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NEW LIQUID LASER IS DEVELOPED BY HUGHES SCIENTISTS

Emits "Coherent Light" at 13 New-to-Laser Wavelengths; Will Aid Study of Matter

MALIBU, Cal., Dec. 3 -- A new "liquid laser" that will become a valuable tool for studying all of nature's matter has been operated successfully for the first time by scientists at Hughes Aircraft Company, it was announced today.

Using organic liquids, the new laser already has emitted "coherent light" at 13 wavelengths never before available to laser action, opening up "dozens or even hundreds" of new laser wavelengths important to the fundamental understanding of matter, the announcement said. The laser also operates on a new principle never before employed.

"All previous laser action has been obtained only through use of solid materials or gases," Dr. George F. Smith, associate director of Hughes Research Laboratories, explained. "Achievement of liquid laser action in a broad class of organic materials promises dozens or hundreds of new laser wavelengths, thus providing a kind of optical channel selection, or tuning, previously possible only at radio frequencies."

Lasers, an acronym of Light Amplification by Stimulated Emission of Radiation, operate at frequencies 10,000 times as high as the highest radio frequencies, as demonstrated for the first time with a ruby laser by Hughes in May 1960. They produce intense narrow beams of coherent, or pure, light brighter than the sun for such applications as space communications, microwelding and basic physical research.

(more)

The liquid laser, which was developed partially under company funds and partially under Department of Defense support and was first successfully operated in July 1962, may also have important applications to communications, Dr. Smith said, "because when you want to switch from one channel to another, you can accomplish this by simply switching from one liquid to another."

This latest Hughes work in the laser field is described in the current issue of "Physical Review Letters," official publication of the American Physical Society, in a paper written by six company scientists. They are Dr. Eric J. Woodbury of the firm's aerospace group at Culver City, Cal., who discovered laser action in the first member of the new family of laser liquids -- nitrobenzene -- and Drs. Fred J. McClung, Gisela M. Eckhardt, Robert W. Hellwarth, Steven E. Schwarz and Daniel Weiner, all of the company's research labs here, where the experiments were carried out.

The new lasers operate on a new principle -- stimulated "Raman" scattering observed in benzene and in six other organic ring liquids, they explained. Although the Raman effect is well known to physicists, it has never before been involved in laser action.

In the ordinary Raman effect, light is scattered from molecules. The outgoing, or scattered, light has different energy and wavelength than the incoming light, the energy difference having been converted to molecular vibrations.

All previous lasers make use of fluorescence from a long-lived upper energy level of an atom or molecule. In the new laser materials, all of which are known to be strongly "Raman active," there is no upper energy level, and initial excitation of the material to an upper level is not required as in previous lasers. However, very strong incident (or "pump") light is required to initiate laser action. As a consequence, it has proven expedient to "pump" the liquid organic lasers with a high-power short-pulse ruby laser (also called a pulsed-reflector, or Q-spoil laser).

The 13 new wavelengths range from 7430 to 9630 Å (angstroms). The new materials presently include: benzene, nitrobenzene, toluene, one-bromonaphthalene, pyridine, cyclohexane and deuterated benzene.

Evidence of laser action is provided by milli-radian beam divergence, spectral narrowing and measurable threshold. At high pumping levels, as much as one-third of the coherent output from the ruby-organic laser occurs at one of the new wavelengths in some cases.

According to Dr. Smith, the ultimate usefulness of the new Raman lasers must await further research and development.

"Liquid lasers offer substantial advantages for cooling by circulation of the liquid," he said. "Since there are a great number of organic materials which are known to be Raman active, there is considerable promise now of step-tuning by choice of organic material. Whole new classes of wavelengths may also be available using the presently known organic liquids with pumping lasers other than ruby. The availability of a large number of wavelengths, using this approach, is almost certain to provide a valuable set of new tools for the spectroscopic study of matter. The implications for more practical applications are yet to be determined."

Table: Raman-laser wavelengths in angstroms (when pumped by a ruby laser).

Benzene	7456	8053	8819
Nitrobenzene	7658	8540	9630
Toluene	7464		
1-Bromonaphthalene	7672		
Pyridine	7457	8053	
Cyclohexane	8658		
Deuterated benzene	7431	7991	

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