pared with that of the inert U-238, The original enrichment technology was developed by the government during World War II as part of the atomic bomb project. Reactors are now commonly licensed to private concerns, but enrichment remains in government hands.

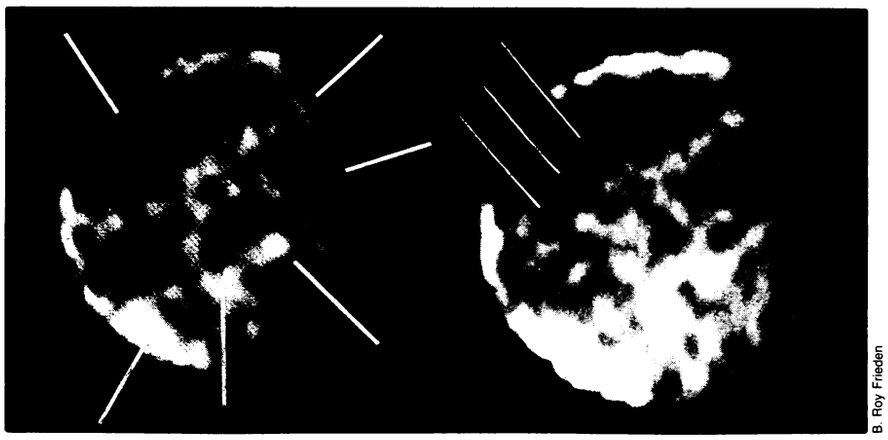
The sudden increase in private interest appears to be due to the development or potential development of new methods of enrichment that promise greater profit and efficiency than the original one. It is momentarily opportune because the congressional Joint Committee on Atomic Energy is considering the Nuclear Fuel Assurance Act, which would facilitate entry of private organizations into the business.

Enrichment depends on separating the two isotopes so that more U-235 can be introduced into or retained within the batch under process. The oldest method, gaseous diffusion, is based on the tendency of light atoms in a gas to rise higher than heavy ones. It is, as economists would say, capital intensive, and slow, requiring repeated processing of each batch. In recent years the gaseous centrifuge, a less expensive and quicker method, based on the idea that the heavier isotope will fly farther than the light one, has developed.

The latest method, still under experiment and not production ready, uses laser light and the fact that the wavelengths preferentially absorbed by one isotope differ slightly from those absorbed by the other. With the proper laser, one isotope can be energetically excited while the other is left alone. If the excited isotope is ionized, it can be collected electrically; if not ionized, it can be swept up by a chemical reaction. A study done at Los Alamos Scientific Laboratory, where experimentation on the laser methods is in progress, compares costs of plants of similar capacity. A gaseous diffusion plant would require $4.5 billion; a centrifuge plant $2.8 billion, and a laser one, if it works (and its proponents are optimistic), would come to only $140 million. Others see substantial savings in laser methods, but not as much as this.

Centar proposes a centrifuge plant. Their announcement says they have done feasibility studies with the Tennessee Valley Authority and have already interested utilities in buying fuel. Exxon proposes a kind of pilot laboratory, an Experimental Test Facility to work on laser methods. They would build it in Richland, Wash., spending about $15 million. If they can break ground in early 1977, they expect operations to start in 1978 or 1979. Garrett is also considering a laser technique. At the same time both Exxon and Garrett have proposed centrifuge plants.

Surface features seen on Ganymede



B. Roy Frieden

Computer-restored images of Ganymede, Jupiter's largest satellite, reveal for the first time some interesting surface details. Both were taken by the Pioneer 10 spacecraft, left with red filter, right with blue. According to the scientists who digitally restored the images, B. Roy Frieden and William Swindell, professors of optical sciences at the University of Arizona, the dark caplike region at the upper righthand edge is consistent with the way a crater, or other large hole, would appear on the dark limb side. Beneath it is a darkened elliptical region that resembles a large, shallow crater. Nearby are other features with a craterlike appearance. The small bright feature in the lower right quadrant appears as the center of a large, scallop-shaped bright arc. The righthand image shows three round details (see pointers) that Frieden and Swindell say very much resemble maria. If so, they add, the maria are very large. Some structure appears evident within the topmost round feature, "which makes it reminiscent of certain lunar maria." The images show a few rather large, bright rings, but whether they are ice or reflections from smooth surface features is unknown. Earlier radar evidence has led to the belief that Ganymede's surface is very rough, largely composed of rocky or metallic material embedded in ice. Ganymede's diameter is about 5,200 kilometers, half again as great as earth's moon. Images and details of restoration techniques appear in the March 26 SCIENCE. □

Comet West's scientific show

As Comet West (1975n) swung around the sun to rise in the east (SN: 2/14/76, p. 104), it provoked a flurry of observations around the world. Comets are not particularly rare phenomena. They run to a dozen or more a year—in the midst of the Comet West activity the first of 1976, Comet Bradfield (1976a) was discovered on Feb. 19 by William A. Bradfield of Dernancourt, near Adelaide, Australia. But comets are fleeting phenomena, so that every piece of data gathered during quick looks helps to build the total picture of what they are. One of the firsts with Comet West was an ultraviolet spectrum.

The comet got progressively brighter as it approached the sun (perihelion came on Feb. 25) reaching a top visual magnitude of −3.65 on Feb. 26 as measured by daylight observations by D. Elmore and S. Koutchmy of the Sacramento Peak Observatory in New Mexico. By Feb. 23, when at the same distance from the sun as Comet Kohoutek, the belle of 1973, it was already intrinsically 1.4 magnitude brighter, according to astronomers E. P. Ney and J. Stoddart of the University of Minnesota.

While it was passing the sun, the comet's nucleus broke into four parts. The exact sequence of events is a bit hard to put together from piecemeal reports, but the recension given by Zdenek Sekanina of the Center for Astrophysics in Cambridge, Mass., goes as follows: On Feb. 22 nucleus B separated from the original nucleus (A) because of the attraction of the sun. Nucleus D probably separated from B on Feb. 25, and nucleus C, which may be short lived, separated from A on March 5.

After perihelion the comet's tail showed a typical growth. According to J. Young of the Table Mountain Observatory in South Africa, the tail was less than 10° long on March 2 and increased by stages to 30° by March 8. Superimposed on the tail of plasma particles was a dust tail composed of so-called synchronic bands (up to 20 in number), which moved laterally and rotated with respect to the fainter plasma tail.

Spectroscopic observations to determine chemical composition were taken in visible light, infrared, radio and (for the first time) ultraviolet. The ultraviolet work was done by Charles A. Barth and C. Lawrence of the University of Colorado using an Aerobee rocket launched March 5. They report evidence for oxygen, carbon and carbon monoxide.

Radio detection of hydroxyl radical emission is reported by J. C. Webber, L. E. Snyder, R. M. Crutcher and G. W. Swenson of the University of Illinois. Visible spectra were taken by various observatories from the University of Minne-

Comet West, with 50-million-mile tail.

sota in the north to the European Southern Observatory in the south and from the Uttar Pradesh State Observatory in India in the east to the University of Iowa in the west. They find carbon in two- and three-atom combinations, cyanogen (CN), CH radicals, sodium and positively ionized water molecules (H_2O^+).

The latest reports in hand at the time of writing give a visual magnitude of 3.1 on March 18. They also predict that the three subsidiary nuclei will continue to separate from nucleus A. By April 22, nucleus B is expected to be half a minute of arc from A, nucleus C nearly a whole minute away and nucleus D 13 seconds away. □

Solar neutrinos: Still negative

The mystery of the missing solar neutrinos remains a mystery in spite of rumors to the contrary. That is the latest word from Raymond Davis Jr. of Brookhaven National Laboratory, leader of the experimental group that has been searching for the theoretically predicted flux of neutrinos from the sun for the last 15 years. The scientists have not seen anything they could call a solar neutrino flux.

What started talk to the contrary was a progress report by Davis that referred to some recent runs of the experiment that yielded high data readings. The experiment consists of a tank of cleaning fluid (perchlorethylene) located in a mine near Lead, S.D. Burial shields the tank from nearly all particles but neutrinos. Incoming neutrinos should react with chlorine nuclei in the fluid to produce a radioactive form of argon. The argon production is monitored to determine the neutrino flux.

For years the experiment recorded only data that were consistently well below what the usual theory of nuclear processes in the sun would expect. Lately, four data runs that fall within the range expected by theory have turned up. These include numbers 27, 36, 37 and 38.

Because the last three runs have been high, some people seem to have concluded that something was wrong with the experiment in the past and has now come right so that solar neutrinos in the expected amount are finally being recorded. Davis says nothing has changed. Whatever is right with the experiment has always been right with it. Other people seem to have concluded that the appearance of three high runs in a row is evidence that the sun's neutrino producing mechanism was turned off and has now turned on. There are theories that provide such off-and-on behavior, one of them (due to Fred Hoyle) giving an 11-year cycle, but Davis thinks them a bit farfetched. In his opinion, Davis told SCIENCE NEWS, the high runs so far can be considered to be only part of the expected statistical fluctuation in an experiment of this kind, and a negative conclusion on solar neutrino flux is the only one yet warranted. □

Mauna Loa: Major eruption predicted

U.S. Geological Survey volcanologists predict that the Mauna Loa volcano on the island of Hawaii will undergo a major eruption sometime before July 1978. They warn that a sustained eruption could, if a sufficiently high quantity of lava is produced, endanger the coastal city of Hilo, the island's economic and transportation center.

The prediction is based on a review of the past eruptive history of Mauna Loa, one of earth's largest and most active volcanoes. The volcano ended its longest period of dormancy ever—25 years—July 5 and 6, 1975. That eruption was small by Mauna Loa standards—less than 30 million cubic meters of lava were erupted.

But scientists at the USGS Hawaiian Volcano Observatory believe the July 1975 eruption was the first phase in a three-phase eruption cycle along Mauna Loa's northeast rift zone. According to this pattern, last year's summit eruption will be followed by another small and brief summit eruption and then immediately by an eruption along the volcano's northeast flank. This fissure is expected to form a "curtain of fire" one to two miles long, with lava erupting at high rates, and lava flowing as far as 10 miles downslope in the first 48 hours. The lava could eventually reach Hilo "if a sufficiently high rate of lava eruptions continue for a sufficient period of time."

Hawaiian authorities have been alerted. Countermeasures are under study. They include diversion of the lava flow by explosives, by construction of earthen barriers and by application of large volumes of water to the leading edges of lava flows in hopes of cooling them enough to form barriers of solid rock. □

Emotions and sudden death

The belief that emotions can trigger sudden death goes back centuries. Only recently, however, has medical science been able to confirm it and to explore how it happens. Animal studies, for example, have revealed that the nervous system is a culprit in heart attacks; that ventricular fibrillation—abnormally fast contractions of the ventricle of the heart—is the critical mechanism responsible for instant cardiac death, and that emotions can trigger this fibrillation and death. Thanks to the advent of human heart-monitoring and cardiac-resuscitation techniques, doctors have determined that emotions can send the hearts of heart disease patients into ventricular fibrillation.

Now a case history further confirms the role of emotions as a cause of fibrillation and subseqent cardiac death. It is reported in the March 18 NEW ENGLAND JOURNAL OF MEDICINE by Bernard Lown and his cardiovascular team at Harvard School of Public Heath. The most intriguing aspect of this history is that emotions appeared capable of setting off fibrillation and heart arrest in the absence of heart disease.

The case concerned a 39-year-old Boston educator who enjoyed excellent health. Then one afternoon while roughhousing with his two teenage daughters, he experienced heart arrest. His wife, a nurse, gave him cardiopulmonary resuscitation. By the time he reached the hospital, his heart was beating again, but it was in fibrillation. The doctors examined him but could find no sign of heart disease. So they looked for a psychological cause for his fibrillation and arrest. Sure enough, psychiatric interviews revealed that the patient had been experiencing some turbulent, repressed emotions. Several months earlier, he had experienced his first career setback. It upset him greatly, since he was aggressive and competitive. Because his wife's father had recently died, she was not giving him the psychological support he desperately needed at this time. Then, while roughhousing with his daughters, he experienced aggressive, erotic impulses that ran counter to his deeply religious, sexually repressed nature. Either these emotions alone, or these emotions coupled with others he had been holding in recently, apparently set his heart into fibrillation and arrest. What's more, his fibrillation intensified while he underwent psychiatric interviews and while he was in the REM (dream) stage of sleep. These two factors further suggested that his fibrillation and cardiac arrest had an emotional origin.

So "psychologic and neurophysiologic factors may predispose to life-threatening cardiac arrhythmia in the absence of organic heart disease," Lown and his colleagues conclude. □