from 10 to 20 feet of sand in areas where unavoidable beam losses will occur. Because the accelerator tunnel could not support the additional load, a concrete arch was built over about half the existing tunnel to carry the extra burden.

A new experimental hall of 50 000 square feet has been added to the East Experimental Area and is now occupied by extensions of the slow external beam system. A new North Experimental Facility is being constructed to serve the new 7-foot cryogenic bubble chamber with a fast extracted beam.

In April the AGS will shut down for three months to connect the linac to the AGS and start injection. A final shutdown is scheduled for early 1972 when remaining modifications are scheduled for completion.

Hydrogen laser holds record for short wavelength

Rodney Hodgson of IBM Research has built the shortest-wavelength laser ever made, making hydrogen lase in the vacuum ultraviolet on eighteen lines between 1520 and 1615 Å, corresponding to photon energies of about 8 eV. Previously the shortest wavelength was 2120 Å, obtained by frequency multiplication of 10 600-Å light from a neodymium-doped glass laser. The new vacuum uv laser is expected to be useful in the study of chemical reactions and the interaction of high-energy photons with matter.

The energy used to drive the laser is stored in a parallel-plate capacitor. Hydrogen gas is contained in a short gap in one electrode. The capacitor is charged to 30 keV, then shorted out, and a very high current flows in the electrodes and through the hydrogen. Electrons collide with hydrogen molecules in the zeroth vibrational level of the electronic ground state, kicking them to various vibrational-rotational sublevels of the first electronic state. One achieves a population inversion with respect to empty high-lying vibrational levels of the electronic ground state.

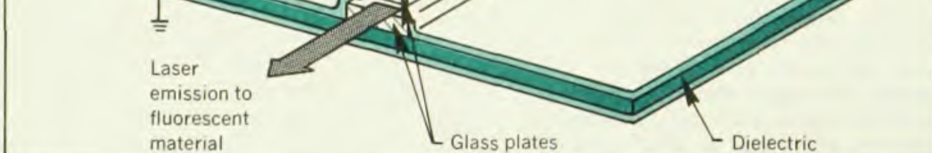
Hodgson reported several laser lines near 1600 Å (*Phys. Rev. Lett.* **25**, 494, 1970) and since then has found lasing in the same range from other diatomic molecules—parahydrogen, deuterium, hydrogen deuteride and carbon monoxide (in the wavelength range 1800–2000 Å). Power output is several kilowatts lasting 2 nanosec. At the Kyoto quantum electronics conference in September John Emmett (Naval Research Laboratory) reported a similar laser in hydrogen with even higher power output.

At the same conference, Yuri Popov and Nikolai Basov of the Lebedev Institute reported using electron-beam pumping of solid xenon, liquid xenon, or both and seeing evidence of laser action in the vicinity of 1760 Å in the vacuum ultraviolet. By extending this work to other condensed rare gases, such as helium or neon, they might get lasing action at about 600 Å.

X-ray lasers? Now that wavelengths of lasers have been so considerably shortened many workers are more hopeful that at least a soft x-ray laser is not too far off. The IBM system, for instance, might be made to lase at 1100 Å some day by populating higher electronic states in molecular hydrogen.

Still just a gleam in the eye is the possibility of a hard x-ray laser. A coherent, controllable source of 2–3 Å would be ideal for solving the phase problem in x-ray crystallographic studies, particularly for complicated biological molecules. Typical proposals for such lasers use very high-power (10^{15} watts) light from an "ordinary" laser, focused down to a very sharp, rising pulse shape (10^{-12} sec). The solid sample then would heat up, giving broad thermal x-ray emission, which would then excite atoms in the solid to produce population inversion involving, for example, K-shell electrons. As the electrons fell back into the K shell they would emit hard x rays.

Now that 8-eV photons are available they offer attractive experimental possibilities because they are energetic enough to break chemical bonds too strong for other available laser energies. For example, the photons can strike a molecular beam, causing the molecules to dissociate, and then one can detect outgoing fragments, their energies and angles in particle-physics fashion. Other possibilities are photoionization studies and biophysical experiments, learning what short wavelengths would do to cellular material. The 1600-Å output could also be used to pump another laser system in order to fill the present gap between 2000 and 3000 Å. (Although some lasing has been observed in this region, the lasers have all been rather special ones.) —GBL



Shortest-wavelength laser uses molecular hydrogen and emits between 1520 and 1615 Å. Laser is expected to be useful for studying chemical reactions and the interaction of high-energy photons with matter. It was built by Rodney Hodgson.

in brief

A room temperature cw semiconductor laser has been built by Izuo Hayashi and Morton Panish of Bell Labs. The 8500-Å laser, which can be driven by a flashlight battery, is a double heterostructure diode composed of four layers of gallium aluminum arsenide alternating with gallium arsenide; the layers are doped with tin, silicon, zinc and germanium. When the device is operated 30% above the threshold of 2700 amps/cm^2, output power is about 20 mW with a power efficiency of 1.5–2.0%.

A proton beam has circulated at the CERN Intersecting Storage Rings for 40 minutes, and a proton stacking procedure was made to operate. A great deal of work remains to complete the ring, refine orbit characteristics and perfect the stacking procedure. The second ring has to be finished and commissioned and then the two operated together. Mid-1971 is the target date for experiments to begin.

The University of Virginia's 40-inch astrometric telescope is being installed at its Fan Mountain Observatory and is expected to be operational by mid-1971. A 32-inch reflector telescope and 10-inch astrograph are also at the observatory. □