physical sciences

From our reporter at the joint annual meeting of the Americal Physical Society and the American Association of Physics Teachers last week in San Francisco

Looking for tachyons

For a long time physicists believed that nothing could go faster than light. The special theory of relativity seemed to preclude it. But lately some theoreticians have argued that what the theory excludes is accelerating objects from rest to speeds greater than that of light. Particles that are never at rest and always go faster than light seem to be possible. These have been given the name tachyons and have been the subject of a number of experimental searches (SN: 2/22/69, p. 196).

If tachyons exist, they have a number of startling properties. One is negative energy. It is hard to imagine the meaning of a particle's having less than no energy, but that is what the mathematics says, and it gave Jerome S. Danburg and George R. Kalbfleisch of Brookhaven National Laboratory an idea how to look for tachyons. If an ordinary particle, an electron or a proton, emitted a tachyon, the loss of the negative energy associated with the tachyon would result in a net increase in the positive energy of the emitting particle. That should cause a sudden change in the motion of the emitting particle, a sharp increase of velocity. They examined 5,000 bubble chamber pictures for such events but found none.

Lasers with explosives

To make a laser requires a means of energetically pumping the substance that produces the laser light, lifting it to a higher energy level. From that level it then drops back to its ground level by emitting the radiation that the structure of the laser renders coherent and powerful.

Chemical lasers use the combustion products of gaseous mixtures to provide large quantities of atoms in high-energy states. Explosions yield more energy in less time than combustion, and they can be started from compact samples of liquid or solid fuel. C. P. Robinson, J. A. Sullivan, W. C. Davis and R. J. Jensen of the Los Alamos Scientific Laboratory are collaborating on a project to develop explosive lasers in which the carbon dioxide would produce infrared light at 10.6 microns wavelength. They have found that the other gases can actually benefit the lasing action of the carbon dioxide if they are present in certain proper amounts. The Los Alamos group is going on to try to improve the efficiency of explosive lasers in various configurations and to test other explosive compounds.

Insulators, conductors and specific heats

In crystalline solids measurement of the specific heat at low temperatures can be used to distinguish between electrical insulators and conductors. The presence of free electrons in the conductors adds a component to the specific heat that is not present in insulators where the only source of specific heat is the vibrations of the crystal lattice. So good is the method that specific heat measurements have been used to find out how many free electrons are in a given metal.

Physicists' regard for this neat relationship has been disturbed lately by studies of amorphous solids such as fused silica, which came to prominence in the publicity about the ovonic switch. Although there are no free electrons in fused silica, the specific heat is almost identical to that of a metal (conductor). At the meeting W. A. Phillips of Stanford University suggested an explanation that will save the distinction in the case of crystalline solids. In a crystalline solid the atoms are tightly packed together, but in an amorphous one the packing is loose. Phillips suggests that this looseness gives room for movements on the part of some of the atoms of the material. This has similarities to the motion of free electrons in the metallic conductors and makes a similar contribution to the specific heat.

Metastable molecules and liquid structure

The structures of liquids and the interrelationships of the atoms and molecules that make them up are extremely complex. In the hope of beginning to understand them physicists concentrate on the study of what is supposed to be the simplest liquid, helium. W. A. Fitzsimmons and J. W. Keto of the University of Wisconsin reported that they have found an indicator, or probe, in the form of a metastable molecule by which the microscopic structure of liquid helium can be observed.

A metastable molecule is one that has been raised to an energy level above the ground state and remains there for a long time before losing its added energy (as much as a tenth of a second compared to a millionth for more ordinary excited states). Since they absorb light from beams shined on the liquid, the presence and activity of the metastable molecules can be followed for the information they yield about the surrounding structure of the liquid.

Motion of electrons in conductors

Electrical currents in metals result from the motion of electrons. Two of the most basic qualities that describe the motion of the electrons are the effective mass, which measures how quickly they get started when a driving force is applied, and the damping rate, which measures how fast they stop when the force is shut off or reverses direction.

To measure the effective mass and damping rate of different metals techniques have been developed that depend on resonant absorption of electromagnetic radiation. Experimenters make use of circular motions and absorptions that depend on the two factors.

Many such measurements have been made in the microwave region of the spectrum. For a number of metals the measurements, especially of the damping rates, require infrared frequencies. They are much more difficult to work with than microwaves, but S. J. Allen, L. W. Rupp and P. H. Schmidt of Bell Telephone Laboratories have developed equipment for it and they report the successful measurement of the electron effective mass and damping rate in potassium metal.