study through news items in the Hartford *Courant* (one of the few newspapers that have apparently carried the story) and sought to spread word among other astronomers both by conversation and by letter to *Sky and Telescope*.

One of those to whom Everhart talked, Leo Goldberg of Harvard, is less alarmed, being less convinced that the government is likely to launch satellites. But Goldberg did say that anything that added to background light in the sky could be a source of trouble. Goldberg, who is a member of a NASA advisory committee chaired by C. H. Townes of MIT, informed PHYSICS TODAY that NASA had referred the reflecting-satellite question to the committee for advice. Goldberg expressed the opinion that NASA was proceeding carefully and would take account of scientific advice as the study proceeded.

Another astronomer who is actively watching the project is John W. Findlay of the National Radio Astronomy Observatory. Findlay is chairman of a committee of the Space Sciences Board of the National Academy of Sciences that is charged with a study of the reflecting-satellite project. This committee is the same one that studied the West Ford (space needles) project for the Academy. When PHYSICS TODAY spoke with him, Findley had preliminary information that his committee members were studying. He was sure that the government would coöperate and would consider the opinions of interested scientists and the possible dangers to astronomy before proceeding. Findlay did not expect that his committee would meet before the first of this month and did not feel that the government was rushing the project.

Meanwhile, representatives of NASA at Huntsville, Ala., while confirming existence of the studies, said that they expected preliminary reports from their contractors by the end of November. But at the time of this writing nothing has yet been made public.

Gas and Solid-State Lasers Operate in the Ultraviolet

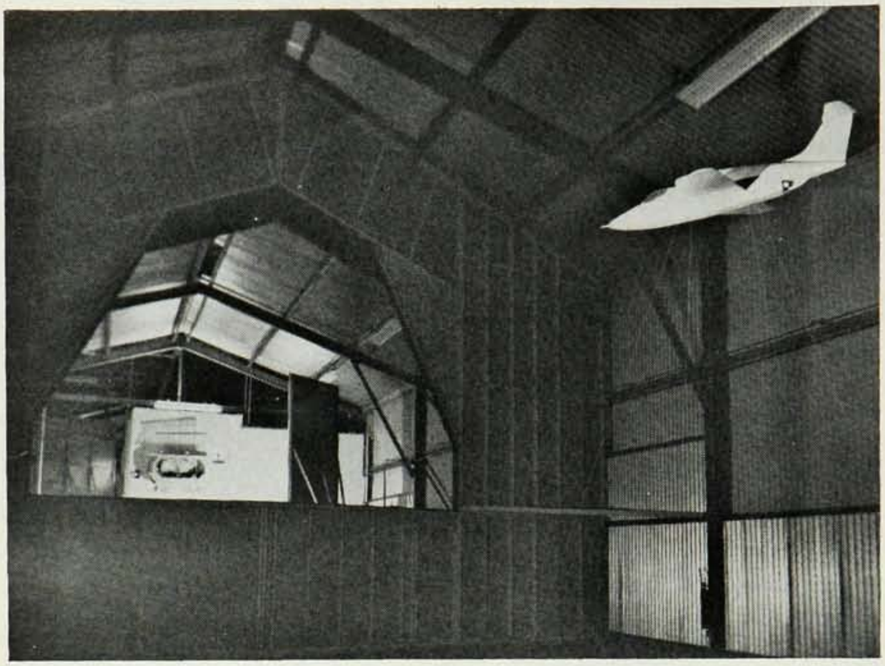
Continuing attempts to discover laser action in short-wavelength regions have succeeded with both gas and solid-state lasers. Roy Paananen of the Raytheon Research Division, Waltham, recently reported that continuously operating uv ionized-gas lasing had been demonstrated over four transitions in three of the noble gases [*Appl. Phys. Letters* **9**, 34, (1966)]. Solid-state semiconductor lasers emitting in the ultraviolet use zinc sulfide and zinc oxide. The zinc-sulfide model made by Charles Hurwitz of the MIT Lincoln Laboratory, has a peak output power of 1.7 W and a power efficiency of 6.5% [*Appl. Phys. Letters* **9**, 116, (1966)]. The zinc-oxide laser reported by Frederick Nicoll of RCA Laboratories, Princeton, although less efficient, is the first solid-state laser to emit in the uv region [*Appl. Phys. Letters* **9**, 13, (1966)].

Gas laser. Uv emission produced by the continuously operating gas laser occurs at 332.4 and 337.8 nm for singly ionized neon and 350.7 and 351.1 nm for doubly ionized krypton and argon, respectively. The laser consists of 26 2.54-cm-long ceramic tubes pressed into aluminum spools to provide mechanical support and cooling. Effective length was approximately 55.9 cm; the end ceramic tubes were tapered to a straight-line approximation of an exponential to avoid violent plasma oscillations at the higher operating current levels.

Before any uv attempts were made, evidence of singly ionized saturation in krypton and argon was examined. With this in hand doubly ionized uv lasing in both these gases was obtained without difficulty.

Singly ionized neon at 0.6 torr provided lasing at 332.4 nm. However, the discharge was accompanied by serious overheating and consequent outgassing of the cathode. Paananen did not find this effect with the heavier noble gases; he plans further investigation.

Zinc-oxide laser. Last May, Nicoll reported uv emission in pulsed operation of an electron-beam pumped zinc-oxide laser at temperatures near that of liquid nitrogen. The zinc-oxide crystals were grown from vapor as plate-



lets parallel to the c axis, and only samples so obtained exhibited uv laser emission. The optical cavity was formed by cleaving two surfaces parallel to the c axis and perpendicular to the grown faces, and the crystals were attached to the copper cold finger in such a way that electron bombardment occurred on the broad grown surface. Samples were bombarded with an electrostatically focused beam pulsed at 0.3 microsec with repetition rate of 700 Hz. Laser threshold was reached at 15 kV and about 3 A/cm^2; efficiency was about 0.1% at 24 kV and 5 A/cm^2. The wavelength of the laser emission is approximately 375.7 nm, corresponding to an observation made by Bernhard Andress [Z. *Physik* **170,** 1 (1962)] which is attributed to recombination of holes and electrons possibly through excitons.

Commenting on Nicoll's work, Henry R. Lewis, director of the Electronic Research Laboratory at RCA, said that the discovery of uv lasing from zinc oxide in single-crystal form is of both scientific and practical importance. Lasers of this kind might be used to produce novel types of television picture and radar displays as well as fast computer printout devices.

Zinc-sulfide laser. One month after the report of zinc-oxide uv lasing, Hurwitz at MIT Lincoln Laboratory succeeded in producing an efficient semiconductor laser using pulsed electron-beam excitation on zinc-sulfide crystals. Crystals grown from vapor were bombarded with an electron beam of approximately 0.5-mm diameter pulsed with 200-ns pulses at a repetition rate of 60 Hz. Hurwitz observed laser emission at both liquid-helium and liquid-nitrogen temperatures. At both temperatures he found several laser lines in the region from 324.5 to 330.0 nm. With 40 keV electrons the laser threshold beam currents were 0.1 A/cm^2 and 0.4 A/cm^2 at liquid-helium and liquid-nitrogen temperatures respectively.

Spectral studies of optical properties of hexagonal zinc sulfide in the region from 320 to 330 nm lack sufficient detail and general agreement to permit identification of optical transitions occurring in the spontaneous and stimulated emission. Hurwitz says that the major spontaneous peaks are probably related to bound exciton states. □