PHYSICS

Hypersonic Sound Waves

Intense waves of sound with the highest frequency ever generated have been produced by bombarding a sapphire crystal from a giant pulse of laser light—By Ann Ewing

➤ THE INVENTOR of the maser and laser, which greatly amplify microwaves and light, has done it again, this time with sound of the highest frequencies ever generated.

Dr. C. H. Townes, provost of Massachusetts Institute of Technology, Cambridge, has found a way to generate intense hypersonic waves in a sapphire crystal by the same kind of "boot-strap" reaction that also works for microwaves and light waves.

Masers are a class of revolutionary new amplifying devices with important applications in communications, detecting radar echoes from planets, and other fields of science and technology.

Lasers give intense bursts of very pure, concentrated light. They have been used as a surgeon's scalpel for delicate eye surgery, to carry telephone conversations and television pictures, and to bounce ruby red light off the moon.

No uses are yet known for the intense hypersonic sound waves. Hypersonic waves are more than five times the speed of sound in air. However, the important fact is that such waves have been generated at all.

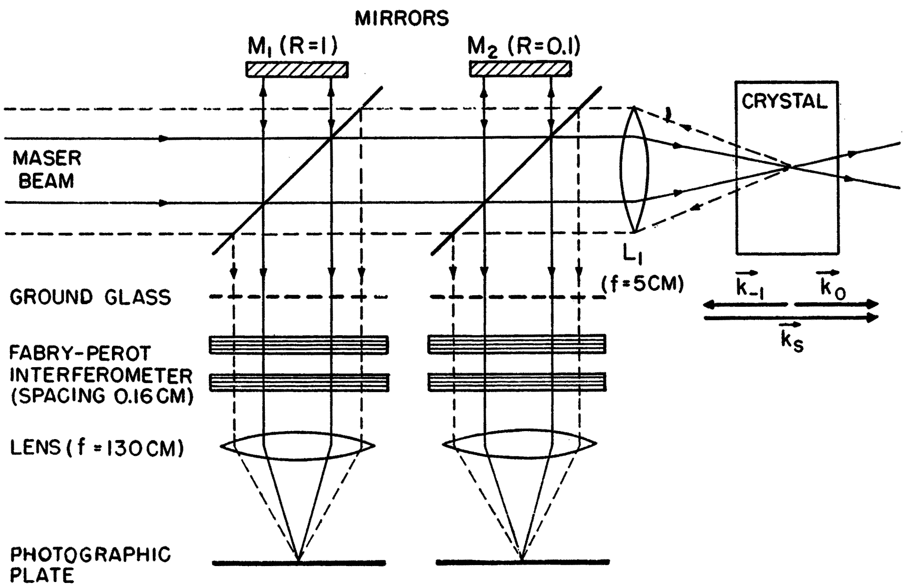
Scientists recently had thought that this could be achieved. Now, Dr. Townes and his co-workers, Raymond Y. Chiao, also of MIT, and Dr. Boris P. Stoicheff, a visiting scientist at MIT from the National Research Council, Ottawa, Canada, have done so.

Details of their experiment were reported in Physical Review Letters, 12:592, 1964.

The hypersonic waves occur because an electric field, such as exists in a light wave, can cause material to contract. When the light is sufficiently intense, this produces a rapid buildup of sound vibrations. In a relatively short time, the acoustic waves can be amplified to such a point that they crack the vibrating material.

Such damage was to be expected from the intense acoustic waves, and the heating that results from their dissipation. However, the scientists say that "at low temperatures, acoustic losses can be much less, threshold power densities much lower, and longer pulses of less intense radiation should result in generation of more moderate amounts and more controlled acoustic waves."

To create hypersonic waves in the sapphire crystal, the scientists bombarded it for 30 billionths of a second with a giant pulse of light at 6,940 angstroms from a ruby laser with a power output of 50 megawatts. When the light struck a sapphire crystal, hypersonic vibrations of 60,000 million cycles per second were produced.



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EXPERIMENTAL ARRANGEMENT—This schematic drawing shows the method by which intense hypersonic waves have been generated in a quartz crystal. The ruby red light of the laser beam is directed at the crystal. The back-scattered radiation was collected by a lens and reflected by two glass-plate beam splitters and mirrors having different reflectivities. The two interferograms photographed simultaneously distinguished clearly between radiation coming from the ruby laser and the hypersonic waves scattered directly backward from the sample

The way in which hypersonic waves travel through solid matter and its effects on matter is one of the problems that interest physicists who study solid state physics. Solid state physics is concerned with the relationship between the thermal, electrical, optical, and mechanical properties of solid matter and its atomic structure.

The work of Dr. Townes and his colleagues should make available a whole new range of hypersonic frequencies, and make it possible to investigate their behavior in many different kinds of solids and liquids.

Hypersonic vibrations have previously been produced by generating a voltage across piezoelectric quartz. These generators cannot be readily used to create vibrations in other materials, however, because hypersonic waves do not travel well between two different materials. The MIT technique should make it possible to generate the sound directly in the material itself.

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ASTROPHYSICS

Orion Nebula Is Astronomical 'Baby'

➤ THE ORION NEBULA, a hazy blur in the heavens visible to the naked eye as a fuzzy patch, is only about 20,000 years old, an astronomical "baby."

The glowing gas cloud is the youngest object to be seen in the skies. The cave paintings of human history and animals were made at about the time the Nebula in the constellation of Orion was born.

The new young age for the Nebula was calculated by Dr. Peter Vandervoort of the University of Chicago. He said that his mathematical model was "in satisfactory agreement" with observations.

Dr. Vandervoort started with simple principles of physics to make his new, relatively simple mathematical model. He used Boyle's Law, which states that the pressure in a gas increases with the temperature, and Newton's Second Law, which states that acceleration is proportional to the force, such as pressure, that acts on a body.

Dr. Vandervoort then calculated the interaction of these forces on a vast scale. He thus found the 20,000-year date for the birth of the Orion Nebula.

The Great Nebula is a glowing gas cloud, extremely thin but so vast that 10,000 stars the size of our sun could be formed from its mass.

Dr. Vandervoort started with recent estimates of the outward motion in the gas cloud, then calculated backward. In this way he found out how long it would have taken, after new stars began to radiate, for the nebulous gas cloud to rush outward to its present dimensions.

He also estimated the effects of turbulence and magnetic fields. His conclusion was that the Orion Nebula is between 14,000 and 23,000 years old. His calculations are reported in the Astrophysical Journal, 139: 869, 1964.

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