Astronomers See Quartz Mirrors Made

Stars Hold Secret of Travel Between Planets

Astronomy

THE other day, for the first time, America's leading astronomers saw the method by which their huge telescopes of the future will be made. After a two-day meeting at Harvard University and Wellesley College, members of the American Astronomical Society journeyed to nearby Lynn, where Dr. Elihu Thomson, director of the General Electric Company's Thomson Research Laboratory, showed the preliminary work on quartz mirrors like those that will be used in the 200-inch telescope in California. The astronomers saw how a 3000-degree "sleet storm" deposits a layer of crystal clear quartz on a disc of opaque quartz. In such a layer the curves required for the telescope mirrors can be ground with even more ease than in the glass mirrors that are used today.

The difficulty with glass is that its size alters rapidly with temperature, but with quartz there is practically no change. Take a stick of quartz a yard long, raise its temperature 1800 degrees Fahrenheit and it lengthens about a fiftieth of an inch, far less than would glass.

This property makes it especially suitable for telescope mirrors, said Dr. Thomson, who is himself an astronomer as well as a physicist. Telescope mirrors are ground to the required dish-shaped curve by rubbing with another glass. The mirror is heated by friction and the edge warms up more than the center. This temperature change causes it to expand, and when it cools the edge is too low. Therefore, in grinding a glass mirror, it is necessary to grind a little, then wait for it to return to normal temperature and then grind some more. But with quartz, Dr. Thomson explained, the grinding can be carried right through to the finish. Even though it is harder than glass, he said, it is no harder to grind. For such reasons as these, and also for advantages that quartz has in actual use, astronomers connected with the California Institute of Technology have decided that the 200-inch telescope now under construction at Pasadena will have a mirror of quartz. Scientists at the Lynn Laboratory are working on the blank from which the mirror will be made.

Until a year or so ago no discs of quartz of the requisite clarity had been made larger than a few inches in diameter. After many trials, with varying degrees of success, a satisfactory method was invented of successfully preparing the disc. A disc of white quartz is made which is too rough to take the polishing and silvering required for a satisfactory mirror. On this is sprayed melted quartz, and a layer as deep as desired consisting of smooth, transparent quartz is quickly formed.

This was the method that the astronomers saw demonstrated. Looking through special masks that gave the eyes protection from the brilliant glare of the flame, even though the intense heat made it impossible to watch for very long at a time, they saw a 3000 degree flame of hydrogen and oxygen deposit quartz at the rate of several pounds an hour. Above the tubes carrying the hydrogen to the flame were chambers containing finely ground quartz flour. This was sucked into the stream of gas like a medicinal solution into an atomizer, and was carried to the flame, burning with intense heat. Here the quartz was melted, but when it reached the cooler rough disc, at only a thousand degrees, it froze solid. Exactly the same thing takes place in nature during a sleet storm. Rain falls on trees and other objects, cooled below the freezing point of water, and a layer of clear ice is the result.

The astronomers saw a complete telescope mirror disc, with a top layer of clear quartz an inch thick. The disc was twenty-two inches in diameter, which is the largest size that has yet been made. But they were told that the present limit of size was found in the furnaces in which the rough bottom disc is made. The largest furnaces now available will just take so large a disc, but one is being constructed to make a rough disc 60 inches in diameter. Then one 100 inches in diameter will be made, and then the 200-inch disc itself will be tackled.

To the astronomers who saw the demonstration, it appeared that the 3000 degree sleet storm would be able to coat a disc of any size, so there seems to be little doubt that the 200-inch mirror will be made when the technical details are solved. It is still very uncertain when this will be completed. But the scientists in charge expect to have the 60-inch disc ready during the coming autumn.

Interplanetary Travel

IN the stars themselves is locked one of the secrets of successful travel between planets by means of rockets. Only with fuels that will yield amounts of energy approaching that of stellar material can we ever hope to get away from the gravitational attraction of the earth taking any useful load along, the astronomers were told by Dr. John Q. Stewart, of Princeton University.

In attaining the momentum needed to operate a rocket, in which motion is obtained by shooting stuff backwards, it is necessary, either to shoot a low mass at a high speed, or a heavy mass at low speed. If the latter course is decided on, the substance of the rocket is rapidly used up. On the other hand, if a relatively small amount of material is used, and it is ejected at high speed, large amounts of energy are needed, and this is also limited, said Dr. Stewart.

In order to fire a projectile from a gun so that it will leave the gravitational attraction of the earth and reach outer space, it must be fired at a speed of at least 7 miles a second. Similarly, said Dr. Stewart, the stuff from a rocket must be fired back with some such speed, if the rocket is to get away from the earth with any appreciable fraction of its original mass left. At a speed of a mile a second, which is the fastest that has been attained with long range guns, less than a thousandth part of the original mass would be left. Thus, for a rocket to carry 500 pounds of flash powder to the moon, as one rocket experimenter has suggested in order that terrestrial astronomers might see the results of the arrival, the rocket would have to weigh many hundreds of tons at the start.

The answer to this problem lies in the use of fuels that will take the rocket out at a speed of 7 miles a second or greater. Dr. Stewart has calculated that a fuel with the unprecedented efficiency of 15 kilowatt hours per pound would be required.

Ordinary coal contains about a tenth as much energy as this.

Ionized hydrogen, in which the atoms have been partly broken could theoretically be used, he said, for this contains about 150 kilowatt hours per pound, even though there seems no possible way of using it.

It is in the stars themselves that one solution lies, declared Dr. Stewart. Astronomers believe that the energy which keeps the stars going comes from the distintegration and disappearance of the atoms of matter. A pound of matter thus annihilated would yield billions of kilowatt hours.

With our present knowledge of sources of energy, Dr. Stewart's figures make any really successful rocket communication with other planets seem very difficult. But the case is different if the idea is merely to reach the upper layers of the atmosphere, higher than any available with balloons or airplanes. A speed of a mile a second might take a rocket to an altitude of a hundred miles, he said, and still carry a useful load of instruments or cameras.

Extent of the Universe

THE size of our universe, and how it is put together, were two of the chief problems to engage the astronomers' attention. Discussing the extent of the universe, Dr. Knut Lundmark, eminent Swedish astronomer, now visiting the United States, told his American colleagues that the size of the universe is at least two hundred million light years. Even though a beam of light travels fast enough to cross the continent from New York to San Francisco in a seventy-fifth of a second, two hundred million years are required for the light to reach us from the most distant objects that come within reach of the astronomers' telescopes.

These vastly distant objects were termed by Dr. Lundmark the anagalactic nebulae. They include the spiral nebulae that have been studied in recent years with the great 100-inch telescope at Mount Wilson Observatory in California and identified as huge swarms of stars. All the stars that we can see, either with the unaided eye or even with most of the present-day telescopes, form a somewhat similar system of stars, except that our own galactic system is far larger than any of those we see beyond its limits.

Dr. Lundmark expressed himself in agreement with a theory proposed by Dr. Harlow Shapley, Director of the Harvard Observatory, that our own system is made up of a number of smaller units, each similar to the outer nebulae. Dr. Shapley has studied a loose swarm of these objects, known as the Coma-Virgo cluster, from the constellations in which it is seen. If such a system were to be compressed, the separate nebulae and clusters would amalgamate and the result would be similar to the system in which we live. This, he believes, gives a clue to the evolution of our galaxy.

Support of this theory is found in the fact that the galaxy contains a number of smaller clusters, one of which includes the sun. These, in Dr. Shapley's opinion, represent the remnants of the individual members like the objects in the coma-virgo cluster. But to them Dr. Lundmark suggested the addition of still another kind of thing. Scattered through our galaxy are numerous balls of millions of stars, called the globular star clusters. Also, scattered through outer space, are many spherical objects, at the same distances as the spiral nebulae, but differing from them because they show no structure. They are just round balls of light, and are doubtless huge globular clusters, so remote that the largest of telescopes fail to reveal the individual stars of which they consist.

The globular clusters in our home galaxy, Dr. Lundmark believes, are of a similar nature. They, too, are mixed up with the local clusters and other units that form the celestial potpourri in which our sun and solar system is such an insignificant part.

Dr. Shapley also told the astronomers of his latest studies on two of the nearest of these outside stellar swarms, the Magellanic clouds. Visible from the southern hemisphere of the earth, they look like detached pieces of the Milky Way. Previously it has been supposed that they are at distances of about a hundred thousand light years. He now calculates them to be about 16 thousand light years closer, and places them at 86 thousand light years. He also suggested that astronomers may be wrong in supposing them the nearest of the outer systems, for perhaps, he said, they may also be associated with the other things that make up our galaxy, and so be part of our own system. They seem to be moving through space, but when this motion is corrected for the rotation of the galactic system that he has discovered, they prove neither to be receding from, nor approaching us. This suggests that in some way they are associated with us. He also suggested that even the Andromeda nebula, a spiral aggregation of stars nearly a million light years away, may really be associated with our own galaxy more closely than astronomers have supposed.

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Dr. Elihu Thomson (right) director of the Thomson Research Laboratory of the General Electric Company, and his associate, Dr. A. L. Ellis, who developed the method of spraying fused quartz in a 3000° "sleet storm." They are shown displaying the 22 inch mirror, the largest yet made in this way, to the members of the American Astronomical Society.