Commun. Math. Phys. 92, 369–395 (1984)

Communications in Mathematical Physics

Glueball Spectroscopy in Strongly Coupled Lattice Gauge Theories

Ricardo S. Schor*,**

Max-Planck-Institut für Physik und Astrophysik, Werner-Heisenberg-Institut für Physik, D-8000 München, Federal Republic of Germany

Abstract. We study the mass spectrum up to $-7\,(1-\varepsilon)\log\beta$ of pure three-dimensional lattice gauge theories with action $\beta\sum_P \chi(g_P)$ for real irreducible χ and small β. Besides the lowest excitation $m_0 \sim -4\log\beta$, we find two nearly degenerate excited states m_1, m_2 with $m_i \sim -6\log\beta$ $(i=1,2)$ and (m_1-m_2) at least $O(\beta)$.

1. Introduction

The existence of glueballs within QCD has been predicted already some time ago by Fritzsch and Gell-Mann [1]. They are receiving increasing attention, in the context of lattice gauge theories, since the pioneering work of Kogut et al. [2]. The information concerning the mass spectrum in the lattice case has come mainly from Monte Carlo calculations and strong coupling perturbation expansions. See, e.g. [3, 4] and references given there. Using appropriate selection rules, excited states have been obtained by locating the lowest excitation within each selection sector, but the methods were not suitable to find states with the same quantum numbers.

In two previous publications [5, 6], we started a nonperturbative study of the glueball spectrum in pure gauge lattice models with the Wilson action

$$S_\Lambda = \beta \sum_{P\subset\Lambda} \mathrm{Re}\,\chi(g_P) \tag{1.1}$$

making the simplifying assumption that the character χ is real irreducible and the space-time dimensionality is three (see Sect. 2 for notation). We found isolated one particle states in the full energy-momentum spectrum of the theory, if β is small enough. The particle mass $m_0(\beta)$ has the asymptotic behaviour $m_0(\beta)\sim -4\log\beta$ as $\beta\to 0$ and is the only spectrum (besides the vacuum) up to the threshold $-6(1-\varepsilon)\log\beta$.

* Permanent address: Dep. Fisica ICEX-UFMG, 30000 Belo Horizonte, M.G., Brasil
** Work partially supported by CNPq (Brasil)