Summary:
Deconfining SU(2) Yang-Mills thermodynamics

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Thermal ground state I

- ▶ PT hopeless even at high temperature
- ▶ short review of Euclidean FTFT
- ▶ selfdual configs. with $|k| = 1$: calorons
  - ▶ constr. of classical fields
  - ▶ results of semiclassical approx.
- ▶ spatial coarse-graining over selfdual configs.
  - ▶ arguments on emergence of inert, adjoint scalar field ϕ
  - ▶ unique definition of $\{\hat{\phi}\}$ via gauge-noninvariant 2-point correlator of field stength
  - ▶ evaluation of this definition (kernel of D)
  - ▶ ϕ's second-order EOM (but: explicit T dependence)
  - ▶ ϕ's potential (first-order equation from compatibility of BPS and E-L, no shift ambiguity in energy density)
  - ▶ ϕ's modulus
- ▶ coupling coarse-grained $k = 0$ to ϕ
  - ▶ perturbative renormalizability (fixation of pure $k = 0$ part of effective action)

Thermal ground state II

- ▶ inertness of ϕ (fixation of interactions between $k = 0$ and pure ϕ part)
  - ▶ a priori estimate of thermal ground state (electric $\mathbf{Z}_2$ degeneracy $\Leftrightarrow$ deconfining phase)
  - ▶ adjoint Higgs mechanism: unitary gauge
- ▶ evolution of effective gauge coupling
  - ▶ Legendre transformation $\Rightarrow$ evolution of mass in dependence of temperature (or vice versa)
  - ▶ fixed points of evolution equation
  - ▶ large-T behavior of e analytically $\Rightarrow$ attractor
  - ▶ $e = \sqrt{8}\pi \Rightarrow S = \hbar$
  - ▶ prediction of critical temperature in units of Yang-Mills scale (onset of monopole condensation)
  - ▶ prediction of T evolution of pressure and energy density at accuracy $< 1\%$
- ▶ outlook: two other phases, some physics implications

The polarization tensor of the massless mode I

- Feynman rules
  - vertices like in PT (without gauge-fixing contributions)
  - on-shellness of massive modes
  - constraints on momentum transfers in four-vertices
- application to simplest radiative correction: one-loop pol. tensor
  - decomposition into transverse and longitudinal structure
  - transverse part: approx. $p^2 = 0 \Rightarrow$ explicit resolution of constraints to limit integration
  - transverse part: no approx. $\Rightarrow$ numerical solution of gap equation
  - longitudinal part: electric charge-density waves of interesting dispersion

The polarization tensor of the massless mode II

- ▶ a particular two-loop correction to pressure
  - ▶ survival at high T
  - ▶ after Legendre: interpretation as deficit $\Delta\rho$ generating density of stable yet unresolvable monopole-antimonopole pairs (large caloron holonomies by absorption of soft fundamental plane waves)
  - ▶ $\Rightarrow$ perimeter law for spatial Wilson loop at high T
  - ▶ resummation of pol. tensor into quasiparticle dispersion of massless mode $\Rightarrow T^4$ correction becomes T correction
- ▶ implication of transverse dispersion: black-body spectral anomaly for $T \sim 2 \cdots 5\, T_c$

Radiative corrections, loop expansion of P I

- 2-loop corrections
  - diagrams, structure of integration, constraints
  - counting of constraints versus "radial loop" variables $\Rightarrow$ allowed regions noncompact
  - result for dominating diagram by deterministic integration
- 3-loop corrections
  - diagrams, structure of integration, constraints
  - counting of constraints versus "radial loop" variables $\Rightarrow$ allowed regions of integration compact or empty
  - result for nonvanishing diagrams by Monte Carlo integration
- loop expansion of pressure: general arguments
  - consideration of diagrams made of three- and four-vertices separately
  - counting of constraints, counting of "radial" loop variables
  - conjecture on termination of expansion into diagrams after resummation of 1PI irreducible contributions to pol. tensor

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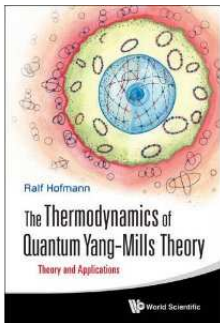
Contains **applications** of $SU(2)_{CMB}$ to:

- ▶ black-body anomaly
- ▶ contradiction to SM Higgs sector derived from primordial He abundance bounds on freezeout temperature for nucleosynthesis in case $SU(2)_{CMB}$ confirmed
- ▶ **U**nexplained **E**xtra**G**alactic **E**mission
- ▶ primordial, magnetic seed fields
- ▶ stability of cold, dilute H1 clouds in Milky Way

Thank you.

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The Thermodynamics of Quantum Yang-Mills Theory

Theory and Applications

World Scientific