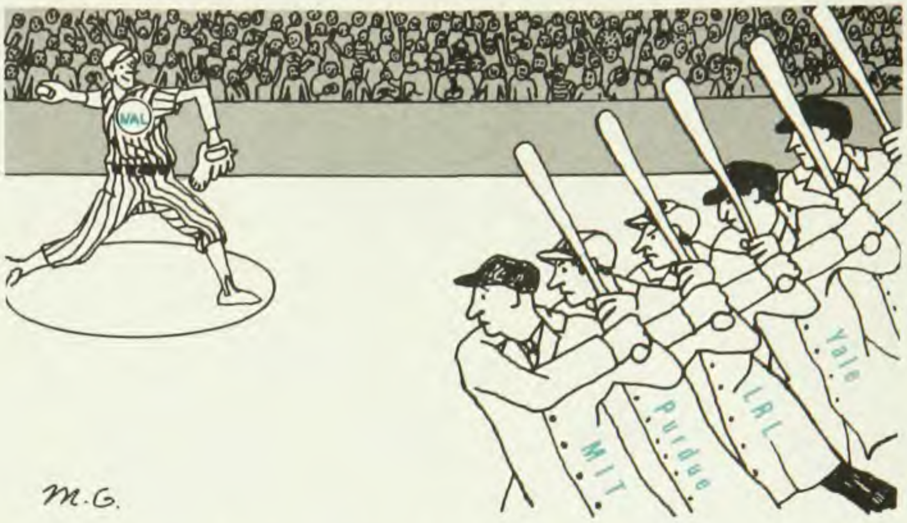

section for a particle hitting a target is the same as for an antiparticle hitting the same target.

Serpukhov experiments show that the π^- total cross section is greater than that for π^+ and may be flattening out. Similarly the K^- cross section is greater than the K^+ and may be flattening out. The Pomeranchuk theorem requires that at still higher energies the π^- and π^+ cross sections would have to converge, as would K^- and K^+.

Prospective NAL experimenters want to use kaon, pion, proton and antiproton beams for total cross-section measurements on proton targets. Pion beams will be available up to approximately the primary proton energy, kaon beams at somewhat less.

Checking the Pomeranchuk theorem will primarily be done with K mesons, Goldwasser said. One kind of proposal would use the highest possible energy beam of $K_L{}^0$, bombard a target with it and look at the emerging beam. Because both $K_L{}^0$ and $K_S{}^0$ can be considered as mixtures of K^0 and $\bar{K}^0$, if these two components have different reaction cross sections with the matter in the target, the outgoing beam will have a different mixture of matter and antimatter—no longer pure $K_L{}^0$. But if the K energy is high enough for the cross sections to be identical the emerging beam will be pure $K_L{}^0$. Goldwasser personally does not believe the energy will be high enough; so there will be some regeneration of $K_S{}^0$. Other experimenters want to try a regeneration experiment at 100 or 150 GeV, measuring phase angles and amplitudes.

Some people are proposing classical electron-machine-type experiments, using beams of electrons or photons produced from neutral pion decay. One could get very close to 500-GeV electrons. Goldwasser noted that "electromagnetic-interaction proposals are not so numerous as strong-interaction proposals. In part this is because fewer machines and fewer physicists have been working in that area." Experiments at NAL could check the validity of quantum electrodynamics at still smaller distances than are possible with SLAC.

Other proposals would like to use muon beams, which are often a better tool for studying electromagnetic interactions than electrons. For one thing, muons don't radiate as readily as electrons because of their larger mass; so radiative corrections, which are often difficult to calculate, are smaller. Experiments are possible that look at charge structure and magnetic structure of the proton. Of course if the muon turns out to be something more than just a heavy electron one may be seeing effects caused by some strange properties of the mu meson, which would have to be sorted out.

A major effort will be on neutrino interactions at high energy, using a 15-foot-diameter hydrogen bubble chamber, which NAL recently started building, and arrays of counters. First-order classical neutrino theory predicts that the neutrino interaction cross section will increase in direct proportion with energy.

Goldwasser commented, "Such an increase in cross section with energy is almost certainly not true, because if it were the cross sections would go to infinity. In fact there are divergences in weak-interaction theory which we hope can be removed theoretically on the basis of NAL experiments." He expects that NAL experiments will find the region in which the cross section ceases to increase, as predicted by first-order theory.

As detection devices, besides the bubble chamber, NAL will have counters, ordinary-sized scintillation counters, spark chambers, wire chambers, and so on. The usual beam-transport systems will be needed, as well as spectrometer magnets for precise momentum analysis, some of which will be built during the next two years.

One of the reasons NAL called for proposals this summer, Goldwasser said, was "to test our ideas about the kind of equipment we might produce against the requirement of real experimenters, who are willing to commit two years of their lives to an experiment, rather than just having us sit back in an arm chair and imagine what experiments might be done."

NAL will try not to commit itself firmly on accepting proposals until the last possible moment, "because physics changes and technology changes," and it does not want to do "an obsolete experiment with obsolescent equipment."

Two Soviet physicists from Serpukhov, Adolph Mukhin and Pavel F. Yermolov, participated in the 1970 summer-study program. Goldwasser says, "We believe that the whole elementary-particle effort is and should be an international one—it's an effort of man, not of Americans or Russians or French." —GBL

US–Soviet collaboration to measure pion charge radius

This month four UCLA physicists hope to arrive at the High-Energy Physics Institute in Serpukhov to participate in the first joint experiment between Soviet and US physicists there. Darrell Drickey will head the US group and Edouard N. Tsyganov heads a group from Dubna. The collaboration will attempt to measure the charge radius of the pion by bombarding electrons with negative pions.

It is generally believed that pions and protons have the same charge radius. Vector-meson dominance predicts an electromagnetic radius of 0.64 fermi. However electron–proton scattering experiments show a radius of 0.81 fermi. Unfortunately the pion does not hold still long enough to be hit with electrons, and one must use the electrons as targets instead to determine pion radius. The Dubna–UCLA experiment will be the first to try determining the radius directly. Drickey says that a measurement of the pion radius would help towards understanding whether this disparity is caused by some peculiarity of the nucleon or to a breakdown of vector dominance.

Hints that the pion might even act like a point particle have been coming from the Frascati electron–positron storage ring, but the experiment on two-pion production is still in an early stage.

In the Serpukhov experiment 50-GeV negative pions will hit electrons in the liquid-hydrogen target, then wire chambers and shower counters will identify the pion and electron and determine their position before and after they enter a magnet (which measures their momenta).

The experimenters hope to determine

the absolute cross section to about 3%. Such precision is needed to distinguish between various theories.

Although CERN physicists have been actively engaged in joint experiments with Soviet scientists at Serpukhov and French physicists are installing the Mirabelle bubble chamber there, negotiations between the Soviet State Committee for the Utilization of Atomic Energy and AEC had lasted for several years. Several preliminary proposals from US experimenters were sent from AEC to Serpukhov.

This spring an exchange of letters between AEC chairman Glenn Seaborg and Andronik M. Petrosyants of the State Committee finally appears to have cleared the way for the first US–Soviet collaboration. NAL had extended an invitation to Soviet physicists to attend NAL's summer study, and Seaborg had categorically agreed that one or more joint US–Soviet experiments could be performed at NAL (although NAL would not promise a specific experiment before receiving a detailed proposal).

Meanwhile some of the Americans proposing experiments had fallen by the wayside, preferring either to wait for the Batavia machine to turn on, or to do an experiment at the CERN Intersecting Storage Rings. But the UCLA–Dubna experiment, which Seaborg specifically suggested to Petrosyants, is particularly convenient for both sides. The Dubna group was already scheduled to start running the experiment in mid-October. And the UCLA participation should improve the accuracy considerably. UCLA will bring over some of the readout electronics, a Hewlett-Packard 2116 B and the associated software to permit on-line operation. The Dubna experimenters will set up the beam, supply the target, wire chambers, shower counters and some readout electronics. —GBL

Second-class currents

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Such a simple description works when there are no strong interactions.

The conserved vector current theory makes the hypothesis that when you switch on the strong interactions the vector component is unaffected. The axial-vector current, however, cannot be conserved. If it were, for example, the ordinary decay of a π^+ into a μ^+ and a neutrino would not occur. So the axial vector component gets multiplied by a factor λ, which results from the strong interaction. λ is the ratio of the axial vector coupling constant g_A to the vector coupling constant g_V and can be experimentally determined (current value is -1.226 ± 0.011).

What can one say from general principles like Lorentz invariance about the form of the Hamiltonian when one introduces the strong interactions? In the limit when momentum transfer is low (much less than the rest mass of the nucleon) the Hamiltonian is:

$$H = [\gamma_\mu(1 + \lambda\gamma_5) + i\sigma_{\mu\nu}(A + B\gamma_5)\,\partial/\partial x_\nu + (C + D\gamma_5)\partial/\partial x_\mu]L_\mu$$

The last four of the six terms are called "induced terms" because they are induced by the strong interaction. The first term and the A and C terms are hadronic vector current terms. Conserved vector current theory says that the first term stays equal to one when the strong interactions are turned on, that A (the weak-magnetism term) is numerically equal to the difference between the anomalous magnetic moments of the neutron and proton, and that C (induced scalar term) is equal to zero. From dispersion relations one can show that D (induced pseudoscalar term) is approximately equal to -0.04. The unknown quantity is B, the induced tensor term.

Confirmation. Conserved vector current theory has had three important confirmations. The theory predicts that the intrinsic decay rate will be the same for all beta decays in which the initial and final spin are zero and there is no parity change. Because there is no change in overall spin, only the vector component is involved. In the eight such transitions known, the rates agree.

Another confirmation is the theory's prediction that the branching ratio for $\pi^+ \rightarrow \pi^0 + e^+ + \nu$ will be $(1.035 \pm 0.005) \times 10^{-8}$. Experiments give a value of $(1.023 \pm 0.069) \times 10^{-8}$.

The third verification was the theory's prediction of a difference between the shape of the beta-decay spctrum for B^{12} and N^{12}. Instead of the "allowed" straight-line behavior, the induced weak-magnetism current produced a bow upwards for one and a bow downwards for the other of the predicted magnitude. While these spectra were being accurately determined, it turned out that the intrinsic decay rates were different, too.

Look in the mirror. In the mean time Steven Weinberg had pointed out that if one studied the mirror pair B^{12} and N^{12} (or other mirror pairs) one might find out something about the induced tensor current. He showed that under the G-parity operation the only terms in the Hamiltonian to change sign are B and C. (The contribution from C would be negligible in beta decay and in any case would be zero under conserved vector current theory.) The terms that changed sign under G parity he called "second-class currents."

In the isobaric triad of mass 12 one can turn the ground state of B^{12} into that of N^{12} by converting two neutrons into two protons in states identical to those of the two neutrons. So under charge symmetry the two nuclei have

NEW f/2 SCHMIDT TELESCOPE at Goddard Space Flight Center is designed for fixed-focus astronomical observations in the presence of changes in ambient temperature. This feature is desirable in photographing comets that are close to sun and can only be observed for short times at dusk and before dawn. Design employs low-expansion CER-VIT rods to maintain spacing between 23-inch CER-VIT primary mirror and focal region assembly. Telescope will also be used to probe solar wind at remote locations by recording orientations of ionized gas components of comet tails. Photo shows comet camera being lowered onto telescope mount.