PART III

THE PHYSICS OF QUANTUM FIELDS

Part III concentrates on properties of the solutions, i.e., on the physics of quantum fields and of statistical mechanics. The individual chapters may be read independently, though the material here is less complete and is written at a more advanced level than Parts I and II. We begin with a discussion of the particle interpretation of field theory: the scattering matrix, the bound state spectrum, and the asymptotic completeness question. In Chapter 16 we present a complete proof of the existence of phase transitions for ϕ^4 quantum fields. We follow this with a report in Chapter 17 on the state of knowledge of the ϕ^4 critical point. In Chapter 18 we give a second existence proof for $d = 2$ quantum fields. Here we use expansion methods (cluster expansions) to analyze the infinite volume limit. Within their domain of convergence these expansions not only provide an alternative to the multiple reflection bounds of Part II, but in addition they establish exponential clustering of correlations and thereby reveal properties of the mass spectrum. In principle these expansions allow a complete understanding of the low-lying energy states of the theory. In Chapter 19 we establish the connection between Minkowski and Euclidean fields which was stated in Chapter 6. One aspect of this discussion shows the relation between multiple vacuum states in quantum theory and the decomposition of an equilibrium statistical mechanics state into its pure phases. In fact, the results of Chapters 16–19 also pertain to properties of equilibrium states and the transfer matrix in statistical physics, as described in these chapters. Chapter 23 provides an introduction to the literature for major issues outside the scope of this book.