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PARALLEL SESSION ON LATTICE GAUGE THEORIES

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During these last two years, much progress has been done in the understanding of lattice gauge theories. Introduced in 1974 by Wilson, they use an adequate cut-off procedure allowing expansions around an infinite coupling constant and leading naturally to confinement. Working on a regular lattice rather than in a continuum space, they are quite similar to statistical models; the techniques of statistical physics are therefore applicable and have brought new powerful tools (see Brezin’s plenary report at this conference).

In particular, the discretization has made possible a numerical estimation of the generating functionals, using a direct integration over fields by Monte Carlo technique. Creutz has remarked that asymptotic freedom laws seem to be followed rather soon for moderate inverse couplings. Although this assumption is yet controversial (Bhanot-Dashen paper and contributed paper 457), it allows to extract results in the continuum limit from feasible Monte Carlo simulations. In particular, mass spectra for gauge systems in the confinement region have been measured for the first time, and can be directly compared with experiments. Such measures have been performed for the gluonic states in a pure gauge theory without quarks (see Berg’s review in this parallel session). Techniques for incorporating fermions have also been developed and provide remarkable results on the hadronic spectrum (see Martinelli’s review in this parallel session). The appearance of these computations is probably the most striking feature in the domain of lattice gauge theory for this year, and this is particularly developed in Rebbi’s plenary report.

In parallel with such numerical estimates, more theoretical works have provided a deeper understanding of lattice theories. Strong coupling expansions are now available for glueball masses. One of the possible analytical analysis is based on the mean field approximation and related techniques (collective coordinates, variational estimates, ...). Although it provides a correct phase structure with a reasonably well placed transition point, this method fails by apparently violating the rigorous Elitzur’s theorem, by always predicting a first order transition while some systems (e.g. SU(2) in four dimensions) have no transition (from Monte Carlo simulations), and by giving an incorrect description of U(1) phases. These defects are now cured by a more careful analysis, and corrections to this approximation can be now computed (Saclay and Niels Bohr groups, contributed papers 272,533).

It is expected that some simplifications occur when the number of degrees of freedom of the gauge group grows indefinitely. Eguchi and Kawai have argued that equations for loops are independent of the size of the lattice in this limit and proposed a model with only one lattice site. Many works have appeared on this model and reveal strange and unexpected properties and peculiarities (e.g. contributed paper 295).

Finally the introduction of fermions on the lattice is not an exhausted subject. No-go theorems about the equal number of right and left handed fermions have been proved (contrib. papers 201,202,21). The problem of species doubling may be enlightened in the cарате of Kähler-Dirac equation formalism (648,716). Finally, an analytic treatment using saddle point methods can be applied after Grassman integration over fermions and provide an analytic determination of the hadronic spectrum (359, 725).