

with almost no power delivered to the external load (output "zero").

The IBM group has fabricated a number of experimental quiterons with lateral junction dimensions ranging from 2.5 to 7.5 microns, exploiting processes developed for Josephson-junction fabrication. The power gain of the quiteron is given by the ratio of the current densities in the acceptor and injector junctions. Thus it depends only on the tunneling barrier heights and thicknesses, not on their lateral dimensions. Therefore one could presumably reduce the size of the quiteron still further without reducing its gain.

For digital switching in computers one requires clear discrimination of binary states and adequate large-signal power gain so that the output of one quiteron can drive the next in a logic-circuit cascade. The group has shown that with appropriate nonlinear loads the quiteron exhibits inversion, with very sharp threshold values of input current and power above which the output drops abruptly to the zero state—very much like an ordinary transistor. The slope of this sudden drop defines the gain of the device. Thus the group finds current gain factors of 30 to 100 and power gains from 6 to 10 in the large-signal regime of interest for digital applications, with power dissipation levels of 10 to 50 microwatts. Faris expresses confidence that the large-signal characteristics of the quiteron will prove adequate for computer applications. The group has also found comparable gain factors in the small-signal regime appropriate to analog applications.

Faris and his colleagues have demonstrated that the quiteron switching time is at most 300 ps. But this speed determination, he points out, is limited by the room-temperature measuring instruments. He estimates that the true switching speed of these early quiterons is about 50 ps. "These are of course our first experimental devices," he adds. "There is much optimization still to be done." The quiteron has yet to be tested in logic circuits.

In addition to switches, a superconducting computer will also need memory elements. John Clarke (Berkeley) points out that Josephson memory elements have the attractive property of dissipating no power except in transit from one binary state to the other, whereas a quiteron memory would seem to involve continuous power dissipation. One might consider making a hybrid superconducting computer, he suggests, with quiteron switches and Josephson memories.

The physical origin of the quiteron gain can be understood by considering the semiconductor-like energy levels of the two superconducting films adjoining

the acceptor junction. With a bias of less than $\Delta_2 + \Delta_3$ across the barrier, electrons from the filled band below the superconducting gap of the third superconductor (S_3) cannot tunnel into the middle layer (S_2) because the top of the filled band of S_3 lies within the forbidden superconducting gap of S_2 . But as soon as one begins intense injection of quasiparticles across the injector junction into S_2 , its gap begins to shrink, exposing the top of the S_3 filled band to the allowed, unfilled band above the shrinking gap and thus permitting a torrent of current to flow across the acceptor junction.

This scenario illustrates a fundamental difference between quiterons and transistors. In both cases the input signal alters the transport properties of the middle layer (the base in a transistor), but only in the quiteron does the input actually alter the forbidden-gap structure of the material; the semiconductor gap of the transistor base remains fixed, but the superconducting gap in the middle layer of the quiteron is shrunk to zero.

Earlier work. The three-layer, two-junction superconducting configuration exploited by the quiteron is not new. It has been used for some time in experiments investigating the physics of nonequilibrium superconductivity. In 1978, Kenneth Gray, who had been doing such experiments at Argonne, built a "superconducting transistor" of essentially the same configuration as

the quiteron. But the physical mechanism by which it achieves gain is somewhat different. Whereas the quiteron employs intense quasiparticle injection to shrink the S_2 gap to zero by driving it far from equilibrium, Gray's amplification involves a much lower intensity of quasiparticle injection. The middle layer remained close to equilibrium, with very little gap shrinkage.

The acceptor current in Gray's work does not result from the conversion of the acceptor junction to an effective N-I-S barrier. Rather, it achieves current gain by a cyclic process across the acceptor junction in which a single injected quasiparticle initiates the breakup of several Cooper pairs. Although the original device was much slower than the quiteron, Gray believes it could be made significantly faster by using materials with shorter Cooper-pair recombination times. The demonstrated current gain of the original device was limited to the small-signal regime. Gray told us that his device has not yet demonstrated the kind of large-signal power gain and nonlinear switching "that make the quiteron an attractive prospect for computer applications."

—BMS

Reference

1. S. Faris, S. Raider, W. Gallagher, R. Drake, Appl. Superconductivity Conf. Proc., to be published in IEEE Trans. on Magnetics, **MAG19** (1983).

Panel on new particle-physics facilities

A new-facilities subpanel of the High-Energy Physics Advisory Panel has been formed at the request of DOE; it is headed by Stanley Wojcicki of Stanford. The subpanel is to consider and make recommendations for scientific requirements and opportunities for a "forefront" US high-energy physics program in the next five to ten years. It is to make specific recommendations for possible new construction for fiscal year 1985. Specifically, the subpanel is asked to include a definite recommendation concerning the proposed Colliding Beam Accelerator at Brookhaven; a formal proposal was to be ready in April. For its recommendations the subpanel is to make cost estimates and to give relative priorities.

The subpanel met in February and is making visits to Fermilab (23-24 April), Brookhaven (10-12 May) and SLAC (20-22 May). High-energy physicists are invited to express their views to the subpanel at a special session during each of the site visits. In addition Wojcicki has asked for written comments from interested particle phy-

sicists.

The week of 5-11 June the subpanel will meet at Woods Hole to conclude its work. The subpanel's report will be reviewed by HEPAP 29-30 June at its meeting in Washington, and HEPAP will then make comments and recommendations to DOE. In July DOE will make its own decisions concerning the FY 1985 budget request.

The subpanel members are: John Adams (CERN), Thomas Appelquist (Yale), Charles Baltay (Columbia), Mary K. Gaillard (University of California, Berkeley), J. David Jackson (Lawrence Berkeley Laboratory), Denis Keefe (LBL), Arthur Kerman (MIT), Lee Pondrom (University of Wisconsin), John Rees (SLAC), Carlo Rubbia (Harvard and CERN), Frank Sciulli (Columbia), Maury Tigner (Cornell), Sam Treiman (Princeton), John Vander Velde (University of Michigan), H. H. Williams (Penn), Bruce Winstein (University of Chicago) and Wojcicki. The executive secretary is Earle C. Fowler (DOE High-Energy Physics). □