Condensed matter and high-energy theory: perfect together

Panel discussion

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Quantum Field Theory

• Quantum field theory is the natural language of physics:
  • Particle physics
  • Condensed matter
  • Cosmology
  • String theory/quantum gravity
• Applications in mathematics especially in geometry and topology
• Quantum field theory is the modern calculus
  • Natural language for describing diverse phenomena
• Enormous progress over the past decades
• Many indications that it should be reformulated.

What is QFT?
QFT in Condensed Matter Physics

Lattice Hamiltonian or Lagrangian
Allow all possible coupling constants
Infinite dimensional space

Explore all possible phases at long distances
QFT in High Energy Physics

Renormalizable continuum Lagrangian
Finite number of relevant coupling constants
Infinitesimal values of irrelevant couplings

Explore all possible phases at long distances

Much smaller set of couplings
More limited starting points
Examples of HE/CM useful cross-fertilization

Older examples

• Global symmetry breaking (lattice, magnets, superfluid, chiral symmetry breaking)
• Superconductivity/Anderson-Higgs phenomenon
• Renormalization group
• Lattice models
• Calculational methods (Feynman diagrams, large N, integrability, ...)
• Low dimensional QFT
• Solitons, instantons, ... (charge fractionization, ...)
• CFT
• ...
Examples of HE/CM useful cross-fertilization

More recent (up to the present)

• TQFT
• Anomalies, interplay between boundary and bulk (anomaly inflow)
• Gauge/gravity duality
• Duality
  – emergent gauge fields
  – spin and statistical transmutation
• Entanglement entropy
• ...

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Examples of HE/CM useful cross-fertilization

Future

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