Amplify Light Beams

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PHYSICS

Amplify Light Beams

An optical or infrared maser-type device is being investigated. Such a device would amplify light or infrared waves using excited gas molecules.

➤ A NEW ATOMIC method for amplifying light beams by using excited gas molecules in a master-type device is being investigated.

This would mean, in effect, that certain wavelengths of the light from a flashlight could be made very much stronger with the same amount of power through use of such an optical maser. Successful development of the device, now undergoing preliminary laboratory tests, would result in important scientific and military applications.

Dr. C. H. Townes of Columbia University reported his work on optical masers with Dr. A. L. Schawlow of Bell Telephone Laboratories to the American Physical Society meeting in New York.

Solid-state masers, made of ruby and other materials, and gaseous masers, which are already developed, operate in the microwave region of the radio frequencies. The term "maser" stands for "microwave amplification by stimulated emission of radiation." In amplifying a weak signal, masers have the great advantage of adding very little background "noise," equivalent for radio waves to the "snow" seen on television sets.

Masers are therefore coming into use to extend considerably the range of such sensitive detecting equipment as radar or radio telescopes, and in radio communications.

Drs. Townes and Schawlow are now investigating the possibility of an optical or infrared maser, which would amplify light or infrared waves.

An infrared maser would have limited application in detecting objects by the heat waves they emit.

One system being investigated for an infrared maser uses atomic potassium vaporized to its gaseous state. The spontaneous emission should be a few thousandths of a watt of power in a system two and a half inches in width and four inches long, Drs. Townes and Schawlow have calculated.

Instead of using a cavity for the gas molecules as in present-day gaseous masers, Dr. Townes said two parallel reflecting plates could be used.

The scientific applications of an optical or infrared maser are based on the fact that it would give a much more monochromatic light beam than now available. It would also give a much higher effective temperature, or amount of energy, to the beam.

If successfully developd, Dr. Townes said, the amplification obtainable could be 1,000 or more times, the upper limit being the critical adjustments necessary.

The optical maser is the only presently known method for amplifying certain wavelengths of light that reproduces the same wave form as the original exciting wave. Other amplifying devices detect the energy, as a photocell does.

The large increase in monochromatic light expected for the optical maser will give scientists a new method for making length measurements by interferometric techniques. The new masers should also allow measurements of length over much longer distances than now possible. Much higher resolution in spectroscopic studies will be another advantage of the optical masers.

Dr. Townes said he could be "very optimistic and reasonably sure" about predicting the future development of these instruments, since his forecasts were based on calculated properties of the proposed masers.

Dr. Townes also reported a solid-state maser attached to the Naval Research Laboratory's 50-foot radio telescope antenna is being used successfully. With it, radiation from Jupiter had been detected that showed some variation in the planet's temperature apparently associated with large-scale atmospheric disturbances. The planet Venus has been shown not to cool off much during its night, and some new astronomical sources of radiation at 9,000 megacycles have been found.

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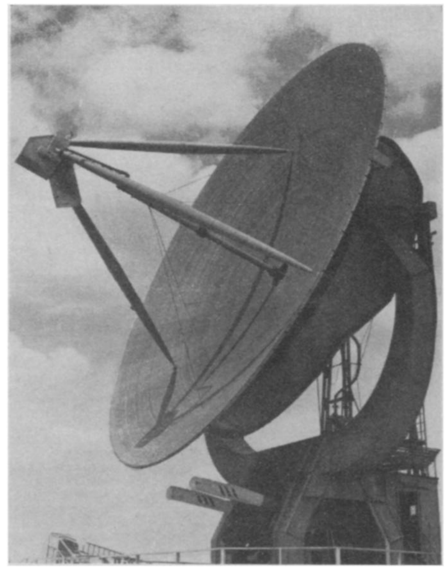

MASER—The solid-state maser shown at the focus of the Naval Research Laboratory's 50-foot radio telescope antenna reflector is being used successfully to detect radiation from Jupiter and Venus. The device is a ten-carat synthetic ruby made to oscillate at microwave frequencies. It increases the range of radio telescopes. (See SNL, May 3, 1958, p. 281 and April 12, 1958, p. 227.)

GEOPHYSICS

Study Radiation Belts

The two recently discovered radiation belts, which might endanger a traveler in outer space, are believed caused by solar particles and cosmic rays.

➤ SOLAR PARTICLES and cosmic rays are the causes of the earth's two distinct radiation belts which threaten man's voyages into space, four University of Maryland physicists reported to the Society.

The outer or "soft" radiation belt, centered some 20,000 miles in space above the equator, is caused by particles from the sun. The second one, called the "hard" radiation belt, is centered about 2,000 miles out and results from cosmic rays smashing into the earth's atmosphere.

Dr. Fred Singer and his co-workers at the University of Maryland believe each belt seems to resemble a giant, invisible "doughnut," deformed to follow the earth's lines of force.

The outer one is considerably more pushed out of shape than the inner belt, but the effect is to give both a set of "horns" turned in toward the earth and centered above the auroral zones in each hemisphere.

Drs. H. Griem and W. M. MacDonald worked with R. C. Wentworth and Dr. Singer in mapping out the shape of the cosmic ray and solar radiation belts.

Dr. Singer suggested a satellite or rocket with a 500-pound payload could be used to inject artificially accelerated particles into the radiation belt region, thus testing experimentally the theory concerning the origin and distribution in space.

The best place for such an experiment with a small linear accelerator of electrons, Dr. Singer calculated, would be from 600 to 1,000 miles above the equator. Particles injected with energies of 2,000,000 electron volts would rapidly spread out within the radiation belt doughnut.

This diffusion would require only a few seconds since the particles move with nearly the speed of light. The particles would then, however, remain trapped within the doughnut, diffusing out of it very slowly.

By studying the number of remaining electrons from day to day, Dr. Singer suggested to the physicists, scientists could learn about the density of the atmosphere in a region of space where densities are normally not measured.

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