ASTRONOMY

Scientists Explore Sun

Photographs show tiny blisters and prominences of threads of gas on the sun's surface. Coronal storms affect short-wave radio broadcasts.

By MARTHA G. MORROW

➤ THE SUN'S outer atmosphere, so faint that it can be seen only during a total eclipse, is no longer a complete mystery. An amazing instrument that eclipses the sun every clear day has shown us that:

The sun's outer envelope is relatively stable and rotates with the sun.

Tiny blisters appearing at the surface of the sun shoot luminous gases outwards.

Three or four days after a fiery storm is seen on the east margin of the sun's disk, shortwave radio broadcasts here on earth, nearly 93,000,000 miles away, are likely to be blacked out.

Prominences, seen as brilliant rosy flames during an eclipse, are composed of interlacing threads of gas.

All this has been discovered through photographs taken high on a Colorado mountain top. Using a telescope that produces man-made eclipses, Dr. W. O. Roberts, superintendent of the High Altitude Observatory of Harvard University and University of Colorado, has learned much about the sun's atmosphere and the way it affects us here on earth.

Lifetimes of Observation

The astronomer who could observe as many as twenty total solar eclipses would set a world record. But even he would have little more than an hour of eclipsed sun in an entire lifetime of study of the sun's outer atmosphere. Several lifetimes of observation, however, are crowded into one clear day at the Climax, Colo., observatory.

The sun is not likely to be hidden entirely by the moon more than once a year. A total solar eclipse that lasts five minutes is considered quite good—an eclipse never lasts longer than seven and a half minutes at best. Only from a tiny strip of earth can people see it as total.

If instruments for photographing eclipses were established in a fixed locality, they could be used for just a few minutes once every 360 years. Yet the sun's corona is studied many hours each clear day at this, the world's highest permanent observatory, more than two miles above sea level.

The prominences and corona represent the atmosphere of the sun just as air forms the earth's atmosphere. The sun itself is composed entirely of gases, but they are so compressed by the great pull of gravity that the sun's surface is sharply defined. The prominences and corona are unstable clouds of gas which sometimes rise as high as 5,000,000 miles above the solar surface.

Prominence of June 4, one of the largest ever photographed, pictured on the cover of this SCIENCE NEWS LETTER, is shown about 200,000 miles above the surface of the sun, blocked out by the metal disk in the telescope. White dot gives the relative size of the earth.

Photographs taken at Climax show that the sun's atmosphere is pulled around with it as it rotates. Bright coronal patches spotted on one limb will be duplicated two weeks later as the same feature passes the other limb.

Even though no spots may be visible on the sun's disk, storms in the earth's ionosphere and disrupted shortwave broadcasts usually follow three or four days after a fiery coronal storm is noticed on the same east margin. Sometimes radio communications are blacked out, and telegraph and electric power circuits completely disrupted. There is seldom any significant geomagnetic activity without bright coronal regions having been located on the east edge of the sun several days previously.

Tiny spike-like prominences have been found on photographs of the sun's outer atmosphere. These spicules usually last only a couple of minutes, never longer than 12. Appearing first as blisters on the sun's edge, a minute or two later they burst, shooting out luminous gases.

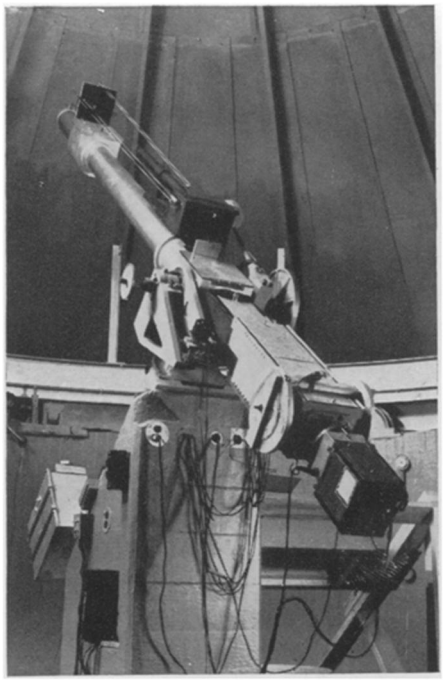
Spicules are so frequent that they are thought to form a link between the sun's interior and its corona. It is hoped they will help explain the mystery of the corona's fantastically high temperatures—much hotter than the prominences and much hotter than the surface of the sun itself.

Concept of Prominences

Interlacing threads of gas, in a complicated network, are now believed to make up the flame-like solar prominences. Because we can no longer believe that bright prominences are quite uniform in intensity, our concept of densities and pressures in prominences will probably have to be revised.

Careful records are being kept at Climax in the hopes of some day finding the key to the relation between activity on the sun and weather here on earth. There seems reason to believe that major storm cycles are initiated by

SNOW SLIDE—Dome of High Altitude Observatory, designed specially to study the sun's outer envelope without an eclipse, is shaped to shed snows.



CORONAGRAPH — The coronagraph is a specialized telescope of unusual design, and is utilized for obtaining artificial eclipse photographs of the sun's corona and prominences.

air movements stimulated by sudden changes in solar radiation. Some day storms on earth may be forecast weeks in advance from a knowledge of storms on the sun.

The sun is eclipsed so infrequently and for such brief periods that astronomers interested in studying it in the past were greatly handicapped. But had the moon been a bit smaller or a little farther away, we might not have known about the prominences and corona at all. The moon would have been unable to produce a total eclipse.

Today the sun's corona is studied daily through use of a coronagraph, invented in 1930 by Dr. Bernard Lyot of France. A metal disk in the telescope blots out the sun just as the moon does during a total eclipse, making it possible to see the surrounding bright gases.

Several coronagraphs are actively in use. Dr. Lyot operates a powerful one high on the Pic du Midi in the Pyrenees. Dr. Max Waldmeier installed one at Arosa in Switzerland. Through Dr. Donald H. Menzel, Harvard College Observatory in 1940 established on the Continental Divide at Climax the only coronagraph in the Western Hemisphere.

The sun's outer envelope, extending into space hundreds of thousands of miles during a total eclipse, appears as a faint pearly halo of light. This greenish-white nebulous atmosphere is about half a million times less brilliant than the sun and its total light a little less than that of the full moon.

To blot out the light of the solar disk and photograph the faint envelope of the sun is no simple task. Face an ordinary camera toward the sun and the picture is usually marred by a series of streaks and blots. These defects are due to reflections between the lenses and from the sides of the camera walls. In a telescope designed specially to study the sun's corona all such reflections must be eliminated or reduced to a minimum.

Until a decade or so ago, a man-made eclipse of the sun was considered a physical impossibility. Ordinary astronomical instruments diffused many hundreds of times the amount of light that the corona radiated into them, and obliterated all traces of the luminous gases in the faint solar atmosphere.

A metal disk at the main focus of the coronagraph, miracle instrument that does produce an eclipse, blots out the sun. A second lens, well behind the disk, reimages the surrounding sky with prominences, spicules and corona. To eliminate light scattered from the edge of the objective lens, a third lens is introduced just behind the occulting disk. This focuses the light upon the camera lens so that the edges can be blocked out with a diaphragm.

Dust-Free Lens

The lens must be entirely dust-free, for each tiny spot on the lens scatters light profusely and shines like a brilliant star. A dusty lens will send far more extraneous light to the plate than is found in the entire corona.

Ordinary brushing or wiping the lens charges the surface with static electricity, causing the dust particles to cling tenaciously. So oil from the human skin is used—with a well-washed finger oil from a well-washed nose is applied to a few spots on the surface of the glass. Then a clean, soft cloth is used to spread the oil over the surface. Babies' diapers were found excellent for this use. When this simple film of face-grease entirely covers the surface, dust particles slide away when you blow.

To be effective, a coronagraph must be installed in an atmosphere as nearly free of dust as possible. Thus observatories having this unique telescope are located high in the mountains. At Fremont Pass the stars shine so brightly on cloudless nights that with the naked eye you can see many seventh-magnitude stars, far too faint to be spotted at sea level.

The observatory itself is unheated, even in sub-zero weather. It has a cone-shaped roof, designed to shed the frequent heavy snows. The house and working spaces are electrically heated so that smoke or warm air from a furnace chimney will not impair observations.

Another coronagraph, larger than the present one and designed for even higher magnification of fine details, is being built and probably will be put into operation at the High Altitude Observatory early in 1948. The old instrument will then be used as a pilot telescope, while the new one will be employed to study radiations of hydrogen, helium and half-stripped iron atoms in the solar corona. When a prominence rises so high above the sun that it would disappear from the present instrument, as happened early last June, the activity of the gases can be captured with the new telescope.

Astronomers hope that within another decade or two a world-wide chain of coronagraphs will permit the behavior of the sun to be watched at all times as if there were a perpetual eclipse. Much remains to be learned about our nearest star.

The coronagraph, which permits the faint light of the corona to be observed regularly, is ideal for most research. But so far only the bright inner portions of the sun's envelope have been visible. Eclipses will have to be relied upon for knowledge of the form and spectrum of the outermost layer. Astronomers will still travel half way around the world to observe the sun's faint outer atmosphere during a total eclipse.

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