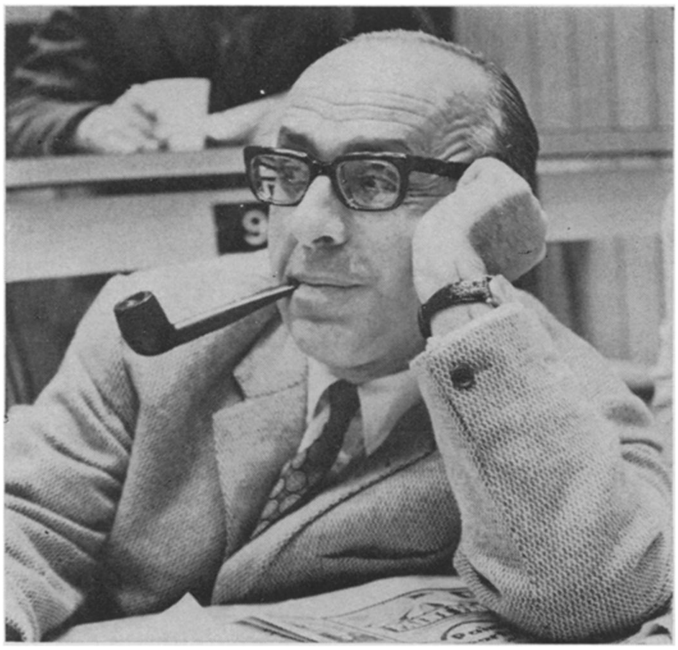
science news
OF THE WEEK

Particles, meet the fields

Slowly but surely, the myriad theories that have evolved to describe a whole microcosmos are combining under a few big umbrellas



Photos: Ray Fisher

Kursunoglu: A broad, new umbrella called G symmetry.

Particles and fields, strong forces and weak, brought together at Coral Gables.

For almost two decades experimental physicists have been discovering a host of subatomic particles whose significance and function in nature have remained a mystery. During the same period theoretical physicists have been trying to construct a comprehensive theory that would explain the nature and behavior of these particles.

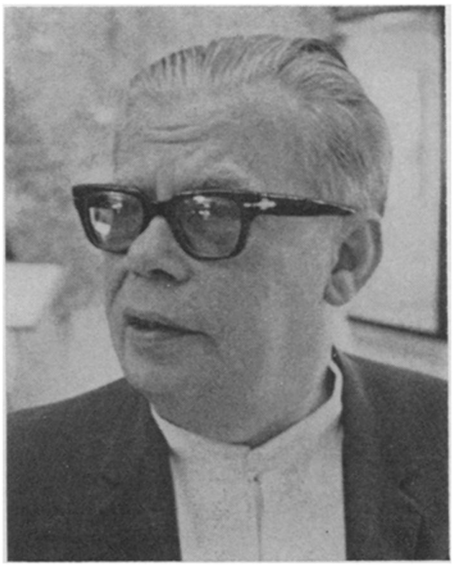
So far, there is no such comprehensive theory. The situation is so complicated—there are more than 100 different particles to deal with—that most effort up to now has concentrated on piecemeal approaches.

Two major approaches are group theory and field theory. For those particles that respond to the strong nuclear force which binds the nucleus of an atom together, group theory has been used; group theories attempt to arrange the particles according to symmetrical geometric patterns that will explain their properties and predict the existence of new ones. For particles that respond to electromagnetic forces and weak subatomic forces, field theories are more effective; they deal more directly with the forces between particles, and in fact treat the particles themselves as mere irregularities in the field over which the forces operate. Thus they attempt to describe the particles' properties and behavior with mathematical equations that take the form of equations of wave motion.

Group theories have received a good deal of attention in recent years. The quark model, which explains strongly interacting particles in terms of smaller, hypothetical sub-particles that make them up, is a typical example of a group theory.

In the last year or so, however, as the situations which group theories tried to describe have grown more complicated, the consequent difficulties of working with the theories have caused them to fall somewhat from vogue. The trend was evident last week at Coral Gables, Fla., where particle theorists meet each year in a Conference on Fundamental Interactions at High Energy to discuss the state of the art. Despite the claimed discovery during the year of a quark in a cosmic-ray experiment (SN: 10/13, p. 198), even the creator of the quark model, Dr. Murray Gell-Mann of the California Institute of Technology, seems to have moved on to somewhat greener theoretical fields.

The tone of disillusionment with group theory was set in the opening talk of the conference by Dr. Nicholas P. Samios of Brookhaven National Laboratory. The prominent features of



Bogoliubov: New and original.

California Institute of Technology
Gell-Mann: Taking Einstein down.

the present collection of strong-force particles can be described by a simple-minded symmetry approach, he says, but better data are needed to see whether it really works. If the situation turns out to be more complex than it now looks, he says, there will be no way to analyze it.

Field theory, on the other hand, was the subject of a number of contributions at the meeting, and many of them were devoted to attempts to connect domains that used to be treated separately. Among these are attempts to bring gravitational fields into particle theory. Though there is no evidence of it, says Dr. Gell-Mann, it is probably safe to assume that the principles of Einstein's gravitational theory can apply in distances so small that "we can use it to talk of particles."

Another place where connection is being sought concerns the interaction between particles that do not respond to the strong force and those that do, as exemplified in the most recent high-energy collision experiments with electron and strong-force particles. Attempts to understand these experiments, says Dr. A. Tavkhelidze of the Joint Institute for Nuclear Research at Dubna in the U.S.S.R., seem to require a thorough revision of the mathematical bases of field theory. He and others who are working on the revisions find that the revised equations turn out to be quite similar to the mathematics being developed by those who, like Dr. Gell-Mann, are trying to apply gravitational theories to the domain of particle physics.

In a more ambitious move to unite group theory and field theory, Dr. Behram Kursunoglu of the University of Miami presented a theory that contains elements of both and has room under its umbrella for all the known particles and many unknown ones. There is room there, he says, both for "things that have been seen and things that have not been seen."

Dr. Kursunoglu was somewhat diffident about presenting his theory, but Dr. Nikolai N. Bogoliubov of Dubna characterizes it as "a new and original approach to understanding the problem of symmetry. Many applications may be expected."

To get what he calls "a master equation for all particles" Dr. Kursunoglu started with the basic equations of the field theory, especially the one for the photon which is basic to the highly successful theory of electromagnetic particles. "To paraphrase a former Secretary of Defense," he says, "what's good enough for photons is good enough for everybody."

These field theory equations, he finds, are compatible with certain symmetrical group-theory patterns which are both larger and more complicated than those used up to now in arranging the strong-force particles. Combining the patterns represented by the different field theories gives Dr. Kursunoglu a master pattern that he calls G symmetry.

Then he proceeds progressively to break the symmetry. Symmetry-breaking has already become a necessity in studies of the strong-force particles, where theorists have found that they had to allow some elements of their pattern to be slightly out of place in order to accommodate the particles as they actually exist.

This more or less regrettable necessity becomes a basic part of Dr. Kursunoglu's theory. By gradually breaking his G symmetry more and more, he predicts the existence and properties of different groups of particles, beginning with the strong-force particles when the pattern is only slightly broken, going to the electron and related particles when the pattern is badly broken and to neutrinos when it is completely broken. Finally the theory predicts particles that have never been observed, including gravitons, whose existence is also predicted by current theories of gravity, and particles associated with a new class of subatomic force not previously encountered in theory or experiment.

For the known particles the theory gives a formula for computing their masses that according to investigation by Dr. Kursunoglu's colleague, Dr. Arnold Perlmutter, is in excellent accord with experiments. So far, says Dr. Perlmutter, the theory does not include the interaction of the particles, that is, their effects on each other. So the next project before Drs. Kursunoglu and Perlmutter is to work the interactions into the theory so that it will predict not only the existence of the particles but also the things that they do to each other. □

PUBLIC POLICY

New broom at FDA

Less than two months ago, Dr. Charles C. Edwards, a one-time Mayo Clinic surgeon turned administrator, assumed the leadership of the U.S. Food and Drug Administration. While declaring, "I am not interested in dwelling on the alleged past failures of this agency," he nevertheless inherited an outfit with a long history of problems with which he must deal.

It is difficult to find anyone who is happy with the FDA.

The drug industry, which must win FDA approval in order to keep its products on the market or to put new ones on, is dissatisfied with the way the agency is implementing the 1962 Kefauver-Harris amendments. These demand proof of efficacy as well as safety for all drugs. In one case, involving the combination antibiotic Panalba, the Upjohn Co. is challenging FDA regulatory procedures in court (SN: 7/26, p. 76).

Not long ago, former commissioner Dr. Herbert L. Ley Jr. testified before the Senate on FDA's position on food additives, including monosodium glutamate and artificial sweeteners (SN: 10/4, p. 295). On the MSG question, he said there was no evidence of harm, only to learn later, from the press, that indications of hazard had been found by his agency's staff. Congress wondered just how FDA operates.

The agency's on-again, off-again attitude toward cyclamates also cast doubt on its operations and caused considerable embarrassment to Health, Education and Welfare Secretary Robert H. Finch. All three issues contributed to HEW's dissatisfaction with FDA, and to Ley's ultimate ouster (SN: 12/13, p. 552).

Within the agency itself, morale is low. FDA scientists do not enjoy the same prestige as other HEW scientists, including those in the Public Health Service and National Institutes of Health, and it is difficult to attract high-level investigators to FDA positions.

Edwards is the fourth man to head FDA in five years. Whether he can cure the agency's ills where others have failed is moot, but in an inaugural address to 100 top FDA staffers recently, he promised a reorganization that would tackle all of the agency's weak spots. Details of the shake-up will be announced shortly, but already the commissioner has indicated some problems he considers worthy of special attention.

One centers around a drug efficacy review completed by the National Academy of Sciences-National Research Council. Scores of products that