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.)

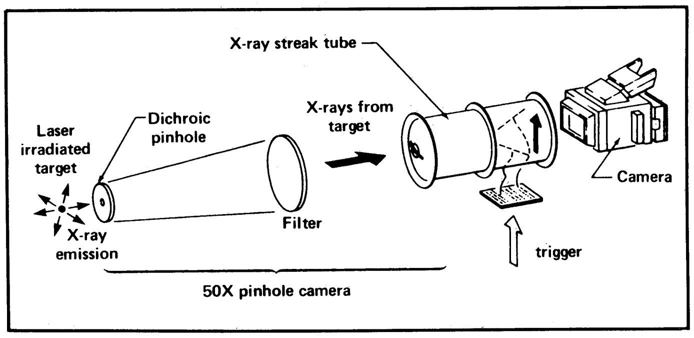
These achievements encouraged the Moscow workers to go on to hydrogen. Hydrogen is a particularly difficult problem because it is impossible to calculate the exact pressure required. Various estimates have been made, ranging from 1 to 10 megabars.

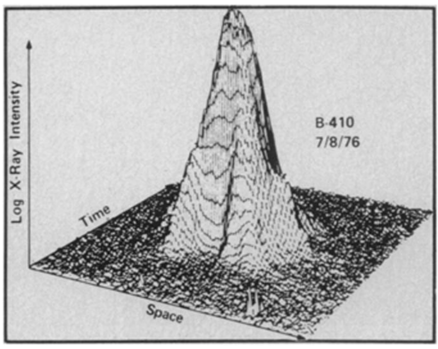
In the experiment, "very pure" gaseous hydrogen was passed between two diamond anvils. The anvils had been cooled to 4.2°K so that the hydrogen froze on them. Then pressure was applied. Electrical contacts were attached to the anvils, and the passage of a current between them was taken to indicate that 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 set-up (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.

Diagrams: LLL

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 (3.4×10^7 cm/sec) and that predicted by the laboratory's LASNEX computer code (3.5×10^7 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 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 propellent 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