Concepts and trends in particle physics

A. A. Tseĭtlin

Usp. Fiz. Nauk **31**, 533–534 (March 1988)

Concepts and Trends in Particle Physics: Proceedings of the 25th International "Universitätswochen für Kernphysik," Schladming, Austria, February 19–27, 1986/ Eds. H. Latal and H. Mitter, Springer-Verlag, Berlin; Heidelberg; New York; London; Paris; Tokyo, 1987 pp. 325.

The Winter School on the physics of elementary particles held at Schladming in 1986 was celebrating a jubilee—its 25th. As the editors of the proceedings have noted in their introduction the aim of the School when it was founded was to introduce the participants to the principal directions in the development of elementary particle physics by means of lectures given by leading scientists. The principal emphasis at the 25th School was on the theoretical aspects of unitary theories (supersymmetric models of grand unification, the Kaluza-Klein and superstring theories and the standard $SU(3)\times SU(2)\times U(1)$ model.

The proceedings of the School begin with the lectures of M. Blau, W. Thirring and G. Landi devoted to the Kaluza-Klein theories. These theories are based on the assumption that the physical space-time has a dimensionality $D>4$. The nonobservability of the "extra" (D-4) dimensions is explained by their "small size" ("compactification"). Multidimensional theories arise in a natural manner in the course of attempts to unify gravitation with the other fundamental interactions. In the lectures by Blau and others a mathematical apparatus is developed required for the description of Kaluza-Klein theories. The case with $D=5$ is examined in detail, and also the cosmological solutions of the D-dimensional Einstein equations corresponding primarily to the compression or expansion of a part of the spatial dimensions.

The lectures by J. Wess are devoted to an introduction to supersymmetric gauge theories and supergravitation in $D=4$. Quantization of the supersymmetric Yang-Mills theory is the subject of the lecture by W. Kummer. A superfield formalism is used and possible choices of a superfield gauge are analyzed.

Approximately a third of the book is occupied by lectures on superstring theory which at present occupies the center of attention of a considerable fraction of theoreticians. The lectures of G. Veneziano—one of the founders of dual theories—give a historical review of the development of the theories of strings and superstrings in the course of the last 20 years. The covariant quantization of string theories is examined, and also the symmetries existing in the theory. It is emphasized that although superstring theories are practically the only candidate for a consistent quantum theory of all interactions, including gravity, serious technical difficulties stand in the way of arriving at their predictions in the domain of relatively low energies.

The mathematical apparatus utilized in analyzing four-dimensional models corresponding to the low energy approximation in the theory of ten-dimensional superstrings is presented in detail in the lectures of G. C. Segre. It is assumed that the six "extra" dimensions form a compact space. The mathematical properties of this space determine the fundamental characteristics of the four-dimensional model (the number of generations, the gauge group, the types of interactions, etc.). The problem of the existence of a vacuum configuration corresponding to the conformally-invariant sigma-model is examined.

The lectures by R. D. Peccei are devoted to the spectrum of masses in quantum chromodynamics and the standard theory of electroweak interactions. In particular, questions are investigated concerning the masses of particles in the Goldstone sector of QCD, the electromagnetic mass shifts, the values of quark masses, the masses of intermediate bosons, the axion mass, etc.

The lectures of H. Satz analyze the thermodynamic behavior of spin and gauge systems in the presence of a random external field. In particular, it is shown that in the $Z(2)$-spin gauge theory in two dimensions a random field leads to the vanishing of the ordered phase and, as a result, to a shift of the critical dimensionality.

In his lectures "Experiments beyond the limits of the Standard Model" the well-known experimenter L. M. Lederman discusses experiments which can lead to going beyond the framework of the standard $SU(3)\times SU(2)\times U(1)$ model (for example, to answer the questions concerning the stability of the proton, the existence of a fourth generation, the compound nature of quarks and leptons, etc.). The principal characteristics of the existing and future accelerators and detectors are listed. Of the accelerators under design or those under construction only the supercollider (SSC) possesses parameters sufficient for the investigation of energies on the scale of 1 TeV, i.e., for indicating the path towards the unified theory of all the fundamental interactions.

On the whole the book is of considerable interest for persons studying high energy physics, providing an accessible introduction to a number of the fields of investigation that are most popular at the present time.

 0038-5670/88/030285-04$01.80