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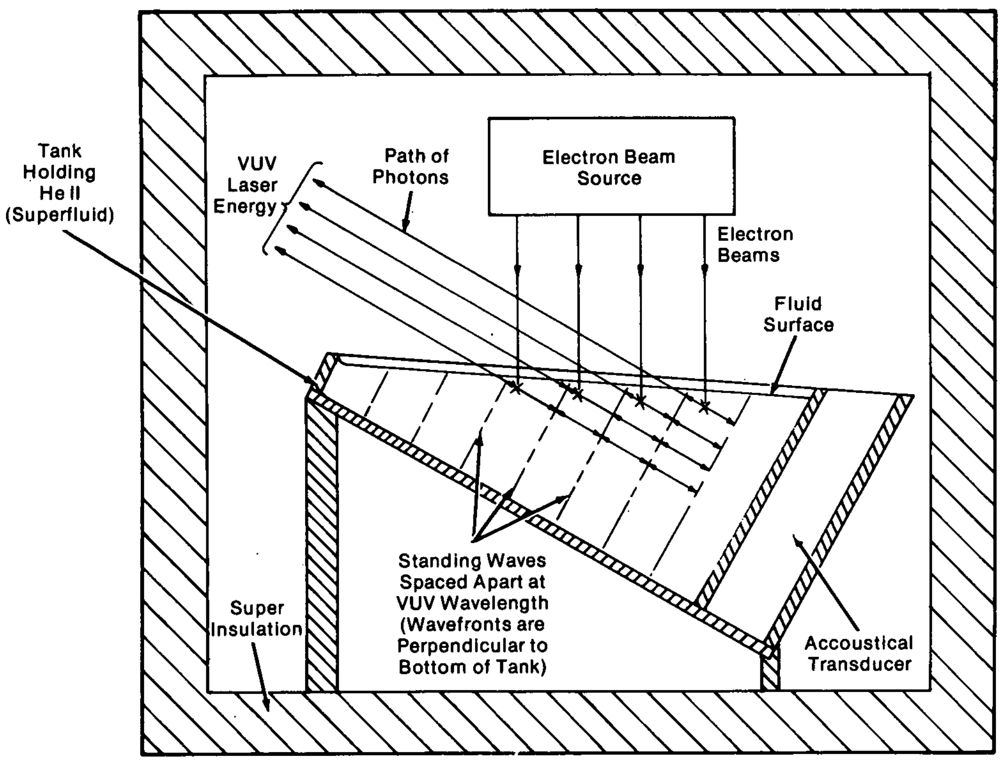
High-Energy Lasers by Using Distributed Reflection: A Concept

A new concept suggests that lasers may be made with higher energy photons than heretofore possible. It has been proposed that vacuum ultraviolet (VUV) lasing can be obtained by bombarding superfluid helium with an electron beam, while coupling acoustic energy into the helium to set up standing waves in the fluid.

VUV radiation is known to be generated when a stream of electrons bombard superfluid helium (He II). The key to this proposed technique is a method of reflecting the generated photons back and forth to produce a coherent beam. Neither mirrors nor any other currently used techniques will reflect photons with wavelengths much lower than 1,700 Å. (VUV radiation is around 800 Å.) This has been the major stumbling block preventing the development of high-energy lasers such as VUV or X-ray.

In the proposed VUV laser, acoustically-induced standing waves with a wavelength fundamentally or harmonically related to the VUV wavelength introduce a spatial periodicity into the optical properties of the helium fluid. This should cause "distributed" reflection of the radiation by Bragg scattering as opposed to the discrete reflection that occurs at mirror



Vacuum-Ultraviolet Laser

(continued overleaf)

surfaces. This method of producing lasing has already been proved in thin-film, solid-state injection lasers.

The standing-wave, helium laser concept is illustrated in the figure. A tilted tank of superfluid helium is contained in a cryostat. An acoustic transducer on one wall of the tank is used to set up the standing waves, and an electron beam source above the tank bombards the helium. The electrons excite metastable states in the helium. Radiation from these states is reflected back and forth between the standing waves, and because of the geometry of the tank, a coherent beam of photons will be emitted from the liquid at an angle 90° from the standing waves. The special periodicity of the fluid may also cause the lasing species in the He II to assume the same periodicity as the acoustic waves. This would result in a self-sustaining, distributed-feedback laser in which the lasing is sustained without the continuous application of acoustic energy.

Several variations to this basic system are possible. For instance, if the electron beam is applied nearly parallel to the He II surface, it may couple directly with the generated laser radiation. The result is amplification such as that which occurs in traveling-wave devices. Also the periodicity could be generated by another laser instead of acoustic waves.

Note:

Requests for further information may be directed to:

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Patent status:

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning non-exclusive or exclusive license for its commercial development should be addressed to:

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