ASTRONOMY

Star Pictures Compared

➤ BY COMPARING PHOTOGRAPHS of stars taken last year with pictures of the same stars taken more than 60 years ago, three Harvard University astronomers have measured how much the objects have grown and found new evidence about their structure and evolution.

The stars they looked at are called planetary nebulae and appear as a dense, bright core—the star itself—surrounded by a diffuse and luminous ring of largely hydrogen gas.

The new evidence, reported at the American Astronomical Society meeting in Cambridge, Mass., indicates that many of these planetary nebulae are surrounded by invisible hydrogen gas, never detected before, that extends far out beyond the white clouds of hydrogen appearing in photographs.

The three astronomers are Prof. William Liller, chairman of the Harvard astronomy department, Dr. Martha H. Liller, his wife, and Barbara Welther, a research assistant.

In 1961, Prof. and Mrs. Liller took pictures at the Lick Observatory of 30 planetary nebulae, then compared their sizes with pictures of the same nebulae taken between 1899 and 1917 with the same telescope. Since the ring of hydrogen is expanding up to 100 miles per second from the single bright star at its center, the astronomers knew how much bigger the 1961 pictures should be. Many of the planetary nebulae were just this size; but others appeared smaller than they should be after 60 years, while a few appeared not to have grown at all.

The estimate of 100 miles a second comes from a measurement of the "Doppler shift" seen in the spectrum of light emitted by the hydrogen clouds and other moving objects in the universe. The hydrogen atoms, which absorb light from the central star, become ionized and re-emit light of a particular wavelength that appears as a bright line in a spectrometer.

Since the hydrogen clouds are expanding, their motion shifts the position of the bright line either toward the red end of the spectrum or the blue end, depending on whether they are moving away from, or toward, the observer. The amount of the shift reflects the velocity of the motion.

Since all the planetary nebulae show a Doppler shift, their hydrogen clouds should be expanding. The problem was why all the 1961 pictures did not show the expected amount of growth during the past 60 years.

Dr. Liller believes this means that beyond the edge of the visible ring of hydrogen gas are invisible clouds of hydrogen. All the hydrogen is expanding, but the bright ring does not seem to expand because hydrogen atoms move away from the edge, joining the invisible hydrogen clouds, at the same rate at which the ring is expanding.

The same explanation holds for the planetary nebulae whose hydrogen rings are expanding, but slower than predicted by the Doppler shift; in this case hydrogen enters the surrounding invisible clouds at a rate slower than the expanding luminous ring.

By comparing the predicted with the observed rates of expansion, the astronomers have been able to estimate how far the invisible hydrogen clouds extend and the total amount of hydrogen around the central star. Since all the hydrogen came originally from the central star, the astronomers can also estimate how big the star was when it was formed and, therefore, about how much longer it can be expected to burn.

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ASTRONOMY

Hazard From Meteors

➤ THE HAZARD from tiny meteors peppering space may be greatest at the moon's surface, Dr. Fred L. Whipple, director of the Smithsonian Astrophysical Observatory, also of Harvard College Observatory, reported to the American Astronomical Society meeting in Cambridge, Mass.

He said that the surface of space vehicles should be carefully chosen or protected to reduce etching by interplanetary dust to the lowest possible limits. This is particularly necessary if long exposure times are expected.

Photographic meteor studies and products formed by cosmic ray bombardment of meteorites provide upper limits of erosion rates for tiny meteoroids in orbit in the solar system, Dr. Whipple said. The rate increases by several orders of magnitude, being greatest for irons, next for stones and least for photographic meteors.

The sequence suggests that the erosion rate depends in some inverse fashion upon the strength or brittleness of the materials, to be expected if erosion is produced by crater-forming impacts with interplanetary dust.

On this assumption and by applying a high-velocity impact theory, Dr. Whipple found that the mean space density for the dust was roughly ten to the minus 21st power grams in each cubic centimeter.

Only the very smallest cometary meteoroids can spiral into the sun by the Poynting-Robertson effect if Dr. Whipple's assumptions are correct. Strong evidence for a high concentration of dust in the earth's immediate vicinity suggests that erosion rates may be greater near the earth than in deep space from Venus to Mars and even beyond.

The steady-state space distribution of meteoric particles under the operation of the Poynting-Robertson effect was reported by Dr. Robert E. Briggs, also of the Smithsonian Astrophysical Observatory. He used orbits obtained from a random sample of photographic meteors to construct the distribution function of the number of meteoric particles continuously injected into the solar system.

The Poynting-Robertson effect was then introduced, with the result that every particle must ultimately be destroyed by a close approach to the sun. Dr. Briggs then derived the resulting steady-state distribution of orbits and, from it, relative values of the space density of particles, which he then computed at many points in the solar system.

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