Meetings

Theoretical Physics Conference

Current problems in solid-state physics, nuclear physics, gravitational physics, elementary particle physics, and quantum field theory were emphasized in the reviews of these fields which were presented at the third annual Eastern United States Theoretical Physics Conference (College Park, Maryland, 30–31 October 1964).

The opening session, with E. P. Wigner as chairman, dealt with solid-state physics. The first paper was presented by J. R. Schrieffer (University of Pennsylvania) who discussed the current status of strongly coupled electron-phonon systems. He mainly considered Migdal's observation that in computing the electronic self-energy due to phonon interactions one may ignore vertex corrections since they are proportional to the square root of the electron-ion mass ratio. This holds even in the strong coupling case, $g^2 \simeq 1$, and can be extended within the Nambu matrix formulation for the case of superconductors, where one has the additional problem of the attractive phonon interaction leading to bound electron pairs.

Theories of magnetism in metals were reviewed by P. W. Anderson (Bell Telephone Laboratories). It has become apparent that the understanding of metallic ferromagnetism is a challenging problem which combines, in the most drastic way, the effects of band structure with the exchange and correlation of the electrons. The main dichotomy which has to be resolved is represented by two extreme models, the one-electron band theory, and the model in which the *d*-electrons are not itinerant. Recent experiments have proved that neither model can be correct. Several recent theories have attempted to find a middle ground, starting from one of the two extremes.

Two separate topics were considered at the session under the chairmanship of G. Breit. K. A. Brueckner (University of California, La Jolla) discussed the present state of the nuclear many-body problem. This subject is currently in a state of flux. Calculations of the nuclear binding energy with new potentials give results which differ from the experimental value by a larger amount than the earlier calculations. Possible explanations of this result are, first, that phenomenological potentials cannot be extrapolated to regions of energy and momentum outside the range of the scattering data. Second, it is possible that one might find potentials which still fit the scattering data quite well, but which also give a good value for the nuclear matter problem (that is, the phenomenological analysis may contain a degree of freedom in the potential structure which has not been utilized). Third, the basic theory of nuclear matter which was used in the earlier calculations is not valid (the first indication of this was noticed by Bethe, Brandow, and Petschek about 2 years ago). It now seems that the difficulty is with the hard core. One possible resolution is to use a hard core in the S wave only.

J. A Wheeler (Princeton University) discussed the challenging problem of "Gravitational collapse—to what?" The problem of gravitational collapse is certainly a great paradox, the understanding of which could lead to advances in gravitational physics, relativistic cosmology (a collapsing star is a model for the collapse of a universe), elementary particle physics (validity of baryon conservation), and quantum theory (the act of observation is different in a closed universe). For systems of less than 10^{56} baryons, almost any reasonable equation of state will predict a stable equilibrium configuration. But, as the baryon number A increases to about 10^{57} baryons, the gravitational forces overcome the repulsive forces, and the system collapses spontaneously. Smaller systems must be pushed over an energy barrier before they are dense enough for the gravitational collapse to occur. This energy barrier increases at first with decreasing A, but for sufficiently small A it again begins to decrease. This suggests the possibility of tunneling through the barrier for extremely small A. Thus one might expect to see a spontaneous radioactivity due to gravitational collapse.

At the session presided over by C. N. Yang, three invited papers on elementary particle physics were presented. G. Feinberg (Columbia University) reviewed weak interactions. The most interesting experimental result of 1964 in this subject was the discovery of an apparent violation of CP invariance (C, charge reflection; P, parity or spatial reflection) in the decay of neutral K mesons. (In the experiment of Christenson, Cronin, Fitch, and Turley the decay of a beam of neutral K mesons was examined at a distance after the production point corresponding to several hundred mean lives of the short-lived neutral K_1 meson, which decays into two pions. Nevertheless, an appreciable number of events which could most easily be interpreted as a K meson decaying into two pions were observed. The simplest interpretation of this result is that the long-lived K meson, K_2, decays some of the time into two pions, a decay which would be impossible if the weak interactions conserve CP.) Feinberg reviewed the numerous theoretical proposals which have been put forward as a result of this experiment. He concluded that it may be possible to reinterpret the experiment in a manner consistent with CP invariance but that the proposals put forward to date are rather artificial. On the other hand, if one accepts the interpretation in terms of CP violation, the strength of the CP-violating interaction seems to be rather weak compared to the weak interactions, so that one may be dealing with a new kind of interaction which may have other peculiar properties.

S. Coleman (Harvard University) reviewed recent developments in the unitary symmetry of the strong interactions. One of the most interesting features is the regularity with which the SU(3) symmetry is broken by the medium strong interactions. In particular the Gell-Mann–Okubo (GMO) mass formula, which can be obtained

in lowest-order perturbation theory, works much better than one might expect. Coleman also discussed the electromagnetic mass splittings within isotopic multiplets, and the selection rule in strangeness-changing non-leptonic weak decays.

L. A. Radicati (Brookhaven National Laboratory) reported on higher symmetry schemes. The success of SU(3) has stimulated interest in the study of higher symmetry schemes which include SU(3) as a subgroup. Although SU(3) was quite successful in baryon and meson multiplets and the GMO mass formula, a number of questions remain unanswered. The SU(6) group provides the right multiplets, reproduces the GMO mass formula, gives the correct ω-ϕ mixing angle, and the correct ratio of the magnetic moments of the neutron and proton. But it is not consistent with Lorentz invariance.

Relativistic particle theory was discussed at the final session, under the chairmanship of J. R. Oppenheimer. The first paper was given by R. Cutkosky (Carnegie Institute of Technology), who discussed S-matrix theory. He noted first the distinctions between the descriptive aspects of S-matrix theory and constructive S-matrix theory, and between the formal and empirical approaches to S-matrix theory. The formal approach is concerned with proving theorems, while the empirical approach is more directly related to the interpretation of experimental data. In constructing a consistent S-matrix theory one usually starts with particles which have definite masses and which interact with definite coupling constants. In calculating measurable quantities, one has to deal with the symmetries, the dynamics, and the approximations. The most outstanding problem is to find out how these items are interrelated. Cutkosky raised the question whether we can understand the dynamical origin of the symmetries, or whether we must impose the symmetries on the theory.

Recent developments in axiomatic field theory were reviewed by A. S. Wightman (Princeton University). The first part of his talk was concerned with the relations between the four so-called axiomatic approaches to a relativistic quantum theory of matter. Some progress has been made, but much remains to be done. Whatever the relative merits of these four theories, they all suffer from the major defect that there are no nontrivial examples. The second part of Wightman's talk was concerned with the attempts to construct a nontrivial field theory in two-dimensional space-time. However the models studied so far seem to be trivial; that is, they are essentially free fields. This suggests that to solve the existence problem in local field theory, one must tackle directly the ϕ^4 theory.

The final paper was by K. Hepp (Institute for Advanced Study), who presented his proof of the LSZ asymptotic condition for a local field theory. This result proves that, in the framework of the Haag-Ruelle collision theory, the LSZ asymptotic condition can be derived for a dense set of states.

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Micrometeorology

In response to the ever-growing need for the application of micrometeorological information to problems of air pollution, national defense, and agriculture, the first national conference on micrometeorology was held 13–16 October 1964. Sponsored by the American Meteorological Society and held in Salt Lake City, Utah, the conference offered an opportunity for exchange of ideas among scientists in the many disciplines which contribute to micrometeorology, including hydrodynamics, aerodynamics, thermodynamics, and statistics.

The micrometeorologist is concerned with the conditions and operative mechanisms in the lowest hundred meters of the atmosphere which influence the distribution and dispersal of substances in the air. In the case of air pollution, the substance of interest could be industrial waste, vehicle exhaust, or any other product of urban civilization. Defense interests include surveillance systems, materials and weapons testing, and field operations. Especially important are the safety criteria in weapons testing, reactor destructs, and the effects of the highly toxic gases and volatile liquids released during the storage and firing of rockets and missiles. The evaporation and dispersion of water are of primary interest for agriculture and conservation of natural resources.

The basic driving force for all atmospheric motions is solar radiation. The flux divergence between the incoming and outgoing radiation describes the gross temperature fields and, indirectly, the wind structure. These factors and the role of convection in the mass and energy transport in the lower atmosphere were discussed. Some attention at the conference was directed to the evaluation of the radiative equilibrium equations for model atmospheres. J. I. F. King suggested that the usual assumption of isotropy be reconsidered. He proposed a solution of the equations which would eliminate the unrealistic temperature discontinuity at the earth-atmosphere interface.

As in any experimental science, the acquisition of data is of vital importance in micrometeorology. One session of the meeting was devoted to discussion of instrumentation. Since the transport and diffusion of aerosols in the atmosphere depends on the structure of turbulence, that is, on the small-scale variations in the wind and temperature fields, much attention was directed toward the accuracy and response of the instruments used in the laboratory and in the field. Care must be taken that data are not affected by the instrument itself or the tower which supports it. Designs for data-acquisition systems which minimize foreign influence while satisfying the additional requirements of flexibility and mobility were presented, and techniques for rapid processing of the large amounts of data were discussed.

Another session dealt with the evaporation of water from reservoirs and from bare soil and with interactions at the air-water interface. Knowledge of this portion of the hydrologic cycle is vital to studies of water supply for agriculture and human consumption. The meteorologist attacks this problem by measuring and analyzing eddy flux, radiation balance, and evapotranspiration.

A link exists between the macroscale atmospheric motion, which can be forecast with some degree of accuracy, and the microscale motions. This link is the mesoscale, or local, wind circulation. Both horizontal flow fields and vertical wind profiles were examined, and reports were presented on several studies aimed at determining prevalent wind patterns at various sites. The results apply only to the specific