A MAP OF THE UNIVERSE

After seven years of hard work, a milestone in astronomical history has been reached in this great photographic Sky Survey

THE FIRST PHOTOGRAPHS from their giant atlas of the universe were released this summer by the National Geographic Society and the Palomar Observatory. The 200 photographic prints went out to nearly 100 scientific institutions and observatories around the world—subscribers to this unique atlas which will consist of 1,758 pictures providing a comprehensive portrait of the heavens as they exist in the 1950's.

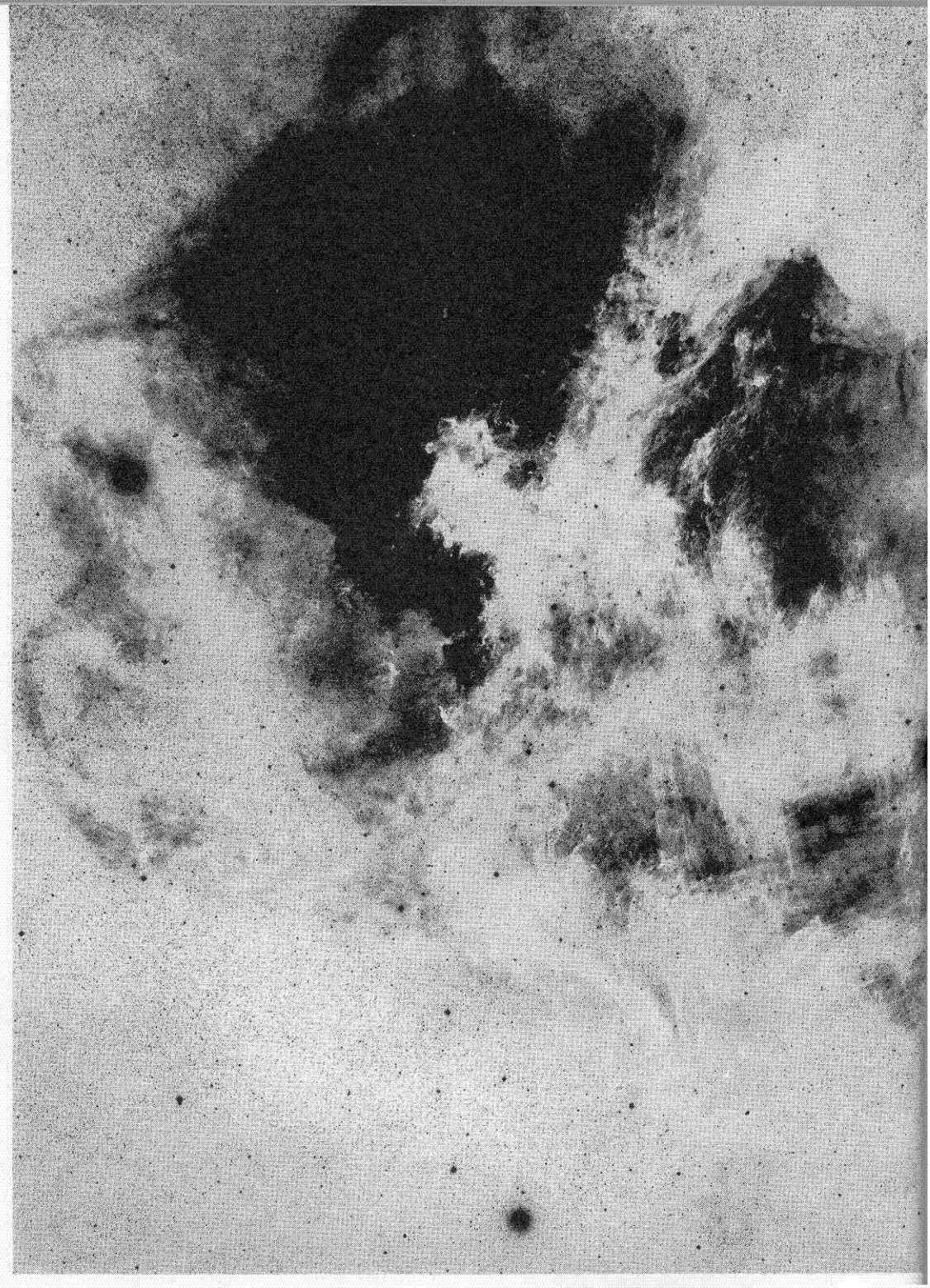
Millions of galaxies, stars, and clusters of stars far out beyond the Milky Way are pictured in detail in the atlas. Many of the space regions have never been seen by astronomers before, and scientists hardly exaggerate when they say that, with the new atlas, astronomers have a century of study before them.

Every photograph in this Sky Survey has been taken with the 48-inch Schmidt telescope. Designed primarily as a scouting camera for the larger telescopes, the 48-inch has proved ideal for the Survey, because though it can reach only about one-third as far as the 200-inch telescope, its wide-angle viewing power covers 500 times more sky. By 1956, when it makes its last picture for the Survey, the 48-inch will have taken seven years to cover every patch of the sky that can be reached from Palomar Observatory. With the 200-inch telescope this job would take almost 5,000 years.

For the Sky Survey, 14 x 14-inch plates are used in the Big Schmidt. Covering the three-quarters of the sky pictured in the atlas requires 879 of these large plates. Two photographs are taken of each field in quick succession—one red-sensitive, with an exposure time of from 40 to 60 minutes; one blue-sensitive, exposed from 10 to 15 minutes. These exposure times were chosen to reach the faintest stars which can be recorded by the instrument. Comparison of the two color plates allows astronomers to measure star colors and to pinpoint faint objects for later observation with more powerful telescopes. Length of exposure plus the extreme speed ($f/2.5$) and great light-gathering power of the telescope makes it possible to record stars down to a brightness of 1/1,000,000 of the faintest star that can be seen with the naked eye.

A very thin, fragile glass, .040 inches thick, is used for the photographic plates. Each plate is examined after exposure by the observer at Palomar for flaws in the emulsion, motion of the image during exposure, error in the focus of the telescope or even slight blurring of the star images due to disturbances of the air above the telescope.

Plates are then sent to Caltech where Dr. Rudolph Minkowski, who has directed the Sky Survey since its beginning, examines them once more and has the final decision on rejection or acceptance.



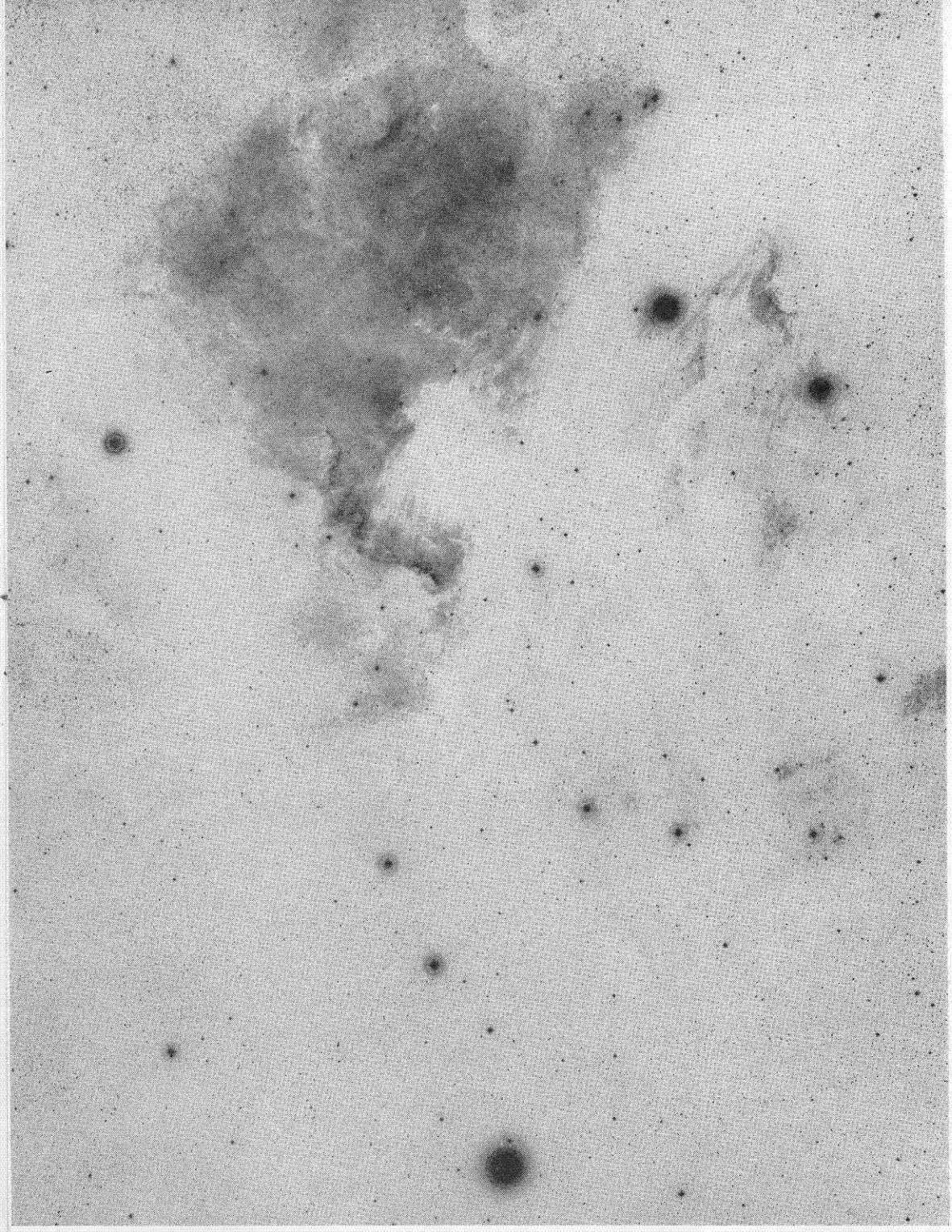
The North American Nebula in Cygnus, shown here as exposed with a red-sensitive plate, was the first nebula photographed in the Sky Survey. Red light is particularly sensitive in detecting dense gas clouds, which glow like neon signs from the reflection of nearby stars.

As an indication of the high standards set for the finished prints, almost 40 percent of the plates were rejected because of flaws or defective negatives. At times it seemed impossible to maintain such perfection of detail, but as Dr. Ira Bowen, director of Mount Wilson and Palomar Observatories, explains: "In the year 2000 A.D., astronomers wouldn't find much value in brown or faded photographs. Extreme definition of the faintest images is necessary."

All acceptable plates then go to James McClanahan of Caltech's Graphic Arts Department, who has charge of reproduction. From each negative plate, two glass positive plates are made, called intermediates, one of which is used to make the final prints at Caltech. The other plate goes to Palomar for safekeeping. All photographic prints which form the final atlas sheets are in negative form because faint stars and nebulae show up better when printed in black against a white sky.

Now that scientific institutions have received their first section of the atlas, the real work begins of counting and fixing the location of the thousands or millions of stellar images. During the actual photographing, there wasn't time for even the first superficial search of plates for new or unusual objects.

New comets and asteroids were found while production was going on, however. But as one Sky Survey observer says: "Actually these comets are a nuisance. Finding one simply means we must stop operations to



The North American Nebula in Cygnus photographed in blue light, eliminating all the density of red glow shown in the opposite picture. From these two photographs, astronomers can compare images, differentiate between hot and cool stars and point up faint objects.

make measurements and record all the material on it."

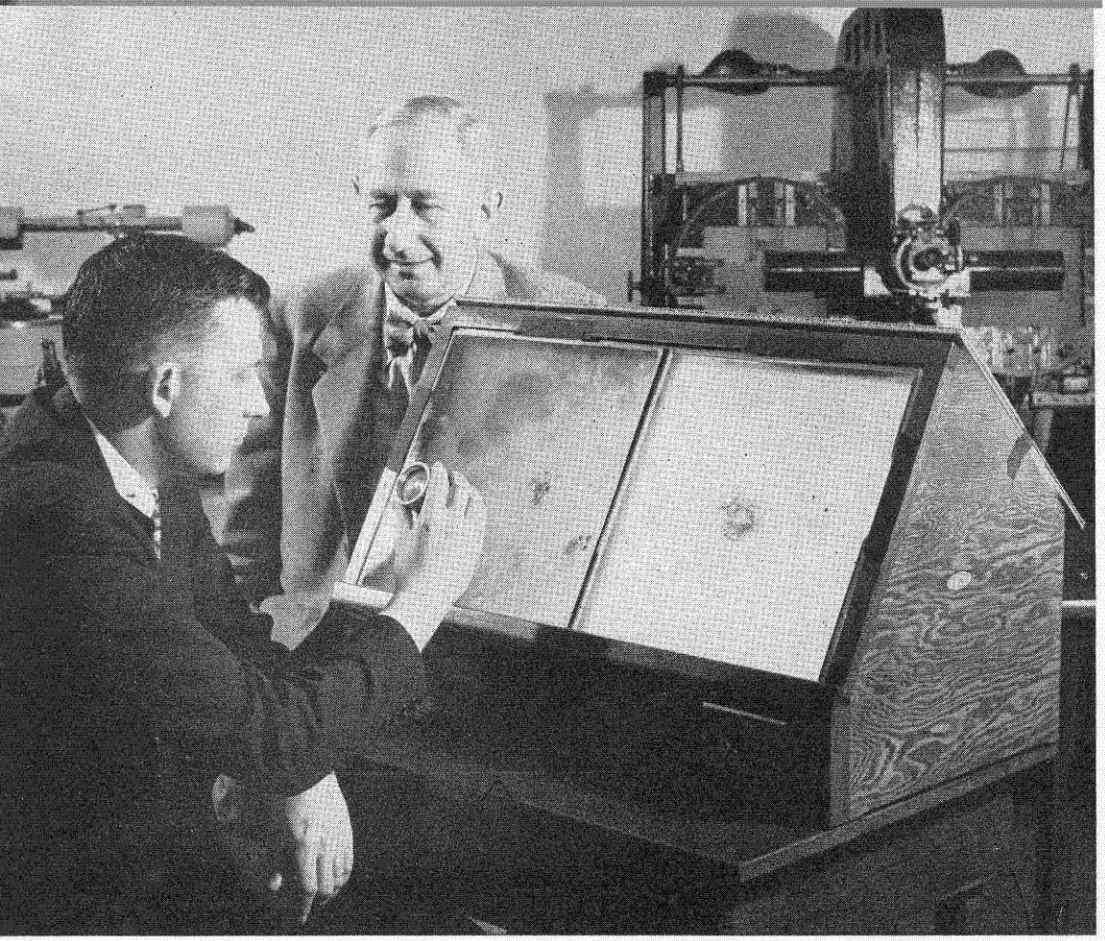
Out of the eleven comets found were two unusual ones. Though most comets approach the sun, then disappear for long periods of time or never reappear at all in our time, the Survey turned up one in 1949 that circles its orbit in only 2.3 years.

Another comet had two tails. This in itself is not unusual, for some comets have many tails, but Number 1950g not only had the standard tail streaming out behind but another one set at a forty-five degree angle.

Thousands of asteroids flashed across Survey photographs and, of these, four were found moving with execessive speed very close to the earth.

One of the chief values of the new sky map will be to highlight new objects such as these, the way a highway map highlights towns.

When an occasional star flares up to millions of times its original brightness to form a nova or "new" star in the future, astronomers will be able to refer to the Survey plates for a record of the original brightness and temperature of the star before the outburst occurred. Extensive study of the plates may reveal the reasons for these stellar explosions. It may furnish evidence for the theory that the stars are continually undergoing a process of birth and death. And it may even give us more knowledge about our own galaxy, the Milky Way—a great pinwheel-shaped system of probably more than a hundred billion stars, of which our sun is one. Because



Dr. Albert Wilson, one of the first Survey astronomer-observers, checking a photograph for defects. Dr. Walter Baade, staff member of the Observatories, is assisting in the selection of acceptable plates.

James McClanahan and his assistant, Hendrik Rubingh, using a vacuum printer to process Survey photographs.

our solar system lies in the galaxy we cannot see the whole of it, but studies of other galaxies may help us understand our own.

Almost 90 percent of the Sky Survey is now finished. The eight remaining sections will be sent out at intervals, so that the complete atlas should be in the hands of scientific institutions in about three years. Nearly 100 copies have been ordered, each at a cost of $2000, which only covers the price of printing. All expenses of the Survey, including the astronomers' salaries, are covered by the National Geographic Society, while Palomar Observatory donates the astronomers' time.

The close cooperation of a few people has been responsible for the perfection of the Sky Survey. Dr. Rudolph Minkowski has acted throughout as a guide and director. Albert Wilson, who was the observer during the first few years of the Survey, is now director of the Lowell Observatory in Flagstaff, Arizona, and George Abell is acting as astronomer-observer, with Robert G. Harrington as relief observer. Charles Kearns is serving as night assistant—the engineer who must always be on hand to assume responsibility for the general behaviour of the telescope. Reproduction problems are under the supervision of James W. McClanahan, with his assistants, Hendrik Rubingh and Gladys Harvey.

General supervision of the Sky Survey is under an advisory committtee represented by Dr. L. A. DuBridge, President of Caltech; Dr. Ira S. Bowen, director of the Mount Wilson and Palomar Observatories; Dr. John La Gorce of the National Geographic Society; and Dr. Lyman J. Briggs, director emeritus of the National Bureau of Standards.