in the early liquid-drop model was reported by Dr. Walter John of the Lawrence Radiation Laboratory at Livermore, Calif., on behalf of himself and colleagues Drs. E. Kenneth Hulet, R. W. Lougheed and J. J. Wesolowski.

The symmetric fission was found to happen to the element fermium. It comes, however, in company with asymmetric fission—some nuclei divide unevenly and some divide evenly—and it is taken as evidence in favor of an emendation of the liquid-drop model, the so-called double-hump theory.

The idea of gradual deformation and splitting in the liquid-drop model became basic to theories of fission. Nuclei were seen as stretching themselves from spheres into ellipsoids, then dumbbells and finally splitting in two. It was found that there existed a so-called fission barrier: The more ellipsoidal a nucleus became, the harder it was to distort further until a certain point of maximum difficulty was passed. After that further distortion became easier.

Fission would occur if the maximum point was successfully passed. It was like climbing a hill. Each step was harder than the one before until the summit was reached. Then it was all downhill.

Discovery of the so-called nuclear isomers forced an elaboration of this view. It was found that nuclei of certain elements—californium is an example—could be divided into two groups. One, the ground state group, lasted a fairly long time before fissioning; the other, the isomer group, fissioned after a much shorter time. Since an element's characteristic lifetime was supposed to depend on the size of its fission barrier, the single barrier could not explain two lifetimes.

Some Russian theorists found that if they calculated the energy engendered by the orbital motions of neutrons and protons inside the nucleus and added this to the liquid-drop model, they got a double-hump theory. Instead of one point of maximum difficulty there were two, with a region between where distortion was first progressively easier, then harder again. The isomers were nuclei that were momentarily in the valley between the humps and needed to pass only the second barrier to complete fission.

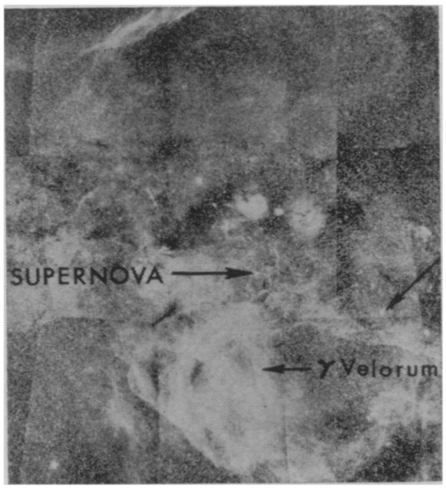
As long as distortion is taken along one axis only, this double-hump theory predicts symmetric fission. But theorists found that if they introduced additional distortion in a perpendicular direction—if they made the nucleus egg shaped instead of a symmetric ellipsoid—the nucleus could get around the second barrier more easily. This is something like going around a hill instead of over it, and it produces asymmetric fission as the unequal halves of the egg come apart to form daughter nuclei.

Nuclei take the easiest possible way to fission, so most elements split asymmetrically. In the case of fermium, says Dr. John, the second barrier is very small, almost not there, and so some fermium nuclei go one way and some the other. For heavier elements, where the second barriers are smaller still, there should be even more symmetric fission.

Dr. John does not expect the discovery to have an immediate effect on the economy of fission reactors. The elements in which symmetric fission occurs are too rare to be used as fuels. He expects the new result to be useful in the study of nuclear dynamics and structure, especially the shapes of nuclei. Some nuclei, certain rare earths for instance, have highly distorted shapes, yet do not fission. The question is why. ☐

NEW SUPERNOVA RELIC

A blast that lit the sky



NASA

Gum nebula: Lit by a supernova.

Nebulae, extended bright patches in the sky, fall into two general classifications. Some are supernova remnants, splotches of matter blown out of a star by a supernova explosion and heated by it until they glow. Others are clouds of ionized hydrogen surrounding particular hot stars that pump energy into them so that they glow continuously. The latter are called Strömgren spheres after the Danish astronomer Bengt Strömgren.

There is one nebula, the Gum nebula, which stretches across 50 degrees of the southern sky, that defies classification under either of these heads. Drs. John C. Brandt, Theodore P. Stecher and Stephen P. Maran of the National Aeronautics and Space Administration's Goddard Space Flight Center in Greenbelt, Md., and David L. Crawford of the Kitt Peak National Observatory at Tucson, Ariz., conclude that the Gum nebula is the first known representative of a third class that combines certain characteristics of both of the others. Their argument is published in the Feb. 1 ASTROPHYSICAL JOURNAL LETTERS.

The Gum nebula was discovered by an Australian astronomer, Dr. Colin S. Gum, in 1952. It had not been noticed before that because it is too big and too tenuous.

It is not visible to the naked eye. "You can't see it," says Dr. Maran. "The surface brightness is too low. You have to have a wide-angle lens and red filters."

The Gum nebula is about 2,600 light years across in its longest dimension and appears to be somewhat elliptical in shape. It would have had to be a supercollossal supernova to have blown matter from a star up to 1,300 light years into space, so the Goddard-Kitt Peak group argues that the Gum nebula cannot be a supernova remnant in the way that the Crab nebula, for example, is a supernova remnant.

On the other hand, although there are stars within the Gum nebula, there are not enough of the right kind of hot stars to ionize such a volume. Thus, the Gum nebula cannot be an ordinary Strömgren sphere.

Instead, the group proposes, the Gum nebula is a fossil Strömgren sphere made by a supernova that happened 11,000 years ago. As the Goddard-Kitt Peak astronomers see it, the supernova gave off a tremendous blast of ultraviolet light which ionized interstellar hydrogen clouds for light-years around.

What is glowing is not matter that was ejected by the explosion but hydrogen that was there before it. The light is produced as the electrons of the hydrogen lose energy and gradually recombine with their nuclei. Unlike Strömgren spheres that are being pumped by hot stars, this one is gradually burning out as the hydrogen recombines.

The measure of the age is provided by the Vela pulsar, which lies in the nebula. According to the most common theory of pulsars, a pulsar is what remains of the core of the star that explodes in the supernova, and pulsar theory gives 11,000 years for the age of the pulsar. On this basis the nebula has between 50,000 and 100,000 more years to glow.

Dr. Maran explains the absence of other such supernova relics in two ways. First, to light up a large amount of hydrogen, a supernova would have to occur in the central plane of the galaxy, where most of the hydrogen is. Second, there may be others around, but they may be too young to see: At first such a cloud would radiate in the radio range. Only after thousands of years would it shift to visible light. ☐