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Book Review: *Les Houches 1984, Session 43, Critical Phenomena, Random Systems, Gauge Theory*

Les Houches 1984, Session 43, Critical Phenomena, Random Systems, Gauge Theory. K. Osterwalder and R. Stora, eds., 2 vols., xxxvii + 1199 pp.

"The study of the mathematical structures of models of statistical mechanics near criticality, of random systems and of quantum field theories—especially gauge theories— has been extremely active and fruitful over the last few years.... At present, progress is very fast and this will probably remain one of the liveliest fields of activity in mathematical physics in the near future.

It therefore appeared appropriate ... to organize in Les Houches a session that offered a careful introduction into the major problems, ideas, methods and results of the mathematical physics of critical phenomena, random systems and gauge theories ... [and equipped] students with the necessary knowledge of *physics* and *mathematics* and [guided] them right to the frontiers of current research."

These paragraphs from the editors' preface describe the theme of what seems to have been a very intensive and successful summer school. There were 10 "main courses" and 27 related seminars (some of which are as long as a main course—e.g., the survey of "percolation and random media" by J. T. Chayes and L. Chayes—while others have a one-page abstract only); a list of titles is given at the end of this review. Judging by the titles of the previous summer schools at Les Houches, this one seems to have been more mathematically oriented than most. This supports Fröhlich's claim (see the introduction to his course) "that mathematics and theoretical physics are on *converging trajectories* once again." Whatever one may think about this, it is a fact that today there exist a large group of people, spread over physics, chemistry, and mathematics departments, who are working on rigorous analysis of physical models. Twenty years ago there were very few such people active. In mathematics, especially, functional analysts and probabilists, and more recently topologists, have joined this group, while from the physics side mainly field theorists and classical and statistical mechanicians pursue mathematical rigor.

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In this *summer* school one finds surveys of a large variety of subjects of interest to the above group of scientists. For instance, gauge theory, renormalization groups, all kinds of disordered systems and critical phenomena, and classical mechanics and dynamical systems are among the topics covered by the courses and seminars. As can be expected, there is considerable variability over the courses of mathematical rigor and of physical content. At the mathematical end there are Varadhan's and Gallavotti's lectures on parts of probability theory and mechanics, respectively. It is much harder for the reviewer to say which subjects are closest to "real physics"—perhaps Thouless' course on electrons in disordered systems and Anderson localization and on spin glasses? His comment, "we are still not good at answering the questions experimental physicists put to us," is surely an understatement, though.

Naturally the background required for the various courses and seminars also varies greatly. Some, such as Lanford's course on computers and numerical analysis, are essentially self-contained and can be read with a little effort by anyone. Some courses, such as Fröhlich's, start with a descriptive introduction; Spencer's introduction gives careful definitions. The reviewer, who is essentially illiterate in physics, would have liked to see more such introductions, especially to the courses on gauge theory and renormalization groups. Most courses expect the student to have a decent knowledge of the subject matter already. For the majority of subjects, these two volumes do not appear to be a first place to send a beginning graduate student, but they *do* admirably fulfil the objective stated by the editors: to "guide them right to the frontiers of current research." The printing is excellent, but it is a pity that there was such a long delay between the actual lectures and their publication, even though that is understandable with so many contributors. In active fields, such as percolation, with which the author is familiar, much progress has been made since this summer school; presumably this is also true for several of the other topics. The table of contents is as follows:

Main Courses

Seminars

Improved lattice gauge theory, M. Lüscher
Simplicial quantum gravity, H. W. Hamber
Rigid interfaces, M. Zahradnik
Multiplicative and additive renormalization, J.-P. Eckman and P. Wittwer
The structure of renormalization theory: renormalization, form factors and resummations in scalar field theory, G. Gallavotti
Bounds on Euclidean Feynman graphs, J. Feldman, J. Magnen, V. Rivasseau, and R. Sénéor
Canonical perturbation theory for Anosov diffeomorphisms, R. de la Llave, J. M. Marco, and R. Moriyon
Invariant manifolds of complex analytic mappings near fixed points, J. Pöschel
Stochastic processes on fibre bundles, C. de Witt–Morette
The local Atiyah–Singer index theorem, E. Getzler
Anderson transition and nonlinear σ-model, F. Wegner
Density of states in lowest Landau level and supersymmetry, F. Wegner
The classification of critical exponents in two dimensions; The supersymmetric Kosterlitz–Thouless phase transition, M. Doria
Instability of tunneling and the concept of molecular structure in quantum mechanics: The case of pyramidal molecules and the enantiomer problem, P. Claverie and G. Jona–Lasinio
Translation symmetry breaking in Z_N lattice gauge theories as a random surface problem—A brief summery, C. Borgs
Random surface representation of $U(\infty)$ lattice gauge theory, I. K. Kostov
Pure and random models of statistical mechanics on hierarchical lattices, B. Derrida
Percolation and random media, J. T. Chayes and L. Chayes
Study of a spin glass model, A. Martin
Some results on spin-glass models, A. C. D. van Enter
Equilibrium and nonequilibrium theory of a geometric long-range spin glass, T. Eisele
Replica symmetry breaking in Ising and quadrupolar glasses, P. Goldhart
The Ising model in a random field: Long-range order in three dimensions, J. Z. Imbrie
Level repulsion in chaotic time-dependent systems, M. Feingold
The density of states of random Schrödinger oprators, R. Maier
A quantum particle in a hierarchical potential: A first step towards the analysis of complex quantum systems, F. Martinelli

Harry Kesten
Department of Mathematics
Cornell University
Ithaca, New York 14853

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