Lattice Gauge Theory '86

NATO ASI Series

Advanced Science Institutes Series

A series presenting the results of activities sponsored by the NATO Science Committee, which aims at the dissemination of advanced scientific and technological knowledge, with a view to strengthening links between scientific communities.

The series is published by an international board of publishers in conjunction with the NATO Scientific Affairs Division

A Life Sciences	Plenum Publishing Corporation
B Physics	New York and London
C Mathematical and Physical Sciences	D. Reidel Publishing Company Dordrecht, Boston, and Lancaster
D Behavioral and Social Sciences	Martinus Nijhoff Publishers
E Engineering and Materials Sciences	The Hague, Boston, Dordrecht, and Lancaster
F Computer and Systems Sciences	Springer-Verlag
G Ecological Sciences	Berlin, Heidelberg, New York, London, Paris, and Tokyo
H Cell Biology	

Recent Volumes in this Series

Volume 153—Physics of Strong Fields
edited by W. Greiner

Volume 154—Strongly Coupled Plasma Physics
edited by Forrest J. Rogers and Hugh E. Dewitt

Volume 155—Low-Dimensional Conductors and Superconductors
edited by D. Jérôme and L. G. Caron

Volume 156—Gravitation in Astrophysics: *Cargèse 1986*
edited by B. Carter and J. B. Hartle

Volume 157—The Physics of the Two-Dimensional Electron Gas
edited by J. T. Devreese and F. M. Peters

Volume 158—Physics and Chemistry of Small Clusters
edited by P. Jena, B. K. Rao, and S. N. Khanna

Volume 159—Lattice Gauge Theory '86
edited by Helmut Satz, Isabel Harriy, and Jean Potvin

Series B: Physics

Lattice Gauge Theory '86

Edited by

Helmut Satz

Universität Bielefeld
Bielefeld, Federal Republic of Germany
and Brookhaven National Laboratory
Upton, New York

Isabel Harrity

Jean Potvin

Brookhaven National Laboratory
Upton, New York

Plenum Press

New York and London

Published in cooperation with NATO Scientific Affairs Division

Proceedings of a NATO Advanced Research Workshop entitled
Lattice Gauge Theory 1986,
held September 15–19, 1986,
at Brookhaven National Laboratory, Upton, New York

Library of Congress Cataloging in Publication Data

NATO Advanced Research Workshop on Lattice Gauge Theory (1986: Upton,
N.Y.)

Lattice gauge theory '86.

(NATO ASI series. Series B, Physics; v. 159)

"Proceedings of a NATO Advanced Research Workshop on Lattice Gauge
Theory, 1986, held September 15–19, 1986, at Brookhaven National Laboratory,
Upton, New York"—T.p. verso.

"Published in cooperation with NATO Scientific Affairs Division."

Bibliography: p.

Includes index.

1. Gauge fields (Physics)—Data processing—Congresses. 2. Lattice theory
—Data processing—Congresses. 3. Quantum chromodynamics—Data pro-
cessing—Congresses. 4. Particles (Nuclear physics)—Data process-
ing—Congresses. I. Satz, Helmut. II. Harrity, Isabel. III. Potvin, Jean. IV. North
Atlantic Treaty Organization. Scientific Affairs Division. V. Title. VI. Series.

QC793.3.F5N36 1986 530.1'42 87-12276

ISBN-13: 978-1-4612-9062-9 e-ISBN-13: 978-1-4613-1909-2

DOI: 10.1007/978-1-4613-1909-2

© 1987 Plenum Press, New York

Softcover reprint of the hardcover 1st edition 1987

A Division of Plenum Publishing Corporation

233 Spring Street, New York, N.Y. 10013

All rights reserved

No part of this book may be reproduced, stored in a retrieval system, or transmitted
in any form or by any means, electronic, mechanical, photocopying, microfilming,
recording, or otherwise, without written permission from the Publisher

PREFACE

This volume contains the Proceedings of the International Workshop “Lattice Gauge Theory 1986”, held at Brookhaven National Laboratory, September 15 - 19, 1986. The meeting was the sequel to the one held at Wuppertal in 1985, the Proceedings of which have appeared in the same Plenum series.

During the past few years, a considerable number of meetings on lattice gauge theory have been held, on both sides of the Atlantic. With our workshop, through early planning and coordination with other prospective organizers, we tried to channel this activity into one major yearly meeting. For 1986, these efforts were successful, and it is our hope that a pattern has been set for the coming years. One result, however, was that the number of participants considerably exceeded that normally found at NATO Advanced Research Workshops. This year, a “nucleus” of NATO-supported experts induced a large number of further interested specialists to obtain their own funds – thus greatly amplifying the impact of the event. The topics covered at the workshop ranged from hadron spectra to strong interaction thermodynamics; they included spontaneous symmetry breaking and Higgs models, renormalization group methods, as well as many contributions on various possible schemes for the simulation of dynamical quarks. First systematic applications of finite size scaling to lattice gauge theory were discussed, and the approach to the continuum limit was considered in detail. The workshop also provided the first major status report in the application of the Langevin algorithm in lattice QCD. Last, but not least, it gave a survey of hardware developments, both on the commercial level and in dedicated institutional facilities.

Much progress and much further promise has come out of lattice gauge theory over the past year. The field continues to expand and attract further disciples – certainly in no small part because of the increased availability of supercomputers. Nevertheless, all that has been achieved so far is just a beginning – as was emphasized at the meeting by Nobel Laureate K. Wilson, who started it all and continues to remind us how much further we have to go to reach the standards of condensed matter physics.

A last, but very pleasant task is to express our sincere appreciation for help and support. The sponsorship of the workshop by NATO was decisive in giving the meeting the international scope we had aimed for. The smooth and efficient services of BNL made running it seem like a routine affair, and our Conference Secretary, C. Sheppard, even made sure that no one had to eat lobster at the conference clambake unless he or she really wanted to. Finally, many thanks are due S. Sanielevici (BNL) for help in proofreading the manuscripts; and Timothy Chiu, Eric Myers and Frank Paige (BNL) who wrote the T_EX macros for this Proceedings. They provided invaluable guidance and assistance throughout.

Helmut Satz

Conference Organizers Michael Creutz, Sid Kahana, Helmut Satz and Claudio Rebbi with Ken Wilson (seated right).

CONTENTS

<i>Lattice QCD at Finite Density</i>	1
I.M. Barbour	
<i>Finite Size Scaling and Lattice Gauge Theory</i>	11
B.A. Berg	
<i>Recent Results from the University of California Weak Matrix Element Calculation</i>	13
C. Bernard, T. Draper, G. Hockney and A. Soni	
<i>Finite Density Aggregation</i>	29
G. Bhanot	
<i>Recent Results on MCRG Studies of the $SU(3)$ β-Function and on Quenched Hadron Masses</i>	35
K.C. Bowler	
<i>Feasibility of Lattice QCD Simulations for Weak Decay Processes</i>	47
R.C. Brower, R.C. Giles and K.J.M. Moriarty	
<i>The Columbia Supercomputer Project: Physics Results Present Status and Future Plans</i>	55
N.H. Christ	
<i>Fourier Acceleration and Lattice Gauge Theories</i>	63
C.T.H. Davies	
<i>Properties of the Gluon Plasma Just Above T_c</i>	75
T.A. DeGrand and C.E. DeTar	

<i>Renormalization and Continuum Limit of Composite Operators in Lattice Gauge Theories</i>	91
A. DiGiacomo	
<i>Langevin Simulations with Dynamical Quark Loops</i>	99
M. Fukugita	
<i>On the QCD β-Function</i>	113
R.V. Gavai	
<i>The Propagator Matrix and the Quenched Approximation at Finite Baryonic Density</i>	125
P.E. Gibbs	
<i>The QCD Glueball Mass in the Presence of Dynamical Fermions</i>	135
A. Gocksch	
<i>More on the First Order Chiral Symmetry Transition in QCD</i>	143
R. Gupta	
<i>The Continuum Limit of SU(2) Gauge-Higgs Model</i>	151
A. Hasenfratz	
<i>The Higgs Meson Mass and the Scale of New Physics in the Standard Model</i>	159
P. Hasenfratz	
<i>The Fundamental SU(2) Higgs Model at Finite Temperature</i> . . .	161
U.M. Heller	
<i>Hadron Spectrum on a $16^3 \times 48$ Lattice</i>	169
Y. Iwasaki	
<i>Higgs Phase Transition in the U(1) and SU(2) Lattice Higgs Models</i>	177
J. Jersák	
<i>Thermal Green's Functions of the Energy-Momentum Tensor and Transport Coefficients of the SU(3) Yang-Mills Gas</i>	187
F. Karsch and H.W. Wyld	

<i>Renormalization Flow Structure in Lattice QED</i>	195
C.B. Lang	
<i>The Gluon is Massive: A Lattice Calculation of the Gluon Propagator in the Landau Gauge</i>	211
J.E. Mandula and M. Ogilvie	
<i>New Developments on Order Parameters and Related Problems</i> .	223
M. Marcu	
<i>The Lattice-Regularized Standard Higgs Model</i>	235
I. Montvay	
<i>Continuum Symmetry Restoration in Lattice Models with Staggered Fermions</i>	245
A. Morel	
<i>Towards the Limit of the Quenched Approximation in Hadron Mass Calculations</i>	257
K.-H. Mütter, P.D. De Forcrand, K. Schilling and R. Somer	
<i>Debye Screening and Nonperturbativity in Hot QCD</i>	269
S. Nadkarni	
<i>On the Comparison of String Models with Lattice QCD</i>	277
P. Olesen	
<i>Numerical Studies of Random Surfaces</i>	279
B. Petersson	
<i>Lattice Gauge Fields and Topology</i>	287
A. Phillips and D. Stone	
<i>Chromomagnetic Monopoles</i>	295
J. Polonyi	
<i>Toward a Pseudofermion Calculation of the Hadronic Mass Spectrum</i>	309
J. Potvin, M. Campostrini, K.J.M. Moriarty and C. Rebbi	
<i>Monte Carlo Determination of the Spin-Dependent Potentials</i>	323
C. Rebbi, M. Campostrini and K.J.M. Moriarty	

<i>Baryon Number Conservation in Lattice Gauge Theory</i>	331
K. Redlich and D.E. Miller	
<i>Experimenting with Langevin Lattice QCD</i>	345
S. Sanielevici, R.V. Gavai and J. Potvin	
<i>Kaon Decay Amplitudes using Staggered Fermions</i>	355
S.R. Sharpe	
<i>Microcanonical and Hybrid Simulations of Lattice Quantum ChromoDynamics with Dynamical Fermions</i>	367
D.K. Sinclair	
<i>Pseudoscalar Masses and Index Theorem</i>	377
J. Smit and J.C. Vink	
<i>Scaling Studies of QCD on Asymmetric Lattices</i>	387
H.B. Thacker and J.C. Sexton	
<i>Monte Carlo Investigations of Asymptotic Scaling in QCD</i>	399
D. Toussaint, S.A. Gottlieb, A.D. Kennedy, J. Kuti, S. Meyer, B.J. Pendleton, and R.L. Sugar	
<i>Results on $SU(3)$ Gauge Theory in a Finite Volume</i>	411
P. van Baal	
<i>The GF11 Parallel Computer</i>	419
J. Beetem M. Denneau and D. Weingarten	
<i>Participant List</i>	421
<i>Photograph</i>	425
Round Table Discussion	
<i>Index</i>	427