

Lecture Notes in Physics

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Managing Editor: W. Beiglböck

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Field Theory, Quantum Gravity and Strings

Proceedings of a Seminar Series Held at DAPHE,
Observatoire de Meudon,
and LPTHE, Université Pierre et Marie Curie, Paris,
Between October 1984 and October 1985

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Springer-Verlag
Berlin Heidelberg New York Tokyo

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ISBN 3-540-16452-9 Springer-Verlag Berlin Heidelberg New York Tokyo
ISBN 0-387-16452-9 Springer-Verlag New York Heidelberg Berlin Tokyo

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Printed in Germany

Printing and binding: Beltz Offsetdruck, Hemsbach/Bergstr.
2153/3140-543210

PREFACE

Perhaps the main challenge in theoretical physics today is the quantum unification of all interactions, including gravity. Such a unification is strongly suggested by the beautiful non-Abelian gauge theory of strong, electromagnetic and weak interactions, and, in addition, is required for a conceptual unification of general relativity and quantum theory.

The revival of interest in string theory since 1984 has arisen in this context. Superstring models appear to be candidates for the achievement of such unification. A consistent description of primordial cosmology ($t \lesssim t_{\text{Planck}}$) requires a quantum theory of gravity. Since a full quantum theory of gravity is not yet available, different types of approximations and models are used, in particular, the wave function of the Universe approach and semiclassical treatments of gravity. A nice possibility for a geometrical unification of gravity and gauge theories arises from higher-dimensional theories through dimensional reduction following Kaluza and Klein's proposal. Perturbative schemes are not sufficient to elucidate the physical content of different field theories of interest in different contexts. Exactly solvable theories can be helpful for understanding more realistic models; they can be important in four (or more) dimensions or else as models in the two-dimensional sheet of a string. In addition, the development of powerful methods for solving non-linear problems is of conceptual and practical importance.

A seminar series "Séminaires sur les Équations non-linéaires en théorie des champs" intended to follow current developments in mathematical physics, particularly in the above-mentioned areas, was started in the Paris region in October 1983. The seminars take place alternately at DAPHE-Observatoire de Meudon and LPTHE-Université Pierre et Marie Curie (Paris VI), and they encourage regular meetings between theoretical physicists of different disciplines and a number of mathematicians. Participants come from Paris VI and VII, IHP, ENS, Collège de France, CPT-Marseille, DAPHE-Meudon, IHES and LPTHE-Orsay. The first volume "Non-Linear Equations in Classical and Quantum Field Theory", comprising the twenty-two lectures delivered in this series up to October 1984, has already been published by Springer-Verlag as **Lecture Notes in Physics**, Vol.226. The present volume "Field Theory, Quantum Gravity and Strings" accounts for the next twenty-two lectures delivered up to October 1985.

It is a pleasure to thank all the speakers for accepting our invitations and for their interesting contributions. We thank all the participants for their interest and for their stimulating discussions. We also thank M. Dubois-Violette at Orsay and J.L. Richard at Marseille, and B. Carter and B. Whiting at Meudon for their cooperation and encouragement. We acknowledge Mrs. C. Rosolen and Mrs. D. Lopes for their typing of part of these proceedings.

We particularly thank the Scientific Direction "Mathématiques-Physique de Base" of C.N.R.S. and the "Observatoire de Paris-Meudon" for the financial support which has made this series possible. We extend our appreciation to Springer-Verlag for their cooperation and efficiency in publishing these proceedings and hope that the possibility of making our seminars more widely available in this way will continue in the future.

Paris-Meudon
December 1985

H.J. de Vega
N. Sánchez

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(*) Lecture given by this author