ASTRONOMY

A Tower to Stop the Sun

Unique Mirror Set-Up at Lake Angelus, Michigan Catches the Sun and Puts Its Flames Into Movies

By DR. FRANK THONE

See Front Cover

HOT lately, isn't it? . . . Seems like there's more thunderstorms, too . . . Caused by sunspots? . . . Papers say they've been getting bigger lately—more of them, coming in bunches . . . Wonder how scientists find out all that kind of thing? . . .

Vague, conjectural, scrappy talk, that you may hear on any simmering street corner, or in the moist spots where people get together to cool off and slake their thirst.

Whether the sun and its spots have any direct influence on earthly weather is a question very far from being definitely settled. Among scientists there are ardent "spot-weatherites," and there are equally ardent "anti-spotters," and they have at each other with great gusto,

" . . . in learned argument about it and about."

But evermore they come out by that same door where in they went. And probably the great majority of interested scientists remain agnostic on this question; can't decide until we have more data, they say.

Affect Communication

There is no doubt whatever, though, that changes in activity on the sun effect our daily lives in a less direct though exceedingly important way. At certain stages in sunspot development, there occurs on earth what is known as a magnetic storm. The skies may be clear on earth and the winds but gentle zephyrs during one of these storms, but they raise very Ned just the same. For the storm occurs in the earth's magnetic field, and it puts telegraph lines, long-distance radio communication, and trans-Atlantic telephones all out of business, sometimes for hours on end. And in the sensitively balanced state of affairs we call civilization, such interruption in communications is catastrophic.

Wherefore, because of these and the many other everyday importances of the sun, as well as for the sheer delight of knowing some new thing, many astronomers are devoting their lives to solar study. They have learned many things about this great flaming star that keeps us all warm and alive, but they need and want to know far more.

Newest among the world's battery of heavy scientific artillery besieging the stronghold of the sun is the fifty-foot tower telescope of the McMath-Hulbert Observatory of the University of Michigan, located on the shores of Lake Angelus, near Detroit. This observatory was founded originally not by or for professional astronomers, but as a serious avocation outlet for three prominent Detroiters, F. C. McMath, R. R. McMath, and H. S. Hulbert. Mr. Hulbert is a judge, the McMaths are civil engineers who later became manufacturers.

Given to University

After it had been built and equipped, the observatory was offered to the University and accepted as part of its equipment. R. R. McMath continues to act as its director. A number of eminent professional astronomers have worked with him, particularly members of the Mount Wilson, Calif., observatory staff. Mr. McMath and Edison Pettit of Mount Wilson are joint authors of an important scientific paper that appeared in The Astrophysical Journal a short time ago.

The first reason for the building of the McMath-Hulbert Observatory was to get motion pictures of the heavenly bodies, something that had never been done before. With a conventional telescope and a motion picture camera controlled by a specially constructed time-lapse drive, fascinating movies of such things as the 1932 solar eclipse, Jupiter's satellites, and sunrise on the moon were obtained as much as half-a-dozen years ago.

For a number of reasons, however, this first equipment was not considered satisfactory for getting motion pictures of events on the sun. Something bigger, specially adapted for solar work, was wanted.

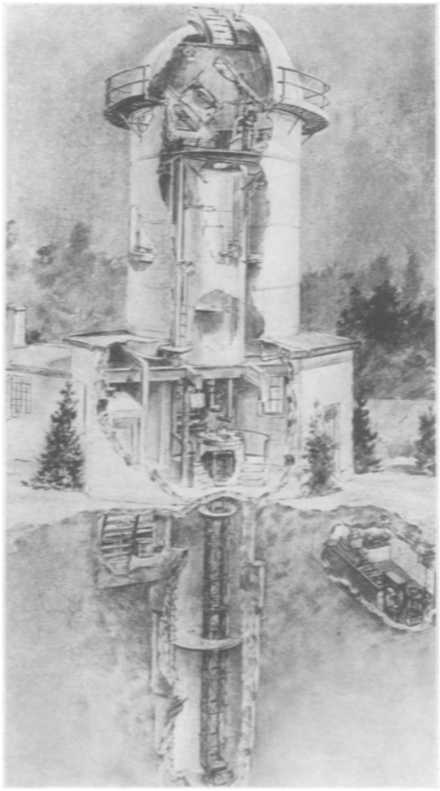
One of the most satisfactory types of instrument for "shooting the sun" is the tower telescope. There were already several of them in the world; though they are all surpassed now in size and power by the new one at Lake Angelus.

The usual types of telescope are always pointed directly at the celestial object viewed or photographed. A tower telescope, on the contrary, always points straight upward, at the zenith; its whole length corresponds to the tube of the conventional instrument.

Sky-Stopper

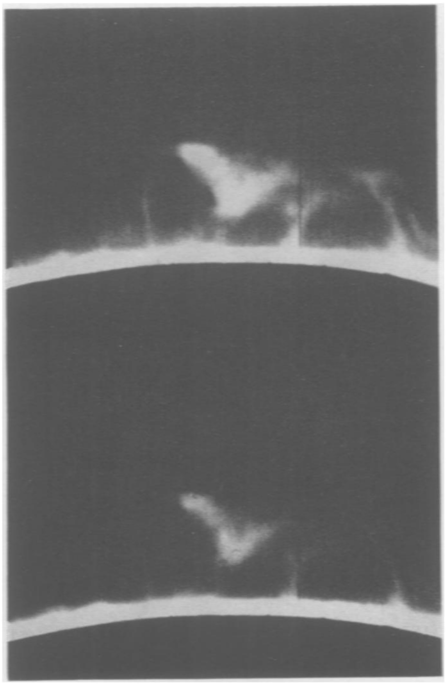
At its top, looking out through the slot in the dome, is a mirror held at an angle, to catch the image of the sun. It throws this reflection against a second mirror, held at a complementary angle. The second mirror throws the beam straight down the long shaft of the tower to where the optical working parts and cameras are waiting to receive it.

Such a set-up of mirrors is known as a coelostat—Greek for "sky-stopper." It doesn't stop the heavenly objects in the march across the sky but by following



HOW IT WORKS

A cut-away view of the 50-foot tower telescope of the McMath-Hulbert Observatory, showing arrangement of instruments, location of workrooms, etc. Drawing by Russell W. Porter.



RESULTS

Enlarged "frames" from the McMath-Hulbert Observatory films of flame-changes on the sun.

them in the right manner it holds their images stopped at the bottom of the shaft. It is a veritable robot Joshua.

In erecting their tower telescope the McMaths showed how an engineering training can come to the aid of scientific enterprise. They built it double-walled, to afford as much insulating air space as possible, for the central shaft and its instruments must be protected against temperature changes that cause things to expand and contract, and so throw delicate adjustments out of line. The space between the outer wall and the central shaft accommodates a staircase to the top.

Economy

The dome that covers the top of the tower represents a stroke of ingenuity that is almost genius. It was discovered that observatory domes built to order cost most outrageously. But manufacturers of water tanks for industrial plants make hemispherical bottoms for them in a wide range of sizes and at regular market prices. So Mr. McMath ordered one of these water tank bottoms, turned it over, cut the regulation observatory slot in its side—and had a perfectly good top for his tower at a fraction of the custom-built cost.

The device at the camera end that makes the new sun movies possible is an interesting evolution of the age-old prism for splitting a narrow beam of sunlight into a rainbow-colored band or spectrum.

Put into a suitable mounting, such a prism becomes a spectroscope. Apply a camera to a spectroscope, so that it writes a permanent record of its spectrum on the plate, and you have a spectrograph.

Spectroheliograph

The next stage in the development belongs to the Mount Wilson Observatory. Many years ago, Dr. George E. Hale of its staff developed an instrument in which the slit through which the sunlight is admitted could be moved. Within the instrument was a second movable slit, timed to travel in step with the first. This would be arranged so that the only light passing through the second slit would be from a single one of the many elements on the sun's glowing surface—say hydrogen or calcium. Each time a photographic plate was thus "wiped" with a one-color line of sunlight, it left a picture of the sun in terms of that light. Because his instrument was a special kind of spectrograph used for the study of the sun, Dr. Hale christened it a spectroheliograph.

In the McMath-Hulbert Observatory, the spectroheliograph is adapted to the speed of the motion picture camera, taking a photograph of the sun (or portion or the sun's disk) for every frame. Because movie cameras used to be called kinematographs (back when the present grayhaired generation were kids) Mr. McMath combined the two names into one long breath-taking tongue-twister and called his machine spectroheliokinematograph. Which describes the instrument nicely. But probably they don't take time to say all of it around the Observatory, at least when they're having to hurry.

The astronomers at the McMath-Hulbert Observatory worked on their solar motion pictures for two years or more before they considered them ripe for a public showing. Then they brought them out—and took critical scientific audiences by storm. Their pictures were a sensation when they were shown before the American Astronomical Society when it met in Cambridge at the time of the Harvard Tercentenary. A short time later the films were run at a meeting of the National Academy of Sciences and again (in the language of *Variety*) "wowed 'em."

Here are some of the things you will see when you get a chance to watch the new solar films: the sun's disk is blocked off by a curved metal shield, to cut down glare; at its edge, shining over the shield, rises a great, palm-like tree of fire, which pulls itself up bodily and hurtles through the atmosphere, to fall in a long arc; smaller, slenderer streamers spring up like wheat in a field, and like wheat sway in ripples as though a wind were blowing over them.

Earthlings that we are, we cannot think of events like these except in terms of wind, gale, tornado. The sunspots, tornadic swirls as they appear to the eye, seem to have even more importance as centers of terrific electric and magnetic activity. What the nature of the attraction is, that pulls toward them the vast masses of matter from the surface of the sun, remains uncertain, but the new motion pictures of these stormy events show their mode of action more clearly than has ever been done before; and where scientists can see how a thing happens they are in better position to figure out why it happens.

Sudden Bursts

One very puzzling thing has been seen in the Observatory films, that had escaped previous visual or single-photograph observations. Enormous clouds of visible matter suddenly form high in the sun's atmosphere, apparently unfed by anything thrown upward by the usual type of eruption. It is difficult to account for these sudden appearances, but careful examination of the films indicate strongly that they are not optical illusions on the part of the camera.

Sizes and velocities of these solar storms and eruptions are truly titanic. What Mr. McMath calls "surges"—sudden upwellings of solar material without actual eruption—have been caught by the camera rising up to a height of more than 43,000 miles, with a velocity of 125 miles per *second*. Another type of outburst, first photographed when it was about 68,000 miles high, climbed to a height of approximately 83,000 miles in a minute and a half, at a velocity in the neighborhood of 190 miles a second.

Figures like these awe the layman by their mere magnitude. They awe the astronomer, too, with the thought behind them of the vast energies involved. But more than they awe him, they inspire and stimulate him, for they represent the opening of hitherto closed doors through which they can go to a better understanding of the sun.