ASTRONOMY-PHOTOGRAPHY

Sun, Moon and Stars In The Movies

The Spare-Time Hobby of Two Engineers and a Judge Reduces a Month on the Moon to 15 Minutes on the Screen

By DR. FRANK THONE

JOSHUA, it is recorded, commanded the sun and the moon to stand still and they obeyed him.

In this modern Yankee land and age of hustle, we are much less interested in making things stand still than in making them move faster. Present-day Joshuas would be more likely to command the sun and the moon to "get a move on!"

Indeed, this has already been accomplished in effect, by a remarkable combination of telescope and movie camera, which obtains films of sun and moon, planets and stars, going through days or months of slow celestial changes condensed into minutes of projection time. A month on the moon boils down into a quarter of an hour on the screen. It beats hollow the classic preference of Tennyson:

"Better twenty years of Europe than a cycle of Cathay."

The place where this feat has been accomplished is, appropriately enough, near Detroit, the city where speed is incorporated into machines and shipped on wheels all over the world. The Joshuas who have turned the trick are three: Robert McMath, Francis C. McMath and Henry S. Hulbert. By day, the McMaths are engineers and financiers and Mr. Hulbert is a judge. But by night they are all astronomers—pioneer adventurers into an entirely new field of the oldest of the sciences.

Although the men are professed amateurs, the solidity of their accomplishment is witnessed by the fact that the University of Michigan has added their observatory to its formal astronomical equipment, and has made them honorary members of the faculty. The university has, indeed, adopted them bodily, for they deeded over their specially built and splendidly equipped observatory and at the same time dedicated their tireless hours of scientific labor as part

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of the university's astronomical program.

Nor is this recognition given for technical accomplishment that is of interest and benefit only to cloistered scholars out of touch with everyday life. Quite the contrary. The movies of the skies which the McMaths and Judge Hulbert have made and are still making are of interest to astronomers, to be sure—the American Philosophical Society, oldest scientific association in the United States, applauded when they were shown before them—but they can be understood and appreciated by anybody and everybody, and will be of much use in the instruction of budding young astronomers in high schools and freshman college classes.

The Time-Shortening Machine

One real trouble with astronomy is that it moves so slowly—a disadvantage it shares with botany and geology. The amateur or student interested in animals sees something moving all the time, but though the sun and moon and planets change their relative positions in fascinating fashion, they move so slowly that it takes days at least, and sometimes months, to see them through to the end. Most of us are too impatient to come back night after night just to see a planet inch its way along among the stars.

This is where the McMath-Hulbert films come to the rescue. The audience can see the month-long day of the moon express itself in lengthening shadows of the moon mountains across the empty lunar seas. It can see the birth, progress and disappearance of sunspots. It can follow the waxing and waning of Venus, which passes through phases like the moon—something first seen by Galileo through his crude telescope generations ago. It can watch Jupiter spinning on its axis, while its family of moons dance around it. It can see all this in a single evening of fascinating scientific entertainment. Or, if it is a school audience, it can see these things an appropriate points in its course, without waiting for a time when the weather is favorable and then sitting up all night for just a fragment of what these remarkable films can show.

It is all done by a reversal of the technique that gives us the familiar slow-motion pictures of the newsreels. In these, the films are taken at a furious speed, and projected at the ordinary rate of sixteen a second. In the McMath-Hulbert films, the pictures are taken slowly, minutes or even hours apart, and then projected at the conventional rate. This makes the changes run through their course with as much of an acceleration effect as the common slow-motion film shows of retardation. Such speeded-up pictures have been shown to a certain extent already, with growing plants and similar slow-changing things as subjects.

It all sounds very simple: just point your camera and crank slowly enough. If that were all! Even with plants that stand still in front of the lens and don't require the help of a high-power telescope the job has its difficulties, as any of the growth-recording scientific camera-men can tell you. But astronomical changes are never even as nearly uniform as growth in a plant, and the celestial objects do anything but stand still. The rotation of the earth sweeps them across the sky from east to west; the change of the seasons moves them (at a slower rate) from north to south and back again; the refraction effect of the earth's atmosphere makes them seem to travel at different rates of speed as they leave or approach the horizon; the planets' revolution about the sun causes them to move sometimes faster, sometimes slower, than the "fixed" stars; and the moon's behavior is a very devil's puzzle to unravel. And all these possibilities of error, which would make the pictures dance and wobble beyond toleration, are increased scores of times by the necessity of using a high-power telescope, which magnifies everything that happens with the large impartiality of the rain which falleth alike on the just and on the unjust.

Astronomers as Gun-Pointers

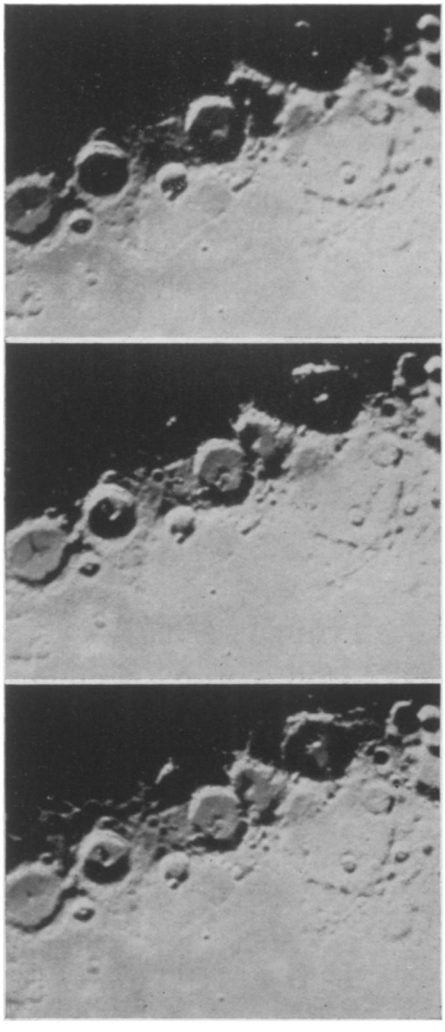
These problems have already had to be met by photographic astronomers who for years have been making "stills" of various heavenly objects. All large telescopes are equipped with mechan-

FRONT COVER ILLUSTRATION

Judge Henry S. Hulbert, Francis G. McMath and Robert R. McMath in front of their observatory at Detroit, of which Robert McMath is director.

isms to compensate for all these error-introducing motions of the earth beneath and the heavens above: besides which an astronomer must always sit behind the big 'scope, his eye glued to the eyepiece of a smaller telescope mounted upon it, keeping the cross-hairs of the objective trained on the target exactly as a gunner on a battleship keeps his piece pointed during every moment of an action.

So the usual guiding mechanisms, both automatic and manual, were used in the reflecting telescope installed by the three men in their observatory at Lake Angelus, with certain modifications to fit them for their job of making motion pictures of the heavens, rather than "stills." For one thing, it would not be necessary for the telescope to be held steady for hours, as is sometimes the case when a "still" of a distant nebula or other very faint object is in the making. The program called for work with comparatively bright things, with exposure times usually of minutes only.



NIGHT FALLS ON THE MOON

Notice the lengthening shadows in the craters as the eye travels up this row of pictures. They were enlarged from a McMath-Hulbert "moon movie."

Keeping the Stars from Dancing

On the other hand, however, there was the inexorable necessity for getting the next exposure into the "frame" at exactly the same spot as its predecessor. If this were not done, the picture would dance on the film, to its ruination.

That problem disposed of, the three sky-impresarios tackled the matter of a camera. This proved to be the simplest part of the job. They took over a standard commercial portable machine bodily. The film mechanism was all right "as was"; all they had to do was take out the driving spring and the rest of the cranking parts and slip it into a special carrier they rigged for it at the eye end of their telescope.

Then came the matter of timing for the exposures, and the development of a special mechanism that would take care of this most important detail unfailingly, automatically and accurately. It had to be adjustable to even more changes than the driving mechanism of the telescope had to take care of. The same camera exposures had to be timed for the brightness of the sun and the dimness of a distant variable star, with all degrees of illumination in between. It had to be able to "stop" the rapid rotation of Jupiter and the relatively fast backward "drift" of the moon across the sky. It had to be adjustable to such time combinations as, "open nine minutes, shut one minute."

There was a deal of hard thinking and wearisome mathematics went into the solution of this problem. In the end, the three astronomers, backed by their mechanical ingenuity and skill, evolved a gear train, similar to the transmission of an automobile but naturally more complicated, connected to the shutter mechanism of the camera with a flexible shaft. The gears were not especially cut, but were selected out of catalogs of standard machine equipment. Where a particular problem called for interrupted action every so often, they cut off one or more of the teeth of the gear to be used. These gears are interchangeable, and one can be taken out and another substituted in a few seconds.

In addition to the variable speeds obtainable with the gear train further flexibility in exposure times can be obtained by varying the speed of the motor that drives it. This is kept at a uniform basic speed through the telechron timing of the city current used, but the three astronomers have introduced circuit variations that make corrections if any vagaries occur, and also enable them to change the speed, though still holding it in uniform relationship to the telechron current. Motors with similarly controlled speeds are used in the pointing mechanism of the telescope itself, and the whole system is kept at the bidding of the operator by a switchboard of push-buttons at his hand. There is even a button to raise or lower the chair in which he sits at the eye end of the telescope.

Patience in the Cold

Even with all this ingenuity, the filming of heavenly bodies is still not an easy task. All sorts of troubles have to be met with patience. The stars whom these astronomical movie men "put into the pictures" perform on their own time, not at the command of any director, and they have to be ready to photograph them just at those moments. Often a part of a film can be made in one night, and then a wait of days or weeks must intervene before the subject is again in position to allow a continuance. So a completed film showing connected action may be as much of a patchwork as any Hollywood "continuity." And this does not take into account the vagaries of the weather, which may shove an obscuring cloud across the heavens just when a moment arrives which they have awaited for months and which will not come again for months more. Nor does it take account of the physical discomfort of night work in an observatory open to a mid-January sky—for astronomical observatories can never be heated.

But the two McMaths and Judge Hulbert make nothing of this. If clouds come they wait philosophically for a clear night later on. If it gets too cold, they put on aviation suits. And they keep steadily at their fascinating avocation of capturing the distant creatures of the heavens and training them to trot or gallop as they will, and as the interests of astronomy may be best served.

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