Science & Technology

The advanced status of the x-ray laser

by Charles B. Stevens

In late May, President Reagan's science adviser, Dr. George Keyworth, revealed that beam-weapon missile defenses are much nearer than most people think. In fact, Dr. Keyworth noted that some systems could be developed within three years. The system that has achieved the most rapid rate of progress is that of the thermonuclear powered x-ray laser.

For some time, it has been realized that first-generation x-ray lasers could be deployed by the mid-1980s as an effective shield against some types of missiles. But recent tests, as reported by William Broad in the *New York Times* on May 15, have dramatically shifted this perspective. X-ray laser lenses have been perfected which make "third generation" x-ray lasers a near-term prospect.

As Dr. Lowell Wood of Lawrence Livermore National Laboratory in California told Congress last year before these recently successful tests: "Even more striking prospects are being seriously studied. One contemplates the functional (and perhaps physical) destruction of entire fleets of ICBMs with a single weapon module lofted by a single defensive missile. Each of these primary prospects has significant, albeit early, experimental results behind them at the present time. They are not dreams, nor are the corresponding applications studies naive."

Apparently, scientists working under Dr. Wood have perfected one of these, a lens for focusing x-ray laser beams. This makes the x-ray laser a trillion times "brighter" than the hydrogen bomb and a million times brighter than the Sun. As a result, a single x-ray laser module based on the Moon could destroy a missile being launched from Earth. Alternatively, popped-up into near space, a single module costing a few million dollars could destroy hundreds of offensive missiles.

X-ray optics

The "scientific" critics of President Reagan's program to render offensive nuclear weapons impotent and obsolete, have consistently claimed that high-power x-ray optics are physically impossible. For example, in his report prepared for the Congressional Office of Technology Assessment, "Directed Energy Missile Defense in Space—A Background Paper," Dr. Ashton Carter of MIT claims, "Since x-rays are not back-reflected by any kind of mirror, there is no way to direct the x-rays into a beam with optics like the visible and infrared lasers." Even after Los Alamos National Lab issued an official critique, which pointed out among other things that "experimental x-ray optics have actually been developed," all of the leading critics continued to endorse Dr. Carter's assertions. Now, Livermore scientists have actually demonstrated such optics on a weapon scale.

While the details of the Livermore experiments have been kept top secret, analyses previously published by the Fusion Energy Foundation, as represented in *Beam Defense: An Alternative to Nuclear Destruction*, and Dr. Friedwardt Winterberg's *The Physical Principles of Thermonuclear Explosive Devices*, have detailed many approaches to high-power x-ray optics. In fact, as Dr. Winterberg's 1981 book details, x-ray optics have been the primary means of improving nuclear weapons over the past four decades.

The most likely form of x-ray optics utilized by Livermore is that of a *magnetic plasma lens*. In this case, the x-ray laser beam self-focuses. Self-focusing is a well-observed phenomenon with all high-power lasers. It is found that an intense laser pulse will non-linearly alter the optical characteristics of a medium through which it is propagating, such that the laser pulse is focused. In infrared glass lasers, this self-focusing process must be avoided, since it will destroy the glass laser amplifiers which make up the laser. Recent Livermore experiments on the Novette fusion glass laser showed that the non-linearity of this self-focusing process increases dramatically as the laser is shifted to shorter wavelengths, for example, from one micron infrared to .25 micron ultra-violet. In the case of the x-ray laser with a .0001 micron wavelength, the self-focusing non-linearity should be much, much greater. And it is.

The use of magnetic plasmas as lens material follows from the fact that, unlike any normal material, a plasma can absorb unlimited amounts of energy and maintain its structure. This type of self-organizing process can be seen in a wide range of magnetic fusion devices (spheromaks, reversed field pinches, etc.) and has led one leading fusion researcher, Dr. T. Okhawa, to discuss the possibilities of astromagnetic plasmas as demonstrating some characteristics of living processes.

From the standpoint of Gaussian-Riemannian relativistic physics, the self-focusing of x-ray laser pulses in plasmas is to be expected. Within a dense plasma, the x-ray laser pulse cannot propagate in an ordinary fashion. As a result, it does work on the plasma. In the process, the beam focuses and produces a channel through which it can propagate. This self-induced transparency is a primary form of physical action encountered.

It is clear on this basis that propagation through a substantial portion of the Earth's atmosphere should also be possible.

Practical implications

It is well known that a "diffraction-limited" .0001 x-ray laser has the ultimate potential of achieving about a power brightness 10,000 trillion times that of the Sun—in the range of 10^{40} watts per steradian. What this means is that anything within the cone defined by the laser beam will feel like it is exposed to a star putting out 10,000 trillion times the energy of our Sun. Nuclear weapons primarily generate x-rays at a power of about 10^{20} watts per steradian. Since the Livermore lens has made the x-ray laser a trillion times brighter than the H-bomb and more than a million times brighter than the Sun, an x-ray laser beam could destroy a missile booster from as far away as the Moon. While much harder targets, such as warheads within re-entry vehicles, could be destroyed within a range of one-tenth of this—10,000 miles.

In fact, it is well known in directed-energy theory that the number of targets that a laser weapon can kill increases as the inverse square of the ratio of different ranges. For example, if one x-ray laser module could kill a booster from a 100,000-mile range, theoretically it could destroy 10,000 boosters within a range of 1,000 miles. And as was demonstrated in the case of mobile cannons with grapeshot against infantry two centuries ago, targeting problems rapidly disappear in the face of such gigantic firepower potentials.

In any case, the full-scale targeting and pointing system can be deployed and tested over the coming year or so without the need of any simultaneous test of the x-ray laser itself. In this case, low-power, already-deployed space-based communication lasers would provide an adequate substitute.

Soviet x-ray lasers?

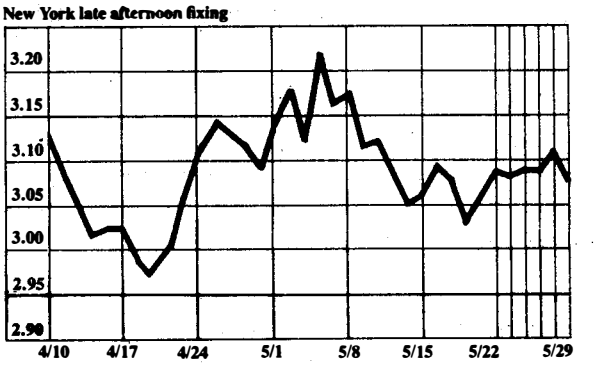
In a recent presentation to the Baltimore Conference on Lasers and Electro-Optics, Dr. Mark J. Eckart reviewed the Livermore experiments which demonstrated a laboratory-scale x-ray laser. At the end of his talk, Dr. Eckart showed the scientific papers which provided the basis for the realization of the Livermore x-ray laser. *Almost all of the papers were done by Soviet scientists.* Dr. Eckart noted that the Soviets have not published many papers on x-ray lasers since 1980, shortly before Livermore was first reported to have demonstrated a bomb-powered x-ray laser.

Most leading experts agree that the Soviet Union has led the world in work on x-ray lasers and has devoted far greater resources than the West. It is virtually inconceivable that the U.S.S.R. would be far behind. There can be little doubt that if the Soviets have perfected the x-ray laser, they will deploy it. (Given the range and demonstrated capabilities of the x-ray, it is almost impossible to detect them before they are utilized.) Therefore, it is most likely that both the United States and U.S.S.R. have within their grasp the capacity to render offensive nuclear weapons impotent and obsolete. Will the U.S.S.R. accept President Reagan's offer "to work together" on this, or will it simply attempt to deploy first and gain an overwhelming superiority?

Currency Rates

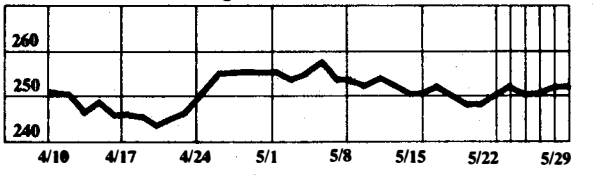
The dollar in deutschemarks

New York late afternoon fixing



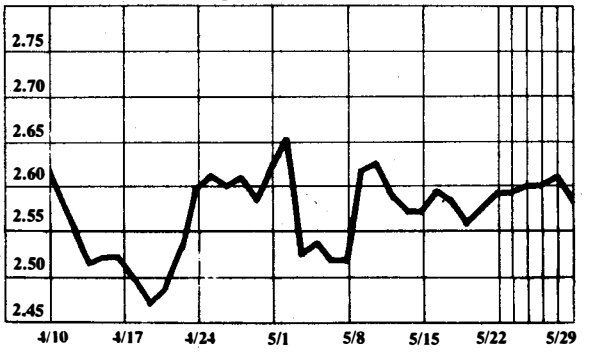
The dollar in yen

New York late afternoon fixing



The dollar in Swiss francs

New York late afternoon fixing



The British pound in dollars

New York late afternoon fixing