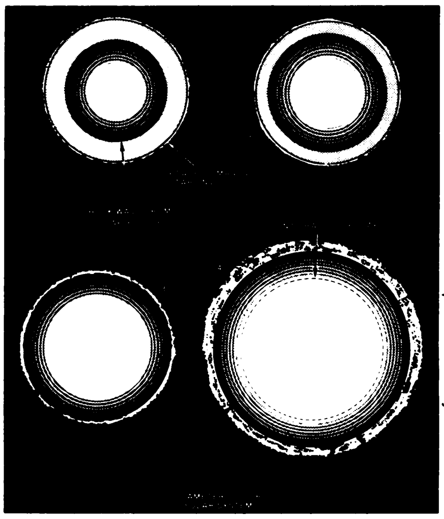
Serendipity catches a supernova

Supernovas are giant explosions of stars. Supernovas are also giant frustrations for astronomers. There is no way to predict when or where a supernova will happen, so astronomers usually don't notice them until the explosion is virtually over and their light has passed its maximum brightness and is starting to fade away.

Now a group of astronomers working at institutions in South America report that they have discovered a type II supernova on its way to maximum brightness and have been able to follow it through maximum brightness and into its decline.



National Optical Astronomy Observatories

Shock from inside star reaches surface at maximum light (3), then explodes star.

Supernovas are divided into two types according to the way their light emission changes. Theory says type I supernovas occur in binary star systems, whereas type II supernovas result from the explosions of lone giant stars: red supergiants or the class known as Wolf-Rayet stars. The South American observers—Mark M. Phillips of the Cerro Tololo Inter-American Observatory at La Serena, Chile, María Teresa Ruíz of the University of Chile in Santiago and Virpi S. Niemela of the Institute of Astronomy and Space Physics in Buenos Aires, Argentina — say their find has contributed "unique" data in support of the theory about type II supernovas. An announcement by the (U.S.) National Optical Astronomy Observatories, which operates Cerro Tololo, calls it "[t]he first detailed observations of a star in its death throes."

Supernovas occur at a rate of about one per galaxy per hundred years. (None has been seen in our galaxy since the 17th century.) This latest one is designated 1983k and is located in the galaxy NGC 4699. Although the observations were made in early (southern) winter of 1983, it took until now to get them analyzed and published in THE ASTROPHYSICAL JOURNAL (Vol. 289, p. 52).

On June 6, 1983, astronomer Marina Wischnjewsky made a plate of NGC 4699 as part of a supernova survey conducted by the University of Chile's Cerro Calan Observatory in Santiago. On the plate she noticed an incipient supernova, a star that was 300 times as bright as it should be. She got in touch with her colleague, Ruíz, then working as a visiting astronomer at Cerro Tololo.

"It was serendipitous that we had this team of experts at Cerro Tololo," says Phillips. "María Teresa specializes in supernova remnants, and Virpi is a specialist in Wolf-Rayet stars."

The astronomers at Cerro Tololo got their first spectra of the object on June 14, 16 and 17, while the supernova was getting brighter, and then followed with post-maximum spectra on July 16 and 18. They believe their data show evidence for a shock wave beginning deep within the star, rising to the surface and then blowing the star's surface material outward. The star, which most likely had a diameter of about 17 billion kilometers on June 6, had expanded to some 80 billion km by late July.

Before maximum light (which occurred on June 23) the star showed spectral patterns characteristic of a Wolf-Rayet star, particularly prominent signs of enrichment with nitrogen. These characteristics abruptly disappeared at maximum light. These Wolf-Rayet emissions are a hitherto unobserved phase of the development of type II supernovas, according to the Cerro Tololo observers. Such a finding raises the suspicion that the progenitor star was of the Wolf-Rayet type. However, the observers say, those spectral features could be an artifact of the explosion rather than a property of the progenitor.

They conclude that "SN 1983k most likely resulted from a massive star with an extended envelope, which had undergone significant mass loss prior to exploding and whose surface layers contained nitrogen-enriched material."

—*D. E. Thomsen*

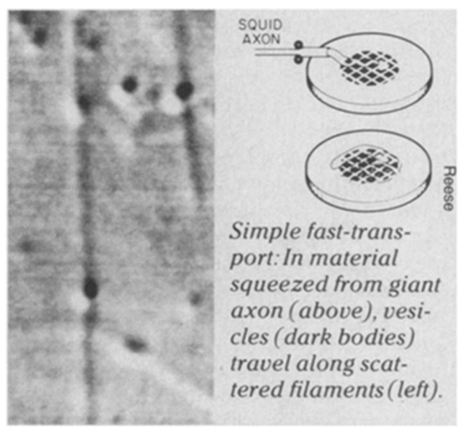
Subcellular life in the fast lane

The video images resemble toy cars speeding along disconnected stretches of highway, where invisible children arbitrarily remove cars and return them to the track. With such videos of microscopic structures, scientists are working out the rules-of-the-road for transportation within a cell, as well as identifying the subcellular fuel, motors and roadways.

Nerve cells, with their long, thin axons and dendrites, present the greatest transport challenge. For more than a decade, biologists have recognized two transport processes, but their mechanisms have been a mystery. The movement of the axon's entire contents (the axoplasm) within the membrane is characterized as slow transport. Within that slowly flowing cytoplasm, some structures zip along, in either direction, at more than 100 times the slow-transport rate.

The complicated activity and the congestion within an axon make analysis difficult. A simplified experimental situation was recently developed at the Marine Biological Laboratory in Woods Hole, Mass., by Thomas S. Reese of the National Institutes of Health. He and colleagues now report that the faster transport uses adenosine triphosphate (ATP) as fuel, a complex of proteins as a motor, and microtubules, single filaments of the protein tubulin, as the roadways. The fast-transport system is distinct from the two types of cellular machinery previously described that produce intracellular movement in plants and animals, Reese says.

In their experimental system Reese and colleagues squeeze the axoplasm from a squid giant axon, which is about 1,000 times wider than any axon of a vertebrate. If ATP is present, filaments move away



Reese

Simple fast-transport: In material squeezed from giant axon (above), vesicles (dark bodies) travel along scattered filaments (left).

from the bulk of the material and adhere to a glass plate. The scientists use video-enhanced microscopy (SN: 4/11/81, p. 234) to view the filaments, which have diameters of 25 nanometers. At a Society for Neuroscience seminar last week in Washington, D.C., Reese showed video images of subcellular structures — vesicles and mitochondria — traveling along the scattered filaments.

From the video images, the scientists conclude that each vesicle and mitochondrion must have more than one attachment site, because they can switch from one filament to another nearby. In addition, each filament has more than one traffic lane, because organelles going in opposite directions can pass without colliding. Using antibodies, Reese and colleagues report in the February CELL that each filament is a single microtubule.

By isolating proteins from axoplasm, they have determined those essential to movement. "We now have a complex of proteins that seems to be the fast-transport motor," Reese says. —*J. A. Miller*