# Physical Sciences

*From our reporter at the joint meeting of the American Physical Society and the Optical Society of America in Washington*

## A scannable semiconductor laser

A semiconductor laser that can be scanned in the way the electron beam of a television picture tube scans its phosphor screen has been developed by four scientists working for the 3M Company in St. Paul, Minn. The device consists of an evacuated tube 20 inches long, which contains at one end an electron gun and at the other a special semiconductor laser target.

The target is made from material such as cadmium sulfide. It is a sliver about 25 microns thick with faces polished optically flat and silvered to form the laser cavity mirrors. When electrons strike a point on one face of the target, laser emission comes from the corresponding point on the opposite face. By using magnetic fields the electron beam can be deflected to strike any point on the target. Thus the point of emission will scan over the face of the target. Possible uses range from recording information on microfilm to optically addressing computer memories.

## Hemoglobin's oxygen affinity

A hemoglobin molecule (molecular weight 64,500) consists of four chains of amino acids, two each of the types designated alpha and beta, wrapped up in a ball-like structure. Each chain contains an iron atom. It is to these four irons that oxygen atoms bind for transport from the lungs.

The hemoglobin chains can be separated from one another, and, when this is done, the separate chains show a higher chemical affinity for oxygen than does the whole molecule. Since the electronic state of the iron changes when the oxygen binds to it, the question arose whether the electronic state of the iron was related to the different affinities of the free and bound chains. A group from Columbia University (B. H. Huynh et al) used the Mössbauer effect to find out.

In both the detached and the undetached cases the iron turns out to be in a high spin ferrous ionic state for a range of temperatures between 77 degrees K. and 200 degrees K. This would indicate that the electronic state of the iron has nothing to do with the difference in affinities.

## No low-mass scalar boson

Theorists who favor theories that unite the weak interaction (one of the two kinds of force that operate only on the subatomic level) with the electromagnetic interaction are rejoicing over confirmations of one of its predictions, the existence of so-called neutral weak currents (see page 284 this issue). While they celebrate, they may spare a concern for the continuing failure to confirm another of its predictions, the existence of a new low-mass particle subject to the weak force.

The existence of such a particle could also explain discrepancies between theoretical and measured values of the energy jumps that a muon (another particle subject to the weak force) captured by an atom makes as it gradually loses energy.

D. A. Kohler, J. A. Becker and B. A. Watson of the Lockheed Palo Alto Research Laboratory searched for the production of such a low-mass particle in certain energy transitions of the nuclei of helium 4 and oxygen 16 atoms. They report that they found no evidence for it. The result does not necessarily invalidate the theory. The thing may yet be found in some other reaction.

## Verifying QED at SPEAR

The behavior of electric and magnetic phenomena on the subatomic level is described by the theory of quantum electrodynamics (QED). This theory has been so successful in its predictions that a certain amount of consternation was caused by some recent high-energy experiments that yielded results conflicting with theoretical expectations (SN: 4/20/74, p. 253).

These, however, were experiments in which particles susceptible to the strong force that binds nuclei together as well as to electromagnetic forces were involved, and it is conceivable that some effect of the strong force may have mixed in. At the SPEAR storage ring at the Stanford Linear Accelerator Center an experiment has now been done that tests high-energy QED in purely electromagnetic interactions.

The experiment, reported by E. Barrie Hughes for a team from the High Energy Physics Laboratory of Stanford University, studied collisions of electrons and positrons of 2.6 billion electron-volts energy each in which the particles bounced off each other; in which they annihilated each other to form two photons, and in which they annihilated to form two muons. Hughes reports that the results are consistent with QED theory.

One effect of using higher and higher energies is to test the theory's accuracy to shorter and shorter distances and time intervals. Hughes puts it in this way: For these purely electromagnetic interactions the theory works to distances as small as $5 \times 10^{-15}$ centimeter and times as short as a small multiple of $10^{-25}$ second. The result only adds to a mystery that theory will have to elucidate, assuming all results are correct.

## The size of neutrons and protons

The "size" of an elementary particle is determined effectively by the total cross section, the probability that anything at all will happen when another particle is shot at it. If the impinging particle strikes within the area defined by the cross section, some interaction between the two will take place.

For protons, theorists used to think that the cross section would be somewhat larger than the actual size of the proton when the impinging particle had low energy because of low-energy effects that permitted the proton to control territory beyond its actual size. But at high energy the cross section should reach a constant value and stay there no matter how the energy changed. This is not true according to some experiments done in the last two years at the CERN laboratory in Geneva. Instead the total cross section for the proton, apparently its size, rises with the energy of the incoming particle (SN: 3/17/73, p. 165).

Now experiments done at the National Accelerator Laboratory at Batavia, Ill., confirm that the cross section rises between energies of 100 and 270 billion electron-volts for the impinging particle. This works whether the incoming particle is a proton or a neutron. The NAL results, obtained by a group from the University of Michigan and the Lawrence Berkeley Laboratory (L. W. Jones et al), show that the increase commences at an even lower energy than the CERN researchers estimated. Questions that now confront experimenters are: Is the rise the same for neutrons as for protons? Is it smooth or stepwise and irregular? Answers will help theoretical understanding of the phenomenon.