INTRODUCTION

In electron correlations the Luttinger model plays a role somewhat analogous to that of the Ising model in the field of spin-spin interactions, as it is the simplest model displaying a number of intriguing and remarkable many body effects which are extremely difficult to analytically understand in more realistic systems. Introduced almost half-century ago by J. M. Luttinger in a paper named “An Exactly Soluble Model of a Many-Fermion System” and published in *J. Math. Phys.* **4** 1154 (1963), it has attracted since then an enormous and still increasing interest. The present volume celebrates the five decades of the impact of the Luttinger model presenting a number of papers constituting a comprehensive and updated introduction to the subject, from the main historical achievements to the more modern research lines.

The Luttinger model owes its solvability to a number of peculiar features, like the absence of a lattice and the presence of linear “relativistic” dispersion relation, which allow an exact solution by bosonization. The contribution of *D. C. Mattis* in this volume reviews the main features of the Luttinger model solution (found in 1965 by *Mattis* himself in collaboration with E. H. Lieb) and extends the Luttinger model to fermions with non constant velocity.

In more realistic models there is no exact solution, the reason being that the transmutations of interacting fermions to free bosons which is possible in the Luttinger model, ceases to be valid. Nevertheless according to the Luttinger liquid conjecture, formulated by D. M. Haldane (*Phys. Rev. Lett.* **45**, 1358 (1980)), a number of features of the Luttinger model remains valid in a class of systems called Luttinger liquids. This manifestation of universality allows the use of the Luttinger model for the explanation of a number of phenomena described by systems apparently quite different from it. This property is however far from trivial, from a theoretical point of view. As explained in the review by *J. Sirker*, the Luttinger liquid conjecture can be partially tested in integrable models like the XXZ chain which can be solved by Bethe ansatz, and information on transport can be obtained. In the absence of exact solutions, a mathematical proof of several aspects of the Luttinger liquid conjecture can be achieved in generic lattice one dimensional fermionic systems by using the methods of Constructive Quantum Field Theory and Renormalization Group, as reviewed by *V. Mastropietro*. While this is true for the static thermodynamic properties, the dynamic properties of the Luttinger model appear to differ from those of fermions on one dimensional lattices, a topic that is explored in the contribution by *L. Pereira*.

Experimental physical realization of Luttinger liquid behavior can occur in several systems. The contribution by *A. Del Maestro* investigates the possibility of realizing Luttinger liquid behavior in Helium-4 nanopores, while the paper of *O. Ciftja* explains the Luttinger liquid description of quantum Hall edges states. A review of the experimental evidence of Luttinger liquid behavior in organic compounds is presented in the paper by *T. Giamarchi*.

The possibility of Luttinger liquid behavior in higher dimensions with singular interactions is discussed in the contribution by *S. Caprara* and *C. Di Castro* using Renormalization Group methods. An exactly solvable two dimensional analogue of the Luttinger model, called the Mattis model, is reviewed and analyzed by bosonization in the contribution by *J. De Woul* and *E. Langmann*.

The papers collected in this volume provide insights into aspects of the Luttinger model that have evolved over the years. These range from the most advanced theoretical topics to its most esoteric experimental realizations. While celebrating achievements of the past the papers in this volume should also help point out issues for future research.

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