Researchers build an ultrasound version of the laser

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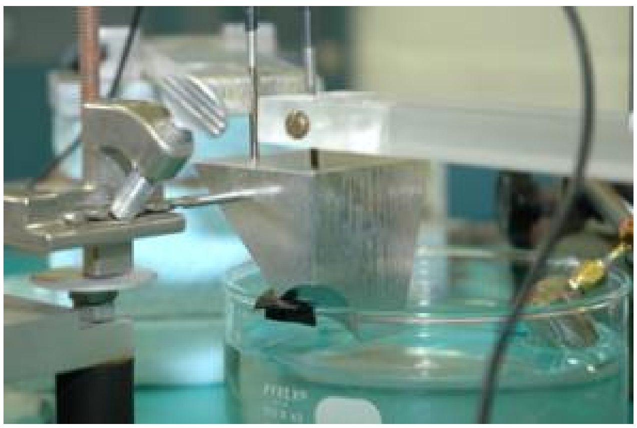

An aluminum block [acoustic cavity] interacts with two electronic auto-oscillator circuits (not shown) via piezoelectric transducers [electro-mechanical 'atoms'] to form a uaser.

Researchers at the University of Illinois at Urbana-Champaign and at the University of Missouri at Rolla have built an ultrasound analogue of the laser.

Called a uaser (pronounced WAY-zer) -- for ultrasound amplification by stimulated emission of radiation -- the instrument produces ultrasonic waves that are coherent and of one frequency, and could be used to study laser dynamics and detect subtle changes, such as phase changes, in modern materials.

"We have demonstrated that the essential nature of a laser can be mimicked by classical mechanics -- not quantum mechanics -- in sound instead of light," said Richard Weaver, a professor of theoretical and applied mechanics at Illinois.

To make a uaser, Weaver, Illinois research associate Oleg Lobkis and Missouri physics professor Alexey Yamilov begin by mounting a number of piezoelectric auto-oscillators to a block of aluminum, which serves as an elastic, acoustic body. When an external acoustic source is applied to the body, the oscillators synchronize to its tone. Like fireflies trapped in a bottle, the oscillators synchronize to the frequency of the source.

In the absence of an external source, the tiny ultrasonic transducers become locked to one another by virtue of their mutual access to the same acoustic system.

"The phases must be correct also," Weaver said. "By carefully designing the transducers, we can assure the correct phases and produce stimulated emission. As a result, the power output scales with the square of the number of oscillators."

The uaser more closely resembles a "random laser" than it does a conventional, highly directional laser, Weaver said. "In principle, however, there is no reason why we shouldn't be able to design a uaser to generate a narrow, highly directional beam."

Optical lasers are useful because of their coherent emission, high intensity and rapid switching. These features are of little value in acoustics, where coherence is the rule and not the exception, intensity is limited by available power, and maximum switching speeds are limited by moderate frequencies.

Nevertheless, uasers may be useful. With their longer wavelengths and more convenient frequencies, uasers could prove useful for modeling and studying laser dynamics. They could also serve as highly sensitive scientific tools for measuring the elastic properties and phase changes of modern materials, such as thin films or high-temperature superconductors.

"Uasers can produce an ultrasonic version of acoustical feedback -- an ultrasonic howl similar to the squeal created when a microphone is placed too close to a speaker," Weaver said. "By slowly changing the temperature while monitoring the ultrasonic feedback frequency, we could precisely measure the phase change in various materials."

Weaver will describe the uaser and present his team's latest experiments at the annual meeting of the Acoustical Society of America, to be held at the Rhode Island Convention Center in Providence, June 5-9.

Source: University of Illinois at Urbana-Champaign