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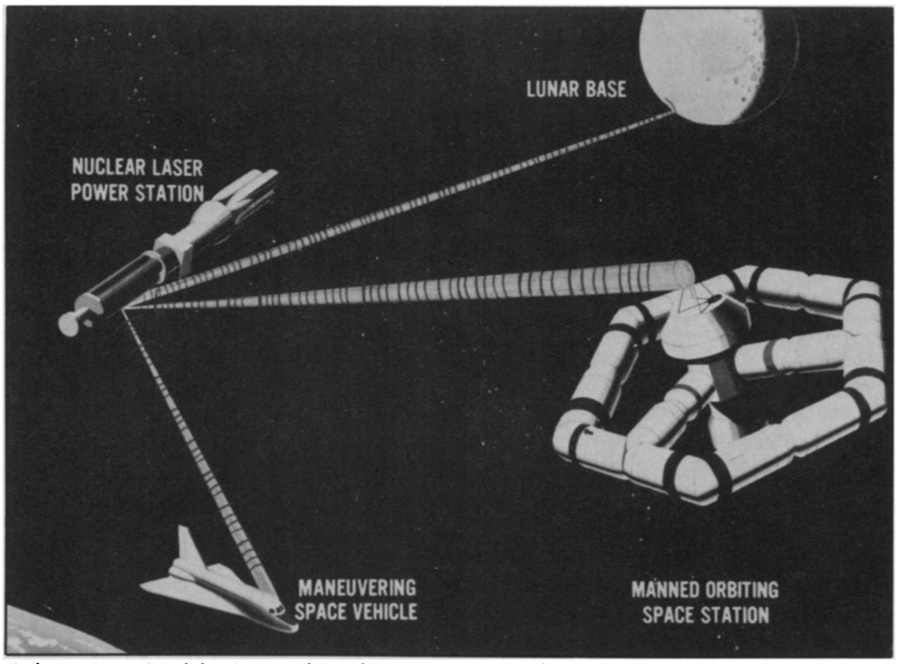

A laser sustained by internal nuclear reaction could provide direct power in space.

Extremely high-powered lasers, with possible applications ranging from shooting down missiles to providing power for space stations, came a step closer to reality last week with a major achievement by a group of National Aeronautics and Space Administration researchers. Their accomplishment was a key milestone in the development of what is called a self-critical, nuclear-pumped laser—a nuclear reactor whose gaseous core literally becomes the laser itself.

A nuclear-pumped laser is one that uses the energy released by nuclear fission, rather than that of an electrical generator, to "pump" or boost the energy in a laser tube until lasing takes place. The first such laser was demonstrated in September 1974 (SN: 10/12/74, p. 229) as part of a NASA-sponsored research program at the Los Alamos Scientific Laboratory in New Mexico, followed about a week later by another at Sandia Laboratories. Until last week, all the tests of such devices had used neutrons from nuclear reactors to bombard a coating of enriched uranium oxide on the inside of the laser tube. The resulting fission energy produced the energy-pumping that caused the lasing.

On May 6, says Frank Hohl of the NASA Langley Research Center in Virginia, his team succeeded in achieving for the first time in a nuclear laser what is known as "volume pumping," a long-sought goal. The problem with uranium coatings on the laser-tube walls has been that all but about 20 percent of the fission energy produced is wasted—absorbed by the tube itself. When the gas pressure in the tube is high, an important avenue to achieving high power, an additional problem shows up in that only the outer part of the gas—the part next to the tube walls—gets pumped.

Volume pumping circumvents both of these ills by producing the fission energy directly in the lasing medium. In last week's test, using a reactor at the U.S. Army's Aberdeen Proving Ground as the "pump," Hohl and his colleagues used a laser tube filled with 90 percent helium 3 and 10 percent argon. Bombarding the helium with neutrons from the reactor produced tritium nuclei and protons, together with enough energy to cause lasing in the argon. Furthermore, says Hohl, the gas mixture was at a pressure of about one atmosphere; since the source of energy (He-3) was thoroughly mixed with the lasing gas, there was no problem of non-uniform pumping.

The next step, in about a month, will be to try volume pumping with more efficient lasing mediums, called excimers, such as xenon fluoride. And then, a couple of months later if all goes well, the stage will be set for the really big step: the introduction of uranium hexafluoride.

Uranium hexafluoride is the gas that is at the heart of a closely related research effort, the gas-core nuclear reactor. Since they do not use the solid fuel rods of conventional nuclear plants, gas-core reactors enable much higher operating temperatures—so much higher, some scientists believe, that they will be able to burn up most of the long-lived waste products that otherwise pose serious disposal problems. The use of UF_6 in the laser tube would mean that the source of the fission energy—in other words, the pump—would be contained within the laser itself. No big electrical generators, not even an external reactor. A neat, self-contained, "self-critical" package.

One difficulty, says Hohl, is that it is hard to make the big UF_6 molecules lase, since they have many transition states which tend to "quench" the lasing action. The alternative is to add a second gas as the lasing medium. In fact, Hohl says, as little as 5 to 10 percent UF_6 mixed with xenon fluoride may be enough to produce a sustained lasing process.

The applied version, probably no sooner than the 1990s, could provide direct power in space to space stations, spacecraft and other recipients using its own, self-generated laser beam. But efficient, high-powered lasers have also been a long-sought goal of weapons developers, so earth-lubbers will be watching too. □

Pain as a passion

Although it's been 2,000 years since Plato and Aristotle described pain as a "passion of the soul," the origins, comings and goings of pain are still largely elusive. This revelation was brought home last week by some of America's leading pain authorities at a Society for Neuroscience Seminar for Science Writers at Airlie House, Va.

The pain researchers agree that pain is an enormous problem for millions of people, and that help is especially needed for patients who suffer excruciating and intractable pain. One of their major leads now for better understanding and combating pain is the recent discovery of pain-relieving molecules that are naturally present in the central nervous system.

True, scientists have made some progress in pinpointing the physiological pathways of pain since they started to study it some 100 years ago, explained Edward R. Perl, a physician and pain researcher at the University of North Carolina School of Medicine. During the latter part of the 19th century, for example, investigators found that the pain message is carried by the sensory nerves. During the early 1900s researchers identified the spinothalamic tract as a major pathway for pain. This tract consists of sensory nerves running up the spinal cord to the brain. Then Perl and co-workers discovered, in the late 1960s, that there are sensory nerves that respond exclusively to pain-producing stimuli, and that these neurons ultimately hook up with the spinothalamic tract. After pain messages pass along these fibers and up the spinothalamic tract, they apparently enter the brain to be processed. But even these nerve pathways aren't the only culprits involved in spiriting the pain message along, said John A. Jane of the University of Virginia School of Medicine.

As a neurosurgeon, Jane deals with