

One-dimensional quantum systems (Bosonization) SS 2012

Introduction

Fermi-liquid theory
Failure of the Fermi liquid theory in 1D

Bosonization for spin-less fermions

Tomonaga-Luttinger model
Particle-hole excitations, bosonic operators
Phi and theta fields
Interaction Hamiltonian, Luttinger parameters
Thermodynamics: specific heat, compressibility
Correlations
Correlation functions of the exponential of fields
Density-density and pairing correlations
Phase diagram

Bosonization for spin-1/2 fermions

Spin and charge
Spin-charge separation, sine-Gordon model
Compressibility and magnetic susceptibility
Correlations
RG equations for the sine-Gordon Hamiltonian: Wilson-like approach
RG equations for the sine-Gordon Hamiltonian: using correlations
Physical meaning of the RG equations
RG flow: massless and massive regimes
Phase diagram for spin-1/2 fermions

Luttinger liquids

Phenomenological bosonization, higher harmonics
Operator product expansion
Mott-delta: commensurate-incommensurate phase transition

Refinements

Long-range interactions
Mott transition
Mott insulator
Umklapp processes
Away from half-filling
Mott-U transition: Luther-Emery solution

Magnetic anisotropy
 Magnetic field
 Magnetic anisotropies in the interaction
Klein factors
Logarithmic corrections

Spin-1/2 chains

The XXZ Hamiltonian
J1-J2 Chain
Spin-Peierls transition
Spin-ladders
Infinite number of chains