

Non Perturbative Methods in Quantum Field Theory

Mondays 11am and Tuesdays 2pm, weeks 1-8 TT16 (DWB Seminar Room)

Solitons

Kinks in D=1+1 scalar (Quantum) Field Theory.

A no-go theorem and its limitations: vortices in D=2+1 scalar FT (KT phase transition).

Vortices in D=2+1 gauge+scalar FT.

Solitonic 'strings' in D=3+1 gauge+scalar FT (Meissner effect and dual-superconductor confinement)

Textures; domain walls; homotopy groups.

Monopoles in the D=3+1 Georgi-Glashow model.

Instantons

Tunnelling in D=1+1 Quantum Mechanics.

Abelian-Higgs model in D=1+1 FT: the dilute gas approximation, n-vacua and theta-vacua; Wilson loops and linear confinement.

SU(2) gauge fields in D=3+1: the dilute gas calculation, n-vacua (Chern-Simons) and theta-vacua,

SU(N) and intertwined theta-vacua.

Fermionic zero modes and index theorems

Anomalies and chiral symmetry breaking (Banks-Casher), charge fractionalisation, sphalerons and the baryon asymmetry in the Standard Model.

Lattice Field Theory

Motivation and applications.

Gauge fields on a lattice and continuum limit(s).

Strong coupling calculations.

Fermions on a lattice.

Markovian Monte Carlo: Metropolis, heat bath.

Some applications drawn from: lightest glueball masses; the running coupling; large N; non-zero temperature; (near-)conformal field theories as time permits.