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Book Review

Fluctuating Paths and Fields. *By W. Janke, A. Pelster, H.-J. Schmidt, and M. Bachmann (editors)*, Festschrift Dedicated to Hagen Kleinert on the Occasion of His 60th Birthday. World Scientific, Singapore 2001. ISBN 981-02-4648-X, 872 p., 148 $, 101 Pounds.

This Festschrift celebrates a jubilee in 2001 of Hagen Kleinert, Professor at the Freie Universität Berlin. It presents on 850 pages 67 contributions of 88 authors, arranged in six great parts: I: Path Integrals and Quantum Mechanics. II: Quantum Field Theory. III: Variational Perturbation Theory. IV: Phase Transitions and Critical Phenomena. V: Topological Defects, Strings, and Membranes. VI: Gravitation, Cosmology, and Astrophysics.

The "world-line" of each of the contributors, which include the four editors, crossed Kleinert's "world-line": they are, with a few prominent exceptions, his former or present students, post-docs, coworkers, or colleagues who collaborated with him.

The articles are supplemented by an abstract of the birthday colloquium delivered by the Physics Nobel Laureate Gerard t' Hooft, a preface with background information on Hagen Kleinert's life and work as well as on the development of the fields where he was active, and finally an index of subjects and names which occupies 52 pages. The volume contains a nice photograph of the celebrated person, but does not contain a formal curriculum vitae and not an ordered list of his publications. The reader interested in the latter is referred to Hagen Kleinert's homepage http://www.physik.fu-berlin.de/∼kleinert

He has written the books [1]–[3] and so far more than 300 papers.

It is not possible to consider the contributions in the volume separately; let us give general comments, following the arrangement of the parts.

I. Feynman's path integral is one of the greatest achievements of quantum theory. The discoverer himself regretted that he was not able to solve the problem of the hydrogen atom by means of his new method. Kleinert was inspired by this

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problem and filled, in collaboration with Ismael H. Duru, the gap. His theory of the O(4,2) dynamical symmetry of the hydrogen atom developed with Asim O. Barut was an important basis for this. An essential ingredient was the use of non-holonomic transformations. Subsequently he solved a large number of problems of theoretical physics by means of the path integral method. Part I presents recent advances of this approach, ranging from improved definitions of the functional integral through applications to group spaces, quasi-classical approximations, and semi-classical dynamics to numerical algorithms.

II. The contributions in this part refer to aspects of the standard model (quantum electrodynamics, quantum chromodynamics, ϕ^4-theory, . . .) as well as to non-standard approaches (Kaluza-Klein, superalgebras, non-commutative geometry, neural networks, . . .). Quantum field theory has always occupied a central place in Hagen Kleinert's research.

III. Some papers of H. Kleinert, in collaboration with R. P. Feynman, W. Janke and others, are fundamental for the so-called variational perturbation theory. Part III reviews this method and applies it to a number of problems (anharmonic oscillator, many-body system with a potential, liquid helium, . . .).

IV. This part discusses both general problems of phase transitions and critical phenomena and concrete models (Ginzburg-Landau, Gross-Neveu, . . .). The preface presents additional information on Hagen Kleinert's role in a number of discoveries of the volume: tricritical point in superconductors, new helical texture in He, icosahedral quasisymmetry of cholesteric liquid crystals.

V. Here one finds articles on rather different fields which are held together by the ideas of extended objects (strings and membranes) and topological defects. Kleinert's use of an analogy between real membranes and some surfaces occuring in chromodynamics has led to the famous Polyakov-Kleinert action for extended objects.

VI. The articles in this part deal with Einstein's general relativity as well as with alternative theories, discuss classical as well as quantum gravity. Themes of Einstein's theory here are: black holes, gamma-ray bursts, the renormalization group method applied to inhomogeneous universes, varying light velocity and cosmological effects caused by a ϕ^4 Higgs field. One paper derives the field equations for a metric, a torsion and a Dirac spinor field from an Einstein-like Lagrangian. Another paper discusses the Friedmann cosmological models in a metrical theory with a Lagrangian of the type $L = f(R)$, $R =$ scalar curvature. Yet another paper derives so-called gravitational excitons by dimensional reduction, where the external spacetime and several internal spaces together form a warped-product manifold. Two themes of quantum gravity are discussed in part VI: the use of path integrals and discretization of two-dimensional gravity by means of the Regge calculus. Kleinert's research covered gravitational theory and cosmology, too. He developed theories with torsion by analogy with the treatment of defects in real

crystals, and on semiclassical corrections of Einstein's theory which arise from quantum gravity.

This collection of articles represents an exciting tour through modern theoretical physics; therefore the volume is recommended to a broad readership.

REFERENCES

[1] H. Kleinert: Gauge Fields in Condensed Matter. Vol. I. Superflow and Vortex Lines. Vol. II. Stresses and Defects. World Scientific, Singapore 1989.

[2] H. Kleinert: Path Integrals in Quantum Mechanics, Statistics, and Polymer Physics. World Scientific, Singapore 1990. Second edition 1995. German version: Pfadintegrale in Quantenmechanik, Statistik und Polymerphysik. Wissenschaftsverlag, Mannheim 1993.

[3] H. Kleinert and V. Schulte-Frohlinde: Critical Properties of ϕ^4-Theories. World Scientific, Singapore 2001.

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