

## ASTRONOMY

# New Supernova Theory

The unsuccessful search for a neutron star in the Crab Nebula may mean that the theory of how a supernova collapses will have to be revised—By Ann Ewing

► A ROCKET HURLED more than 60 miles into the atmosphere has returned to earth with evidence that at least one supernova is not what it was thought to be.

Because of this discovery, scientists may have to rewrite their theory of what happens when a star suddenly blazes forth as a supernova, releasing in one second energy comparable to the sun's normal output for a billion years.

The theory has been that when such a super-explosion occurs, a neutron star so dense that each cubic inch weighs about a billion tons is left behind. A neutron star radiates only a ten-billionth of the visible light put forth by the sun, but it is ten billion times brighter than the sun in pouring out X-rays.

The high-flung rocket was launched July 7 at precisely the second required to take the longest possible look at the Crab Nebula, which is one of the most thoroughly studied of supernova remnants. It is known to have exploded on July 4, 1054, when it suddenly appeared in the sky with a brightness exceeding that of Venus.

The visible nebulous material is the expanding wreckage of the supernova, a gas shell expanding at 780 miles a second. Last

year scientists discovered that the Crab Nebula was a strong source of X-rays.

The July 7 rocket was hurled aloft with instruments to determine whether or not a neutron star left from the supernova explosion was the source of these X-rays. The Crab Nebula was scanned during the time when the moon passed between the source and the rocket's instruments.

If the X-rays had been coming from the Crab Nebula, their numbers would have dropped abruptly as the moon cut them off. However, the fall-off was slow, which means that the X-rays are coming from an extended source, not a neutron star.

However, the X-ray source could be an extremely hot gas having a temperature of 10 to 20 million degrees, Dr. Herbert Friedman of the Naval Research Laboratory's E. O. Hulburt Center for Space Research in Washington, D. C. told SCIENCE SERVICE. Drs. S. Bowyer, E. T. Byram and T. A. Chubb cooperated in the unsuccessful search for a neutron star in the Crab Nebula.

Dr. Friedman said that the non-discovery does not mean that neutron stars do not exist elsewhere. He said it does mean that the theory on how a supernova collapses

will have to be revised, if preliminary calculations prove correct.

Dr. Friedman had high praise for the performance of the Aerobee rocket launched from White Sands, N. Mex., and of the instruments, which functioned "perfectly."

The Aerobee had to be above most of the earth's atmosphere and the instruments aimed in the correct direction at precisely the time the moon cut in front of the Crab Nebula. Only a 15-second launching "window" was available.

Dr. Friedman said that the Crab Nebula supernova may have involved the explosion of the entire star, with no core at all left as a neutron star. The extended source of extremely hot gas, he suggests, would be the remains of the star's interior.

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## Astronomers See Galaxy Better "Tilted Upright"

► ONE OF NATURE'S largest structures, the Andromeda Galaxy of 100 billion stars, has been "tilted upright" so that earth-bound scientists can take a better look at it. The galaxy was lifted by mathematics and unconventional photography.

The overall appearance of this nearest big neighbor in our Milky Way galaxy has been difficult to perceive because the gigantic pinwheel structure, some 100,000 light years in diameter, is seen from earth almost edge-on. The pinwheel consists of a spherical hub of stars from which project two spiral arms of stars, gas and dust.

There is a great deal of interest in galaxies because they are the largest structures in the universe. Virtually all visible matter is found in them. There is particular interest in Andromeda because it supposedly is much like our Milky Way galaxy and also because it is the nearest large galaxy. It is 2,200,000 light years away, one light year being six million million miles.

A cross-hatch lattice tracing was drawn of Andromeda's arms in the almost edge-on position. The work was done by Dr. Halton C. Arp of Mt. Wilson and Palomar Observatories, operated by Carnegie Institution of Washington and the California Institute of Technology. Dr. Arp lifted the lattice upright mathematically.

Observatory photographer William Miller photographed a picture of Andromeda from such an angle as to foreshorten the edge-on appearance. He made it appear that the ensuing photo had been taken "looking down" on the galaxy. The photo roughly checked Dr. Arp's geometric projection.

The astronomer pointed out that the new look at Andromeda shows the galaxy to be much less similar to our Milky Way galaxy than supposed. Andromeda's two major spiral arms are symmetrically coiled and spaced some 13,000 light years apart.

In the Milky Way galaxy the arms are much closer together and probably are either multiple or branched. This agrees with previous observation that our galaxy has a higher percentage of gas than Andromeda and thus, by inference, a higher percentage of young stars, Dr. Arp said.

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William C. Miller

*ANDROMEDA "TILTED"—This photograph of the Andromeda galaxy, also known as M-31, was printed on an easel tilted 15 degrees from edge-on. Despite the elongation of the circular nucleus, defocusing and variable magnification from top to bottom, the main spiral features appear approximately as they would if M-31 were viewed flat-on.*