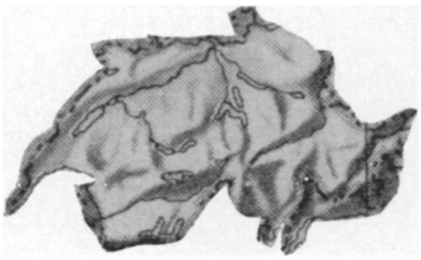
LETTER FROM GENEVA



Quark hunt still fruitless

Latest CERN experiments push the particle closer to the edge of unreality

by H. N. Schwartz

It is a pretty well established piece of scientific folklore that the word quark was invented by James Joyce and applied by a literary-minded physicist to a hypothetical ultra-elementary particle that was introduced into theoretical physics at about the beginning of this decade. The almost meaningless name seems to fit a particle that no one has ever seen and that some doubt exists.

The quark came into physics as a result of physicists' attempts to find some order among the dozens of subatomic particles that had been discovered. They found that if they arranged the known particles in an orderly fashion according to certain characteristics, they came up with certain symmetrical patterns in which each particle had its assigned place, rather like pieces on a chessboard (SN: 2/17/68, p. 158).

The mathematical name of these patterns is Lie groups or unitary symmetry groups. They have been used to predict the existence of new particles: There were places in the patterns where particles should be but none were known to fit. Several have since been found.

Meanwhile, physicists studying the patterns determined that the whole system could be built up by combining, in various ways, the properties of only three ultra-elementary particles. They therefore suggested that these ultra-elementary particles exist, and the name quarks was applied to them.

For years, then—despite the fact that their inventor, Dr. Murray Gell-Mann of the California Institute of Technology, insists that they probably don't exist—physicists have searched for quarks with the diligence of literary scholars searching for meaning in a passage of Joyce, and with about the same result: nothing. The carrot that leads them on is twofold. First, quarks are supposed to be very heavy, so perhaps putting more energy into the experiment will work. Second, free quarks should be extremely rare since theory says they have a high probability of combining with each other to form other particles. Perhaps, therefore, more delicate searching techniques are needed.

The CERN laboratory in Geneva has been one of the world centers of the quark hunt. A group of its physicists has recently done a quark experiment of much greater delicacy than before.

They used the highest energy particles they could get, protons at 27 billion electron volts provided by their proton synchrotron. A stream of the protons was directed against a stationary target. Hopefully, quarks might be made in such a collision.

To find out if they had been, the CERN physicists took advantage of a peculiar quality of the quarks: fractional electric charge. All known subatomic particles that have electric charge have it in the same amount; the unit is usually called one electron charge for handy reference. But to make three quarks add up properly to particles with one unit of charge, the quarks have to have either one-third or two-thirds of an electron charge.

Beyond the target, the CERN physicists set up an electrically and magnetically tuned channel to sort any quarks that might appear out of the rest of the experimental debris. The channel was tuned so that a particle with one unit of charge would have to have more than 30 GeV/c of momentum to go into it. Since the momentum of the original protons was only 27 GeV/c and no more momentum can come out of such a collision than goes in, no particle from the experiment could have that much.

But if a particle should have a fractional charge, the tuning would allow it to come into the channel with a fraction of the momentum. With one-third charge it would need only 10 GeV/c to go into the channel, and such particles could come out of the collision. Fractionally charged particles that were caught by the channel would be delivered to ionization counters. The ionization they caused would be proportional to their charge, and thus the amount of charge could be found out.

Particles with negative and positive charge in one-third and two-thirds amounts were sought, but not found.

From the experiment the CERN staff concludes that the probability (cross section) for quark production is 10^{-39} square centimeters, 100 times as small as previously determined.

Meanwhile, another quark experiment, at the 76-GeV accelerator at Serpukhov in the Soviet Union, also failed to find any. Serpukhov is the world's most powerful accelerator, and this combination of results leaves the CERN staff feeling that quarks are not likely to be found by existing accelerators.

CERN is about to construct a 300-GeV accelerator, and the physicists feel that this will probably be the next weapon to use in the hunt. That is, if the quark theory lasts until it is built—or unless experimentalists accept Dr. Gell-Mann's assertion that quarks are only mathematical, not real.