photographs to reveal it.

These are but a few of the researches that have brought several hundred astronomers to Malaysia to wait anxiously for next Thursday, hoping and hoping that the weather will be good and their efforts not in vain. Some have already been at their stations for months, getting their instruments ready. Now practically all construction work is finished, but their time is not idle. Dozens of rehearsals are being held, and will be held up to zero hour next Thursday. With so much depending on what can be done in a very few minutes, everyone must know just what to do at the right time. As one member of the party counts seconds, another inserts the plates in the camera, another opens the lens. The lenses are covered, plates removed, other plates inserted.

If the weather should be cloudy the astronomers will be disappointed, of course. But they will waste no time in vain regrets, for they are good sportsmen, and realize full well the chance they are taking. And there will be another eclipse, visible in Canada and New England, on the afternoon of August 31, 1932, for which preparations will soon begin.

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