Science & Technology

A revolution in the H-bomb x-ray laser

by Charles B. Stevens

Continuing advances on a new approach to realizing x-ray lasers, originally developed by Dr. Charles Rhodes of the University of Illinois, promises to revolutionize H-bomb pumped x-ray lasers for missile defense. This breakthrough promises to increase the overall efficiency of converting H-bomb energy into missile lethal laser-pulses by as much as a million times.

The Rhodes experiments, which have opened up the road to efficient x-ray lasers (xrasers), consist of simply directing high power excimer laser-beams into chambers containing gases. As Rhodes notes, the irradiated gases then produce shorter wavelength radiation at an efficiency above 1%. He also points out that this experimental result appears to be contrary to existing theories on the interaction of radiation with matter.

Rhodes has hypothesized that the input excimer light is absorbed by the gas atom's outer electrons "collectively." That is, the electrons act as though they are free plasma electrons and not bound in an atomic orbit.

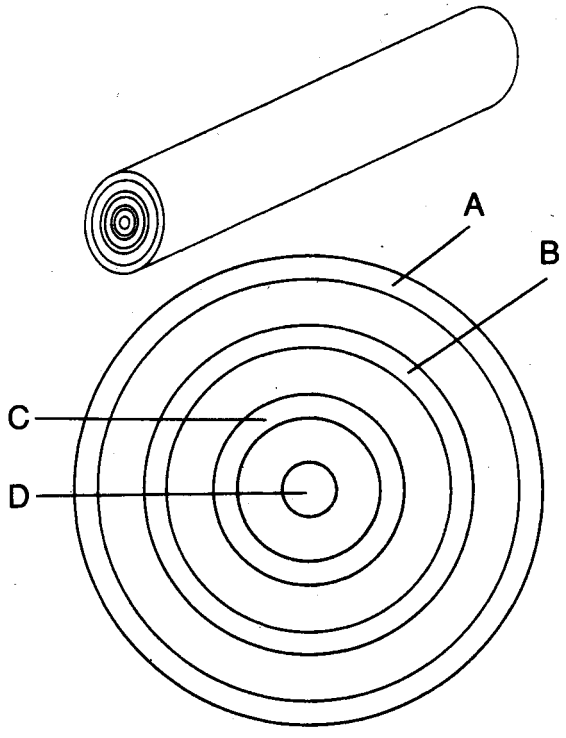
Once this input radiation is collectively absorbed, the outer electrons then apparently excite a higher-energy, inner-orbital electron in the gas atom. This is precisely what is needed for pumping x-ray lasers. But Rhodes has been able to achieve this x-ray laser-type pumping at an efficiency up to one billion times better than existing demonstrated methods.

The overall result is that much more efficient x-ray lasers are possible. Dr. James Ionson, director of the Strategic Defense Initiative Division of Innovative Science and Technology, has been quoted as stating that the Rhodes approach could be fully demonstrated by the end of this summer.

Weapon's implications

When combined with the recent Livermore breakthrough on high-power x-ray optics, this more efficient x-ray laser-pumping scheme of the University of Illinois opens up the near-term prospect of realizing a truly potent anti-missile device: A single nuclear-weapon-pumped x-ray laser module, lofted into space on a single missile, could develop tens of thousands of lethal x-ray laser pulses each of which could destroy a ballistic missile in its boost phase, over a range of thousands of miles. Most significantly, these combined breaking developments open up the possibility of taking a "buckshot" approach to destroying missiles. Instead of pointing each x-ray laser pulse at an individual missile, the aggregate of lethal pulses can be simply aimed in the general direction of a flight of offensive missiles.

For some time it has been known that just as the primary, incoherent x-ray output of a nuclear explosive can be used to directly pump x-ray lasers, it can also be used to pump longer wavelength excimer-type lasers, such as the KrF. This in itself could prove to be an effective anti-missile weapon, since excimer-lasers are as much as 100 million times more efficient than the existing types of x-ray lasers. That is, excimer-lasers convert 100 million times more of the bomb energy into missile-killing laser-beams. But work at the University of Illinois under the direction of Dr. Charles Rhodes is rapidly leading to the possibility of efficient x-ray lasers. And, in fact, the bomb-pumped excimer could be used to produce x-ray lasers at a million times the efficiency of present ones.



These seven concentric circles represent an idealized cross section of a gold x-ray laser (xraser) rod. They define four regions of interest: A—Incident incoherent radiation—optical laser light or bomb-produced soft x-rays—is absorbed and re-emitted in a harder spectrum of x-rays. B—Radiation is absorbed this time deriving from region A. It then re-emits the radiation, but only specific wavelengths (line radiation). C—This is a barrier to hold back the inward propagation of the shock wave deriving from the absorption processes in regions A and B. D—This shows the gold lasing rod, which is irradiated with penetrating hard x-rays.

Contrary to some depictions in the popular media of 6-foot-long metal x-ray lasing rods, the H-bomb pumped xraser (x-ray laser) has dimensions of a hair when lasing. Actually, the xraser is first in the form of a series of hollow cylindrical metal foils which are imploded and pumped by the x-rays from the nuclear explosion. In any case, tens of thouands of these hair-like xrasers can be pumped by a single bomb. But given the assumption that there are no optical means of focusing high energy xraser beams, many of these beams would have to be directed to the same target in order to produce a combined pulse with sufficient intensity to be lethal to a missile in the boost phase. Therefore, as previously projected based on this assumption, only a few score missiles could be destroyed over a distance of a few thousand miles by the xraser bomb. The recent Livermore xraser lens breakthrough has changed all of this.

The plasma lens

As reported in the May 15 *New York Times,* in early May Livermore scientists demonstrated a magnetic plasma lens for focusing the output of xrasers. The result is truly dramatic. The focused xraser beam is a trillion times brighter than a hydrogen bomb, and a million times brighter than the sun. This means that extremely small xraser pulses can be focused to lethal intensities over ranges of thousands of miles. It therefore means that instead of combining pulses, individual pulses can be used to kill missiles in their boost phase. The result is that hundreds of lethal xraser pulses could be produced by a single xraser bomb.

When combined with the breaking Rhodes development, this capability could theoretically be extended to develop millions of lethal pulses. But practical limitations should limit this to only a few tens of thousands.

How it would work

Once an offensive missile launch was detected, xraser bombs would be popped up into near space, as close to the missile fields as possible. While hypervelocity rockets could be used for this, Dr. F. Winterberg of the University of Nevada has suggested that electromagnetic railguns could achieve a faster deployment than this pop-up defense.

Once in near-space, the xraser bomb would be ignited. The x-rays from the nuclear explosion would pump excimer-lasing. This excimer-laser output would then pump xrasers in turn. The xraser pulse outputs would then be focused by magnetic plasma lenses. By simply aiming the entire xraser salvo in the general direction of the offensive missiles, the entire volume of space occupied by the offensive missiles would be filled with tens of thousands of lethal xraser pulses.

By using several xraser bombs from several directions, the missiles would be caught in a devastating crossfire. This buckshot approach immediately overcomes the difficulties of pointing xrasers and plasma lenses. It would do to missiles what Carnot's grapeshot cannons did to massed infantry.

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