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.)

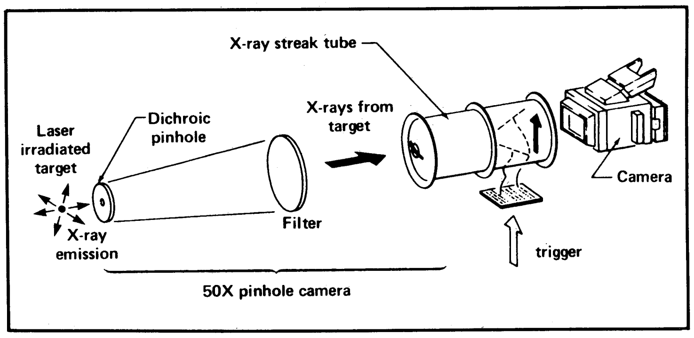
These achievements encouraged the Moscow workers to go on to hydrogen. Hydrogen is a particularly difficult problem because it is impossible to calculate the exact pressure required. Various estimates have been made, ranging from 1 to 10 megabars.

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.

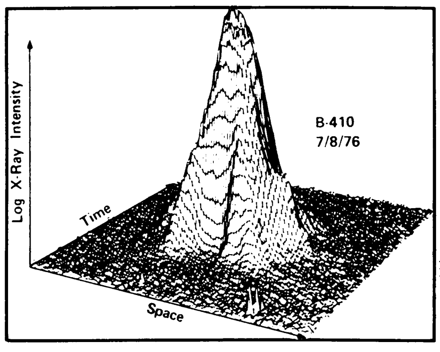
To be sure that the change in resistance was not due to other causes, such as accidental contact between the anvils, control experiments were undertaken. One of these was a kind of reversal of the basic procedure. The pressure was held at a level at which the hydrogen was on the brink of melting. Holding 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.



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 with some fine particles, dump the "fines" into the hopper of the craft's biology instrument and then deliver the presumably dust-free pebbles over to the organic chemistry device. The unexpected tackiness of the surface particles at the Viking 1 site had prompted the inorganic chemistry team to try to start lander 2's analysis with solid chunks rather than dust, so that the clinging dust would not be left over to confuse the instrument's readings of the pebbles.

The sampling arm scooped up its prize (the shallowness of the resulting trench was thought perhaps to indicate a solid rock or unexpectedly tough crust below the thin, looser surface material) and delivered a share to the biology instrument, which began analyzing the soil in three separate experiments.

It then pulled in in preparation for heading over to the inorganic chemistry hopper, but in the process of rotating its scoop for the task, it abruptly stopped working. All the lessons from lander 1's once-stuck arm had been applied—it was operating in a warmer part of the day, and no two extension or retraction movements were made in the same direction without a counter move in between. But it stuck. What's more, it stuck in almost the only place possible where neither of the lander's cameras could see it.

Engineers concluded that the problem might be a faulty switch controlling the rotation of the scoop around its own axis, so it was deemed safe to order the arm simply to extend 16 inches into camera range. A photo confirmed the diagnosis, and since the switch could be circumvented by changing the arm's operating sequence, plans were made to deliver the hoped-for pebbles to the inorganic chemistry instrument on Sept. 16. Two days later, the arm was to be sent out again, this time to gather a sample for the device that seeks organic molecules in the surface material. The discovery of organics, some Viking biologists feel, would make a much stronger case for interpreting the results of the biology instruments as representing possible life processes. "It doesn't get any easier," says one engineer. "Now if it just stays happy. . . ."

While contending with lander 2's recalcitrant arm, Viking officials were also weighing the possibility of a fourth run for lander 1's pyrolytic-release biology experiment, in hopes of clearing up ambiguous results from the previous cycle (SN: 9/11/76, p. 164). The advantages, said mission director Thomas Young, "appear to be very high," a view which PR experimenter Norman Horowitz emphatically shares, since a fourth run could make the scientifically important difference of repeatable results in a potentially momentous investigation. Orbiter 1, meanwhile, continued on its orbital survey of the planet, which began when its periapsis was desynchronized on Sept. 11 from Mars' period of rotation. □

Animal drug feeds: The human threat

Since the discovery in the 1950s that antibiotics promote growth in livestock, antibiotics in animal feeds have become a multimillion dollar industry and have undoubtedly helped feed the world's populations. At the same time there has been a swell of evidence that antibiotics in animal feeds are helping human bacteria build resistance to antibiotics, a trend that might possibly open people to deadly and once-conquered infectious diseases.

In 1972, for instance, the Food and Drug Administration's Task Force on the Use of Antibiotics in Animal Feeds garnered ample study results to underscore the possible danger. More evidence has accrued since then as well, some of the most recent and tightest of which is published in the Sept. 9 NEW ENGLAND JOURNAL OF MEDICINE. This particular study is also interesting because it offers some insights into the controversy and partisanship surrounding the subject.

Stuart B. Levy, George B. FitzGerald and Ann B. Macone of Tufts University School of Medicine carried out a prospective study to determine whether the gut bacteria of a farm family became antibiotic-resistant once the family started raising animals on antibiotic feed. The family's neighbors were used as controls. Within a week after the family started feeding their chickens feed supplemented with the antibiotic tetracycline, the chickens' gut bacteria became almost entirely resistant to the antibiotic. Increased numbers of resistant gut bacteria also appeared, but more slowly, in the farm family, but not in their neighbors.

Six months later 31.3 percent of weekly fecal samples from the farm family contained 80 percent tetracycline-resistant bacteria as compared with 6.8 percent of the samples from the neighbors. These resistant bacteria were found to contain plasmids (extrachromosomal pieces of DNA) conferring antibiotic resistance.

Even more notable, after three to four months' exposure to tetracycline, chickens and farm dwellers excreted bacteria that were resistant to other antibiotics as well. Some 36 percent of bacteria from the farm family showed resistance to three or more antibiotics compared with 6 percent from the neighbors.

True, no sickness arose among the farm family during the study. Still, Levy and his colleagues believe that the family's intestinal bacteria represented a reservoir of resistance genes that could be transferred from nonpathogenic to pathogenic bacteria. These findings, they conclude, "clearly demonstrate that antibiotic-supplemented feed is a factor contributing to the selection of human resistant strains of bacteria. These data speak strongly against the unqualified and unlimited use of drug feeds in animal husbandry. . . ."

This, however, is not the interpretation offered by the organization that sponsored the study—the Animal Health Institute, a Washington trade association that represents the drug companies who make the antibiotics that go into animal feeds. According to Jerry Brunton, director of scientific activity at the AHI, the results "came out in a way that some transfer occurs, but in a very, very low order of magnitude. And there has been no indication that any of this information has any direct bearing on the safety to man, that is, has caused any harm whatsoever. Now we have to carry this one step further: Can we find that someone has been compromised by this?" Gerald Guest, the FDA scientist who has been in charge of assessing data on the subject since 1973, draws still another conclusion: "Levy's data show that the people who are handling the animals, people who are working in slaughterhouses, etc., are the ones potentially at risk."

The reason the AHI undertook a study in the first place whose results might turn out to compromise its own interests is that the FDA published a requirement in the Federal Register in 1973 that drug companies would have to prove the human safety of antibiotics in animal feeds over the next couple of years if they wanted to continue selling them. This requirement stemmed from the FDA task force recommendations of 1972 (SN: 5/27/72, p. 349).

Whether the Tufts study results will ultimately be interpreted by the FDA either for or against antibiotics in animal feeds will depend not just on this study but on numerous others being performed by antibiotic manufacturers to satisfy FDA requirements, not to mention the many already assessed by the 1972 FDA task force. It is the belief of Dwight Mercer, an FDA scientist on the 1972 FDA task force and now intimately involved in reviewing the data, that the FDA will probably levy certain restrictions against the use of antibiotics in animals. But he doubts whether they will be implemented for another three to five years. Guest, however, says, "I don't think it will be that long."

Meanwhile, there is the question of how much scientific data must be gathered to constitute proof that antibiotics in animal feeds are or are not a human health hazard. Arthur K. Saz, a microbiologist at Georgetown University Medical School and a member of the 1972 FDA task force, believes the FDA had enough evidence to implement restrictions back in 1972. In Mercer's view, "there has been a lot of hassle about this. It has been the subject of several Congressional hearings. A lot of people are asking why something wasn't done at the time. The only thing I can tell you is that it was not politically expedient to do it then." □