

ASTRONOMY

Universe Still Expanding

Giant Hale telescope shows faint nebulae, 50% farther into space than previously penetrated, still follow puzzling "law of red-shift."

► THE UNIVERSE continues to expand with extraordinary speed as far as the giant Hale telescope of Mt. Palomar has been able to detect the puzzling "red-shift" in light from faint nebulae or "universes."

The 200-inch mirror, equal in light-gathering to a million human eyes, has now captured evidence, in the hands of Dr. Milton L. Humason of Mt. Wilson and Palomar Observatories, that the "rainbow" spectra of nebulae light has a change that can be interpreted to mean that the nebulae 360 million light years away are rushing away at 38,000 miles per second, more than one-fifth the speed of light itself.

This most distant "red-shift" strengthens the idea that it is caused by an actual recessional velocity, caused by what can be considered an "explosion" of the universe along the lines of the Lemaitre expanding universe theory first suggested over two decades ago.

The rate of red-shift continues half again farther into space's depths than reached with the 100-inch Mt. Wilson telescope a decade ago.

The great galaxies observed with four to six hours exposures made with the world's largest telescope were first located with the 48-inch Schmidt telescope, world's largest of its type.

Dr. Humason's report to the Astronomical Society of the Pacific, meeting at the University of Southern California in Pasadena, disclosed the discovery of 800 new clusters of nebulae during the two years of the National Geographic-Palomar sky survey, whereas only 20 were previously known.

To give you a scale of the universe: Light travels 186,000 miles a second. One light year is roughly six trillion miles. The most distant cluster of nebulae in which red-shift has now been observed, 360 million light years from earth, is two followed by 21 zeros miles away.

On the spectroscopic plates light dispersed by a prism is broken down into its component wavelengths in a spectrum only one-tenth of an inch long. Lines in that spectrum indicate the presence of particular wavelengths. With the distant object these lines are shifted about one-twentieth of an inch toward the red, or longer wave length, end of the spectrum.

The shift has been explained by many astronomers as due to the "Doppler effect." This effect, for instance, is what causes the drop in pitch of a locomotive whistle as it speeds into the distance and its sound waves

are lengthened in relation to the listener.

If the shift actually is due to the Doppler effect, an implication would be that nebulae everywhere were catapulting away from us in all directions at speeds increasing with their distance—that the entire universe was expanding, like a giant balloon, at a tremendous rate.

The light observed from the most distant cluster studied to date left its source some 360 million years ago. At that time, on the velocity-shift interpretation, the cluster was roaring away at 38,000 miles a second. Since then it may have migrated 70 million light years deeper into space. The message

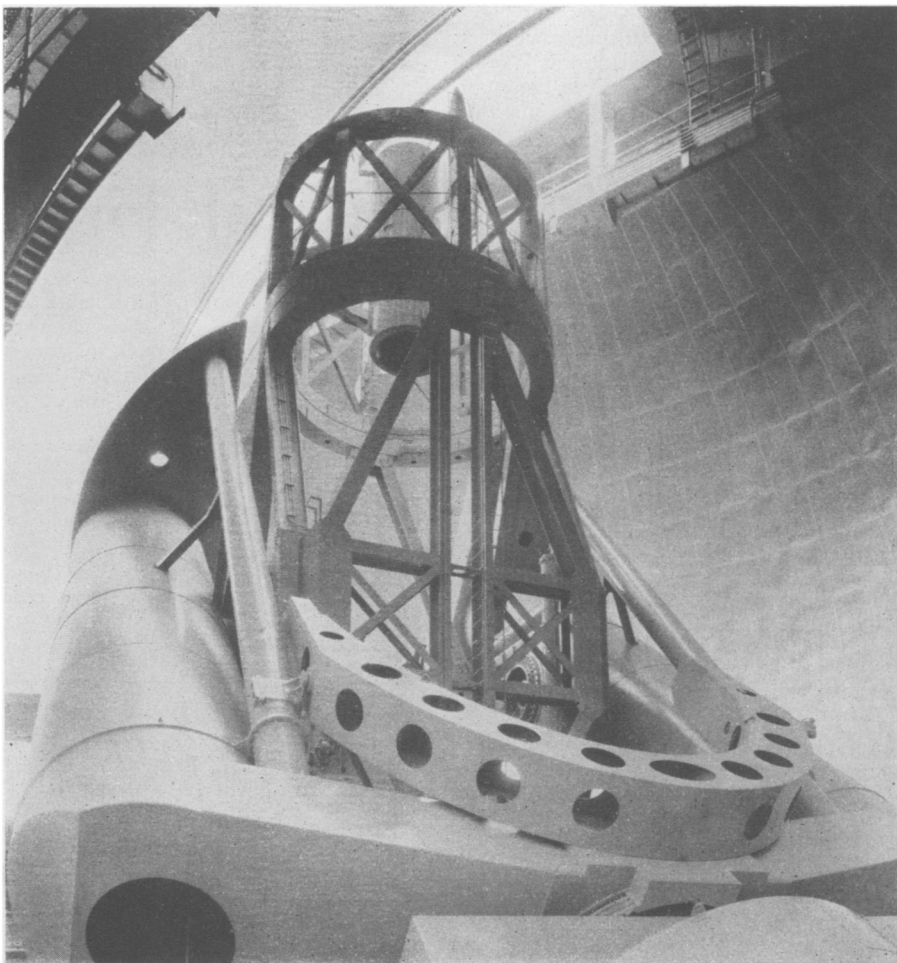
that tells what is happening to it today will reach earth several hundred millions of years from now.

A most important astronomical milestone will have been reached, if at some point in his continuing study, Dr. Humason should find that more distant clusters show red-shifts corresponding to velocity increases of less, or of more, than 100 miles a second for each million lights years distance.

Should the red-shift be less than expected in that distant past, the interpretation would be that the rate of expansion of the universe has been speeding up since then. This would mean that the expansion began earlier than now indicated and that the "age of the universe" is more than the two billion years now supposed.

Should the red-shift be greater than expected, the reverse would be true.

Whether this evidence may be found is, of course, impossible to predict. Its interpretation depends, too, on an accurate knowledge of the distances involved and an



GIANT TELESCOPE—Searching far into the heavens, the Hale 200-inch reflector telescope at Palomar Observatory has shown that even at tremendous distances, light from nebulae has a red-shift, indicating these universes are speeding away from us.

answer to the question of whether red-shifts actually are velocity-shifts. A possibility exists that the light from far-off objects may have lost energy during its long, lonely journey through space, causing its wavelength to increase. In this case, some principle of nature as yet unknown would account for the red-shifts.

However, whether or not they represent speeds of recession, Dr. Humason said, the red-shifts promise to give astronomers a convenient yardstick to establish the distances of new-found objects in space. Once the red-shift is measured, the distance will automatically be known. This will be possible when the range of the law, now regarded as a first approximation, is pushed still farther into a cosmos and after uncertainties in distances assigned to outlying nebulae are removed.

The latter is the province of Drs. Edwin P. Hubble, Walter Baade and their colleagues. They report that construction of a thoroughly reliable scale of cosmic distance is now under way, using all the resources on Mt. Wilson and Palomar.

The over-all program involves not only photography but also extremely sensitive photoelectric cells developed during World War II. They are being used to measure the brightness of stars and nebulae several

million times fainter than the faintest stars the human eyes can see.

Step by step, as outlined by Dr. Hubble, the distance scale will be set up as follows:

Globular clusters, or compact masses of thousands of stars, relatively near the earth, will be used to establish the distance of the great spiral nebula, Messier 31. This will fix the brightness of its Cepheids, or regularly varying giant stars, and its novae, or exploding stars.

Cepheids and novae then will be used to measure the distance of other nebulae as far out as the Ursa Major Cloud and the first cluster found in Virgo. These are roughly six and eight million light years away.

This done, the astronomers will have a collection of about a thousand nebulae of all types. The nebulae themselves can then be calibrated as distance indicators. Their average brightness, variations from the average and the brightest nebulae in clusters will provide a yardstick to measure the distance of more remote clusters.

"When the new scale is available," Dr. Hubble says, "the law of the red-shifts can be formulated precisely. It can then be discussed with confidence as a clue to the nature of the universe."

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silver iodide or dry ice than that man can actually make it rain, Dr. Barnes pointed out to the subcommittee.

If actually making rain should prove possible, this would also be of great value in helping to control forest fires. Some cloud seeders have made claims that they have put out fires, but these assertions can not be verified.

When forest fires are burning, even an increase in the air's humidity helps to slow down the fire's spread, making it easier to control by conventional methods.

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METEOROLOGY

Break Up Clouds, Halt Fires

► BREAKING UP clouds to prevent dry lightning that causes disastrous forest fires was urged by Dr. Carleton P. Barnes, research coordinator in the Department of Agriculture's Agricultural Research Administration. The clouds would be seeded with silver iodide or dry ice.

More research on actually trying to make it rain by similar methods is also needed, he told a House Interior subcommittee holding hearings on a bill to authorize the Interior Department to spend \$25,000,000 for research on rain-making and on "sweetening" salt water.

Lightning is the cause of many disastrous forest fires each year. By dissipating the towering cumulus clouds that are often the source of dry lightning storms in the Northwest and Southwest, Agriculture's Forest Service officials believe they could cut down considerably on the devastation from lightning-caused forest fires.

Breaking up clouds also has military applications. It might help to clear a target area for bombing runs or to clear an airport closed in by bad weather.

Evidence is much stronger that clouds can be broken up by seeding them with

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