Date. No.

2020. 9. 23

① Topo相变 80学时 { 能带理论 / 长分类/群论 / 计算方法 } ② Topo QFT { 同伦群、同调群 / Path Integral/量子化 / Goldstone定理 / Soliton } Topo { 能带 / defect } 2年一次

--- 本学期.

本学期内容
- 重整化 RG * Peskin QED. QCD
  - ϕ^4
  - NLσM + Topo term
  - Sine-Gordon model
  - Thirling model
  - Topo相变 ← XY model ⇒ Thouless (BKT)
  - Spin Liquid / Spin-gauge duality
  - Luttinger-Liquid / Bosonization
  - CFT / QHE

市面上凝聚态场论教材、专著. { ①内容 ②区别 }

1. Peskin QFT

核心：如何解决发散问题 ← 物理的 or 计算的 / 本征的 or 非本征的

I. Feynman diag & QED

Quantization

II. Renormalization / RG ※ (发散)

(ϕ^4 Theory, QED = Dirac eq + EM

III. QCD / Non-Abelian Gauge Theories

量子化 → Feynman diag → RG/R

QED - Abelian gauge - U(1) / QCD - Non-Abelian gauge

2. Mahan. Many body physics

(Green function为主)

I. Green function at $T=0$. $G_{ij} = -i\langle T\, a_i^\dagger(t)\, a_j(0)\rangle$

II. Green function at $T\neq 0$

→可用 Path Integral 代替

※缺少讨论发散问题

缺少讨论 gauge potential

缺少讨论 Broken sym & 相变理论

缺少 QHE

III. 可解 models (Luttinger liquid ↔ Bosonization) ※

IV. 电子气体 (Fermi Liquid)

V. 强关联

VI. 电声作用

VII. dc conductance

VIII. Optical properties

IX. SC (Fermion配对)

X. SF (Boson配对)

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3. Atland. Condensed Matter Field Theory
(Path Integral 为主)

I. Particle → field
II. Quantization
III. Path Integral
IV. Functional
V. Perturbation / Feynman diag
VI. ~~Broken sym (Higgs, Goldstone)~~
VII. Response Theory
VIII. RG (ϕ^4, NLσM, BKT, Ising model) ※
IX. Topology (Homotopy, θ-term, WZ-term, CS term)
X, XI } 非平衡(经典、量子)

优点
①细节多
②网上课件/video
③更新

缺点
乱!

基础

4. Shanker.
I. 统计物理
II. Ising model
III. Statistical to QM
IV. QM to Sta mechanics
V. Feynman diag
VI. Coherent rep (B. F. Spin) ☆
VII. 2d Ising ※ ← 引入 Kramers-Wannier duality
VIII. exact solution of 2D Ising
IX. Majorana fermion
X. Gauge Theories on lattice ※ { XY, Ising
(文小刚书. Chapter 6 / Fradkin)
XI. RG ※
XII. 临界现象
XIII. RG of ϕ^4

XV, XVI } RG of interacting fermion (Shanker, RMP, RG)
XVII, XVIII } Bosonization in 1d. (Bosonization讲得最好的) ※

~~XIV~~ XIX. Duality (Ising, XY ...) ☆ → Spin-Gauge duality
XX. QHE

※

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5. Nagaosa

I. Basic of Field Theory

(*此)

II. Path Integral (讨论得很简单)

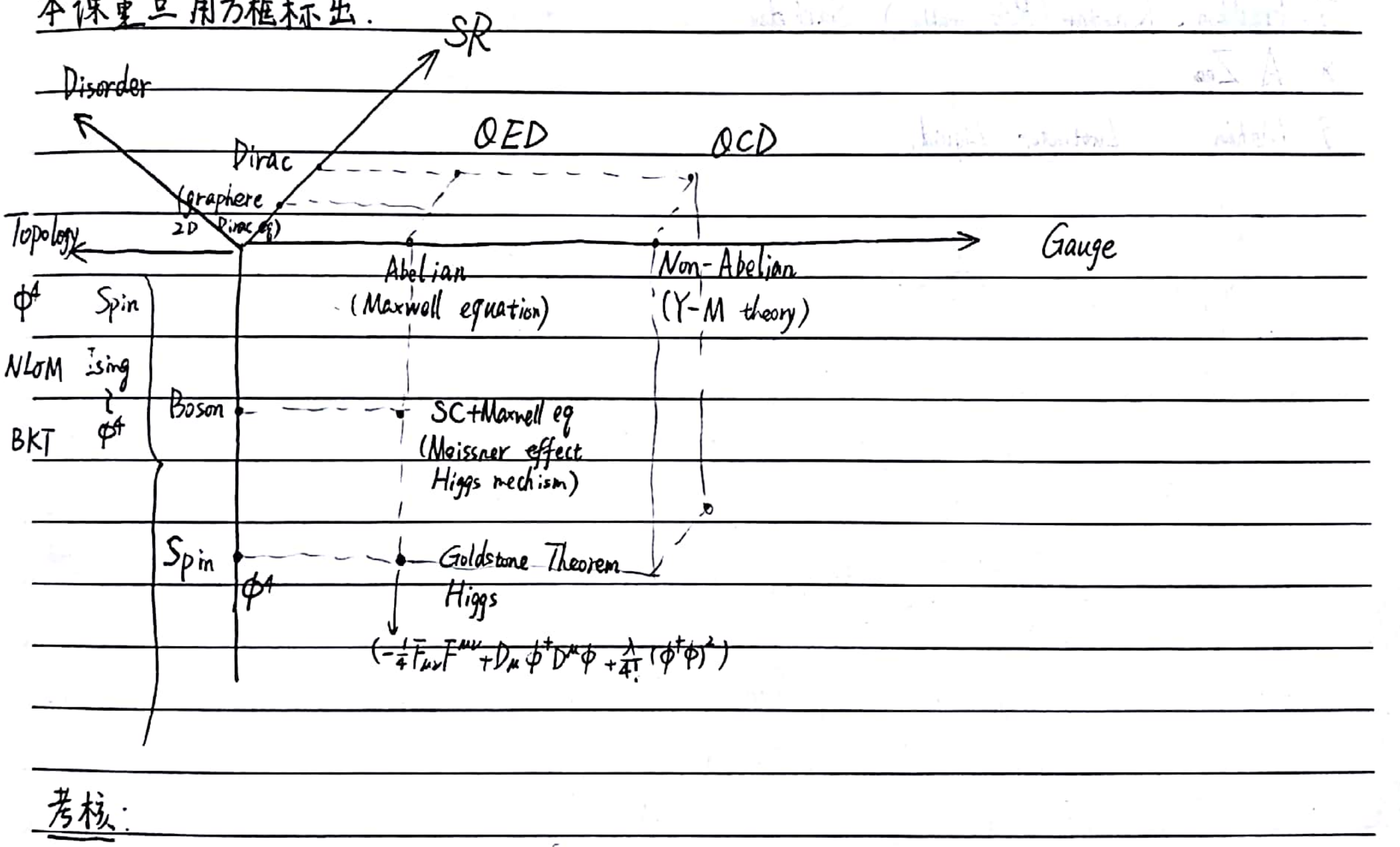
III. Broken sym & phase transition ·X·
(§3.3 BKT, §3.4 Lattice gauge theory)
XY model ⟷ U(1) gauge theory

IV. Application { RPA (无规相近似)
Bogoliubov theory of SF

V. SC (RG处理，路径积分表示)

VI. QHE & Chern-Simons Gauge Theory ·X·

本课重点用方框标出.



考核:

1. 作业 : 50%

2. Project (1人组 或 2人组) : 50%

本课程情况:

国内很少开. Yi Zhou (浙大 ⟷ 物理所)

国外 ① UIUC, Fradkin. QFT书 (Spin-Gauge duality, 1979)
② MIT, Kardar (KPZ model) { video
粒子的统计物理
场的统计物理
③ Simons & Altand, 剑桥, video
④ Sachdev, Havord. 课件
⑤ UCSB...