Some concluding remarks

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Grand Opening- Congratulations, KITS

New Horizons– Grand Feast

- Topological properties
- Unconventional superconductivity
- Other emergent phenomena: QHE, CDW, spintronics ……

"Topology" heat wave

- Topological insulator, QAHE, Weyl fermions, 'highlights', 'breakthroughs', 2016 Nobel prize in Physics, Buckley Prize,……
  'hourglass' fermion, triplon fermion……
- 'New paradigm' in physics: theoretical prediction-material synthesis-experimental confirmation
  'topological quantum chemistry',
  no Wannier function
  predictive power: DFT, weak correlations
- What is the next?
  topological phases and
  topological phase transitions

Topological phases:

- SPTs-symmetry protected topological states
  TI, IQHE, Haldane spin chain….
  SR quantum entanglements

- SETs-symmetry enriched topological states
  FQHE, spin liquids,……
  LR quantum entanglements

'Hunting' of new SETs
good news from numerics;
Lanczos+tensor network states, DMRG
spin $\frac{1}{2}$ Kagome lattice, Chiral spin liquids

Failure of Landau symmetry-breaking and exploring new paradigm

Classifications and phase transitions between them;

Phase transitions between Bosonic SPTS

DH Lee, CK Xu, ZC Gu, Y Ran……

Exciting news-speculations:

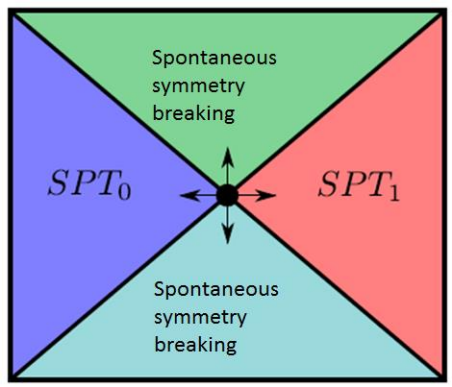
Counterpart of AdS/CFT, inclusion of Fermions, calculation of neutrino mass……

Main results

- A theorem about topological phase transition in 1D

Lokman Tsui et al, Nucl. Phys. B accepted

1. Theorem:
In 1 D bosonic SPT transitions are described by conformal field theories with central charge ≥ 1



2. SPT transition are Multi-critical point of Landau forbidden transition and SPT phase transition.

- A holographic theory of bosonic SPT phase transition valid for any d.

Lokman Tsui et al, Nucl. Phys. B **896**, 330 (2015).

1. The critical state possesses
   - 1D: fractionalized particles
   - 2D: fluctuating loops (with gapless excitations)
   - 3D:fluctuating membranes (with gapless excitations)

2. Critical point has emerging duality symmetry.

From DH Lee

Some redundant comments out of context

- 50s-70 QFT for Condensed matter physics, BCS theory of superconductivity, symmetry breaking, gauge-field theory, Higgs, standard model, grand unification
- 'Discovery' of elementary particles in CM Universes monopoles, Majorana fermions, Weyl fermions…… curious, but not so fundamental
- **Grand unification** of particle physics and CM Derive elementary particles as collective excitations of 'vacuum', topological phase transitions as counterpart of quantum gravity, a kind of AdS/CFT duality

High Tc—still an open problem

Thirty (31) years of cuprates, ten (9) years of iron-based superconductors

Progress mostly due to experiments, more insights from careful examinations, but not yet fully understood:

Mottness vs SC, doped Mott insulators;
Nature of PG, intertwinning order (PDW?);
SC properties in certain region;
cooperative interactions and mechanisms:
interface-proximity effects;
topological superconductivity—fully pin down Majoranas;

Condensed physics-a thriving field

- New ideas;
- New tools, experimental, analytic & numerical;
- New materials;
- New applications;
- New talents;
- New excitements !

Thank You Very Much!