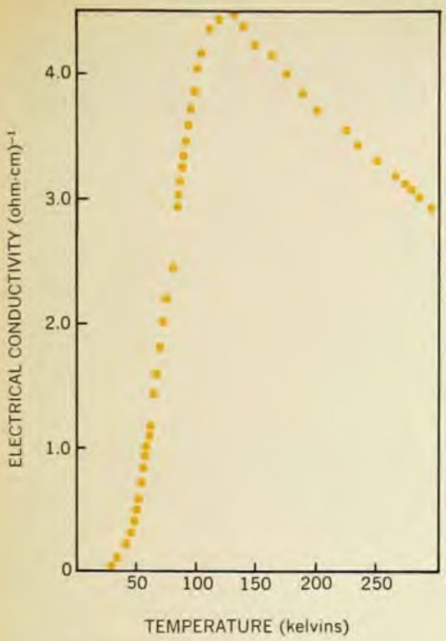

Electrical conductivity along the long axis of a plastically deformed cadmium sulfide crystal shows unexpected rise with decreasing temperature above 125 K, and then an exponential decrease below there.

pseudolinear chains with partially filled electronic energy gaps. He does not propose any model to explain the exact form of the temperature dependence of the conductivity above a temperature of 125 K.

The exponential decrease of conductivity below 125 K suggests to Elbaum a Peierls-type metal–semiconductor transition.[2] Such a transition was predicted for a one-dimensional array of atoms with an initially uniform spacing. As the temperature decreases the spacing may become nonuniform, although still periodic. The decrease in translational symmetry leads to new forbidden gaps in the energy values of the electrons. If such a gap happens to straddle the Fermi energy of the electrons, the system changes from a metallic conductor to a semiconductor. The electrical conductivity should then decrease exponentially below the transition temperature.

Elbaum fit his measurements of the conductivity σ in the z direction to the form

$$\sigma = \sigma_0 \exp(-\Delta/k_B T)$$

where k_B is Boltzmann's constant and T is the temperature. The parameter was found to be 210 ± 5 K. According to the theory of a Peierls transition, the transition temperature T_c should be related to the gap parameter at $T = 0$ K by the equation

$$k_B T_c = 0.57\Delta_0$$

If the experimentally measured Δ is taken to be the gap parameter and $T =$ 125 K to be the transition temperature, Elbaum obtains the relationship

$$k_B T_c = 0.60\Delta$$

The possibility that impurities may account for the observed behavior of cadmium sulfide cannot be ruled out. If impurities, especially metallic ones, tended to become situated on the dislocations, they could give rise to the observed increase in conductivity along the z direction. Although Elbaum feels this possibility is unlikely, he is planning more measurements, taking care to prepare pure samples of cadmium sulfide. He also plans to search for similar behavior in other compound semiconductors which, like cadmium sulfide, have reasonably wide energy gaps. —*Barbara G. Levi*

References

1. C. Elbaum, Phys. Rev. Lett. 32, 378 (1974).
2. R. Peierls, Quantum Theory of Solids, Oxford U.P., London (1953); page 108.

Swiss cyclotron system produces 590-MeV protons

The Swiss Institute for Nuclear Research (SIN) has announced the production of a 590-MeV proton beam from its cyclotron at Villigen. The SIN cyclotron system, composed of two cyclotrons, later produced pions from a thin target. Muon production and polarized-proton beams are anticipated for later this year as experimentation gets underway.

The SIN system. The initial acceleration of protons is accomplished in a Philips injector cyclotron. It is designed to provide 100 microamps of protons at 72 MeV to the ring cyclotron at 50-MHz pulse frequency; it also can provide a variety of ions and polarized beams at different energies to allow for low-energy research. The injector cyclotron produced its first internal beam in August and its first extracted beam of full energy (72 MeV) on 31 December.

The second stage of acceleration occurs in the ring cyclotron where, in January, the first 590-MeV protons were extracted. This broke the previous record of 100-MeV protons for isochronous cyclotrons set at the University of Maryland. The magnetic cyclotron field is provided by eight separate 250-ton magnets installed during 1972. The ring cyclotron receives particles where the orbital radius is 2.05 meters and accelerates them via four rf cavities to a radius of 4.5 meters.

The configuration, with the injector cyclotron outside, allows large box-shaped rf cavities with high accelerating voltages in the ring cyclotron, thereby producing a large energy gain for each turn, well above 2 MeV. This simplifies the extraction process and potentially allows an extraction efficiency above 95%.

Although progress in producing the proton beam was rapid, a few problems were encountered along the way. During early tests, a failure of an rf vacuum feedthrough forced testing to be done with only three of the four rf cavities. When the first beam was produced, the yield from the ring cyclotron was only 4 nanoamps—a tiny fraction of the 1 to 1.5 microamps from the injector and the 0.6 to 0.8 microamps measured after one revolution of the ring cyclotron. A major cause was a faulty mount for a support plate of the pole-face windings. It was repaired, and, when all four cavities operated properly, intensity at the beam stop reached 0.5 microamps.

Pion production. In late February positive pions appeared. The pion channel was set for particles with momentum of 300 ± 3 MeV/c—the rate of production was 3×10^3 positive pions per second, the result of a 30-nanoamp proton beam impinging on a thin carbon target. Later, after adjustment to the injector cyclotron, 300 nanoamps of protons could be provided to the target. The approximate proton-to-pion ratio was one-to-one in a 10-cm^2 cross section of the still untuned beam. In mid-March 1.8 microamps of protons were extracted and used in further pion-beam tests. The SIN pion production comes six months after pions were generated at the Clinton P. Anderson Los Alamos Meson Physics Facility, which yielded a 647-MeV proton beam and is now operating at 800 MeV with a beam current of 2 to 6 microamps with seven channels simultaneously operational.

Experiments at SIN are being set up around the first target area with new experimental areas around a second pion-beam target expected for the fall. Also slated for the fall are two more pion beams and a neutron time-of-flight path. Muon mass production with a superconducting solenoid is scheduled for the same time, and polarized protons are anticipated for the winter. About 50 experiments, mostly from Swiss and German research centers, are in preparation for their first runs.

Daresbury accelerator

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at least 1 part in 10^4.

Estimated capital cost of the new facility is £8 million at current price levels. Funds come from the Science Research Council. This figure includes the accelerator and tower, and experimental hall with space for nine