

## Radar image of Venus hints at tectonism



Radar image of north Venusian hemisphere shows basin (center) and Maxwell (right).

Volcanoes are numerous on the surface of the earth and frequently in the news. Our various visitors to Mars have given evidence of volcanism on that planet. Now, it appears, Venus joins the group of volcano-spawning planets. The first map made from the data of a new radar study of the planet, which covers a large section of Venus's northern hemisphere, exhibits three features that, observers say, are hard to attribute to external causes such as meteorite bombardment. They appear to be evidence of internal tectonic activity, possibly volcanism.

The three features include a large area discovered by previous radar studies and tentatively named Maxwell plus two small spots on the northern edge of a newly discovered "basin" that may or may not be a meteorite crater. The radar map that shows them results from a survey of the planet undertaken at Arecibo Observatory in Puerto Rico by D. B. Campbell and R. B. Dyce of Arecibo and G. H. Pettengill of Massachusetts Institute of Technology. Their report is in the Sept. 17 SCIENCE. According to these observers, their present work is the best resolved radar study of Venus to date.

Radar can "see" the surface, but interpretation of the returned signal faces important difficulties. One is the lack of sensitivity when long wavelengths are used. The other is the so-called delay-Doppler ambiguity: If the radar beam is wider than the planet—at planetary distances this is difficult to avoid—each point on a radar map will contain superimposed information from two points on the surface that happen to lie at equal distances from the antenna.

Improvement in sensitivity was made

possible by the recent resurfacing of the Arecibo telescope, which allows the use of centimeter wavelengths, thus permitting an improvement up to 50 times the best previous figures for Venus studies. The two-point ambiguity can be resolved by interferometry, using a second telescope at some distance from the first. The difference between the backscattered signal received at the two telescopes can separate the information from the two points. For interferometry a second antenna 30 meters in diameter was constructed 10.7 kilometers north-northeast of the main (330-meter) Arecibo telescope. The arrangement was calculated to provide a resolution of about 4 kilometers on the surface of Venus in equatorial regions. At latitudes beyond 30° the resolution would be gradually degraded, reaching 20 kilometers at 60° latitude.

The data were taken in two-hour observing sessions each day for a two-month period around the inferior conjunction of Venus in August 1975. When such data have been properly reduced, they can be turned into images, photographic prints that show the difference in brightness reflected from different parts of the surface.

The image now published shows the area between northern latitudes 46° and 75° and over 80° in longitude. The average resolution is about 22 kilometers.

The two most salient features in the picture are a dark area about the size of Hudson's Bay (1,500 kilometers north to south and an average width of about 1,000 kilometers) and a bright area about the size of Oklahoma. The dark area is bounded by bright streaks, and—"in spite of the implications"—is called the northern basin. The bright boundary may be

a steeply sloped rim. The origin of the basin can possibly be explained as the result of a meteorite impact, and such an interpretation is strengthened by a somewhat bright region to the southeast of it that could be the sort of ejecta blanket that such impacts throw out.

But the large bright area (Maxwell) and the two bright spots on the northern edge of the northern basin are something else. These areas all give the impression of overlying an older surface. Maxwell is big enough so that an enhanced image and detailed study could be made. It and the two bright spots of the basin show a probable high degree of surface roughness, well-defined boundaries and irregular shapes. There is also a suggestion of a series of linear ridges. "In conclusion," say the investigators, "Maxwell and the two other high-contrast features seem very indicative of tectonic activity," perhaps a large lava flow.

The noted characteristics make "an origin based on the impact history of the planet hard to conceive. There are no equivalent features on the moon." This in its turn throws some doubt on the meteoritic interpretation of the origin of the basin, because if tectonics could do what it seems to have done in Maxwell, it could also have made the basin. □

## Soviets produce metallic hydrogen

"Nature did hydrogen a grave injustice," says Leonid Vereshchagin, director of the Institute of High Pressure Physics in Moscow. All the other elements in hydrogen's column of the periodic table are metals. Hydrogen alone is an electrical insulator, a dielectric. (The characteristic of a metal is that it has a structure endowed with a certain number of free electrons that can drift through the material as an electric current.)

Since location in a given column of the periodic table establishes a presumption of similar behavior, scientists have long believed that it ought to be possible to pressure hydrogen into a transition to a metallic state. Attempts to pressure hydrogen into a metallic state have failed up to now.

Ye. Yakovlev, a senior researcher at the Moscow Institute of High Pressure Physics, reports a success. His report and Vereshchagin's comments were first published in *PRIRODA*, a publication of the Soviet Academy of Sciences (issue No. 4 of the 1976 volume). An abridged English version appears in the Sept. 2 NEW SCIENTIST.

Researchers in the United States have tried to make metallic hydrogen with explosives. Explosions do produce very high pressure shock waves, Yakovlev concedes, but they have the drawbacks of high temperature and short duration "compounding the difficulties both of ob-

taining the metallic hydrogen and of retaining it in that state." The Soviet researchers preferred to use high static pressures. They developed an apparatus that would exert pressures up to 3 megabars. At pressures around 1 megabar they had success in forcing diamond, silica and other substances into metallic states. (A 50-year-old theoretical suggestion by J. D. Bernal says that at a high enough pressure any substance will change to a metallic state.)

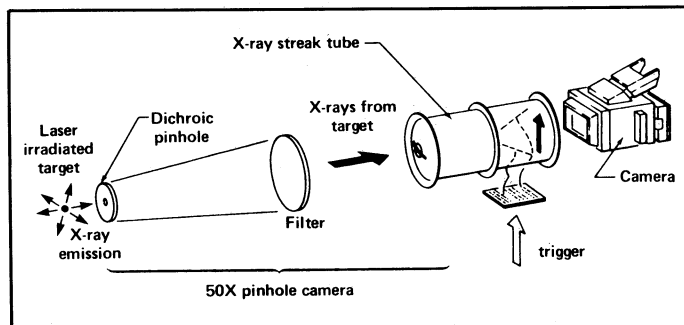
These achievements encouraged the Moscow workers to go on to hydrogen. Hydrogen is a particularly difficult problem because it is impossible to calculate the exact pressure required. Various estimates have been made, ranging from 1 to 10 megabars.

In the experiment, "very pure" gaseous hydrogen was passed between two diamond anvils. The anvils had been cooled to 4.2°K so that the hydrogen froze on them. Then pressure was applied. Electrical contacts were attached to the anvils, and the passage of a current between them was taken to indicate that the hydrogen had entered a metallic state. At various pressures between 1 and 3 megabars, the electrical resistance of the hydrogen dropped from 100 million ohms (excellent insulator) to 100 ohms (not a bad conductor). This indicated the possibility that the hydrogen had entered a metallic state.

To be sure that the change in resistance was not due to other causes, such as accidental contact between the anvils, control experiments were undertaken. One of these was a kind of reversal of the basic procedure. The pressure was held at a level at which the hydrogen was on the brink of melting. Holding the pressure and raising the temperature slightly would make melting begin. The researchers were able to measure the rate of the transition from the conducting state back to the nonmetallic liquid state. "Our measurements indicated that the [drop] in resistance in the hydrogen had been the result of a phase transition into the metallic state. So we concluded that we had indeed made metallic hydrogen."

The quest for metallic hydrogen is important not only for what it can teach us about the structure and behavior of unusual metals. Vereshchagin points out that certain theories indicate metallic hydrogen may be a superconductor at very high temperatures, possibly 200° or 300°K (the latter being room temperature) provided there is a way to keep it a stable metal at such temperatures. Furthermore, metallic hydrogen would make an ideal fuel, having a high energy density and no pollution problems. Further studies will try to find out whether the metal Yakovlev and collaborators have made is superconducting, whether it can be held stable and whether large volumes of it can be made with a "gigantic" press that is about to be completed. □

## X-ray photos confirm fusion calculations



Photographic setup (left) for detecting X-rays. A computerized interpretation of the results (below) shows localized burst of X-rays with distinct features indicating stages of implosion.

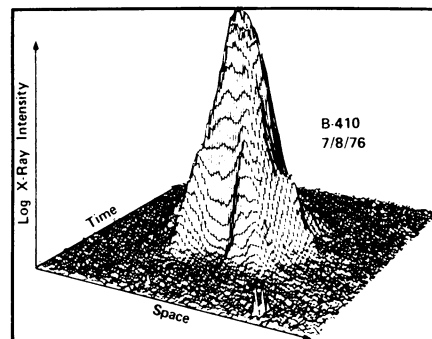
If useful fusion energy is ever to be gathered from laser-imploded hydrogen targets, ways must be found to understand what goes on inside the tiny pellets, only 100 microns in diameter, during their busy 100-picosecond destruction. A new photographic technique developed at the Lawrence Livermore Laboratory has provided the first direct glimpse of this process, and the results show that previous computer predictions of implosion velocities have proven remarkably accurate.

The idea for the technique is surprisingly simple. Just as a pinhole in a piece of paper will transmit the image of a lightbulb placed in front of it, a much smaller hole in a piece of metal will allow X-rays to pass and cast the image of their source. If a slit is pulled across a piece of film, exposing only one portion at a time to the image of the lightbulb, the position and speed of a bursting bulb could be estimated. Similarly, X-rays casting an image of the pellet can be converted into electrons, which are swept across a fluorescent screen, giving a time-sequenced picture of target implosion.

In papers published in *PHYSICAL REVIEW LETTERS* (Aug. 30) and delivered at the 12th International Congress on High Speed Photography in Toronto last month, Livermore scientists reported achieving pictures with spatial resolution of 6 microns and a time resolution of 15 picoseconds. This precision allowed them to distinguish four distinct phases in the pellet implosion: initial heating by the laser, inward motion of the glass shell, momentary stagnation at the center, and final disassembly.

LLL's associate director for lasers, John L. Emmett, told *SCIENCE NEWS* the experiment represents a "significant milestone" in the development of laser fusion. An important part of the success, he said, was the very close match between the implosion velocity measured ( $3.4 \times 10^7$  cm/sec) and that predicted by the laboratory's LASNEX computer code ( $3.5 \times 10^7$  cm/sec). For such complex systems, agreement within a factor of two is often considered good news, and Emmett says spatial resolution may be further refined to one micron within a few months.

The importance of the computer codes may be better appreciated by considering



Diagrams: LLL

that such modeling must adequately represent the pellet over an almost unfathomable range of conditions. The density of neutrons released, for example, has already increased a million times since the first experiments, and must increase 100 million times again before a practical energy generator is created. In the fusion race with the Soviets, American scientists generally feel they are ahead in computer modeling and diagnostic techniques like those just reported. Soviet scientists, however, may benefit from more powerful laser systems.

The LLL team of physicists that developed the new X-ray photography technique include David T. Attwood, Lamar W. Coleman, John T. Larsen, and Erik K. Storm. □

## Viking 2 biostudies begin; scoop unstuck

Back in July, the Viking 1 orbiter suffered a propellant pressurization problem before it even got to Mars, but engineers worked out a way around it. Lander 1 threatened catastrophe when its soil-sampling arm stuck, but that passed too. The Viking 2 orbiter caused a near-panic when two of its gyros blew their fuses just after its lander departed for the Martian surface, but it was brought back into line, and this week lander 2 continued the tradition.

Early Sunday, lander 2's extendable arm set out, under computer control, to gather its first sample of the surface from the site of the plains of Utopia. The goal was to pick up some solid pebbles together