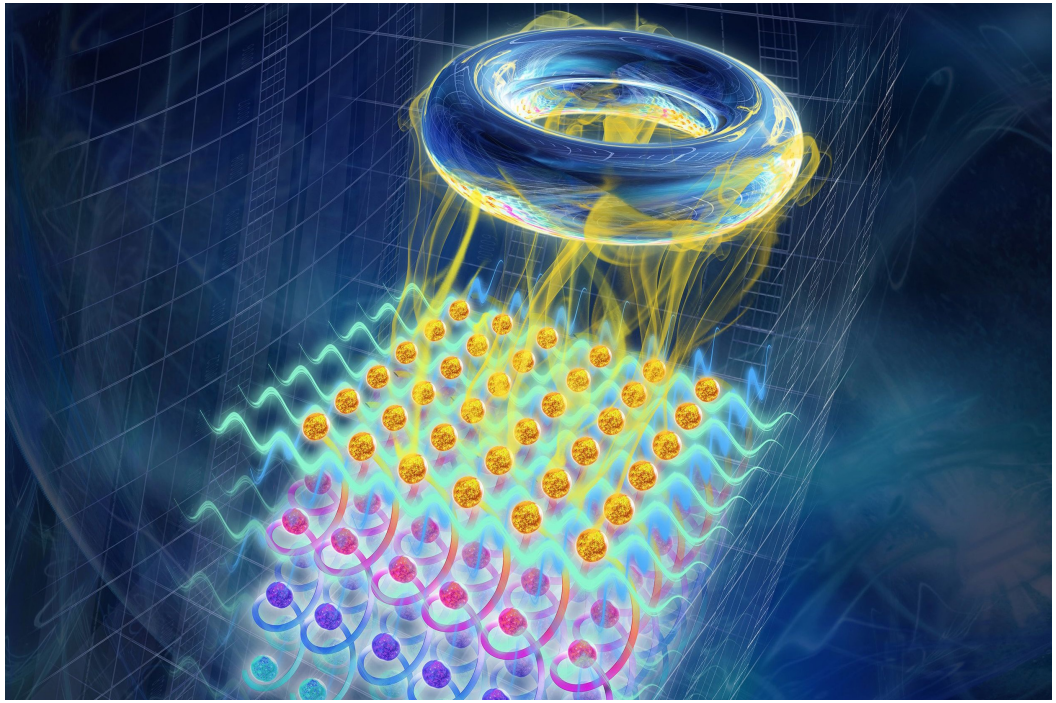
Applications of Generalized Symmetries to Quantum Matter

Interests: Generalized symmetries, anomalies and topological aspects of quantum field theories and quantum lattice models.

Goal: Develop new methods based on these concepts to study phase diagrams of correlated quantum matter.

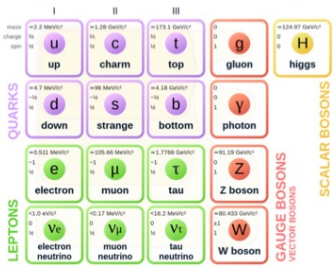


Global Symmetry:

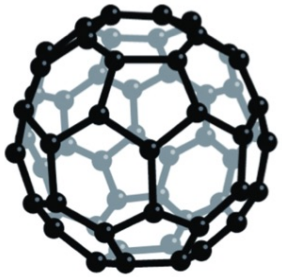
Useful as:

i) As an organising principle for states and operators

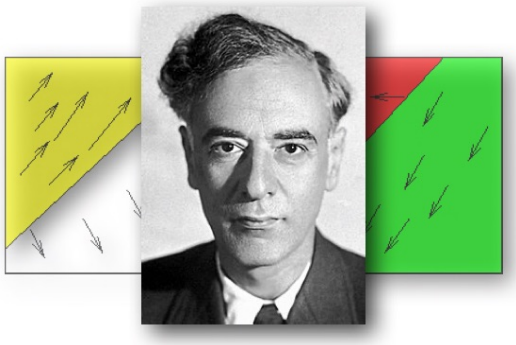
ii) Constrains low-energy physics/dynamics



Standard Model



Crystallography

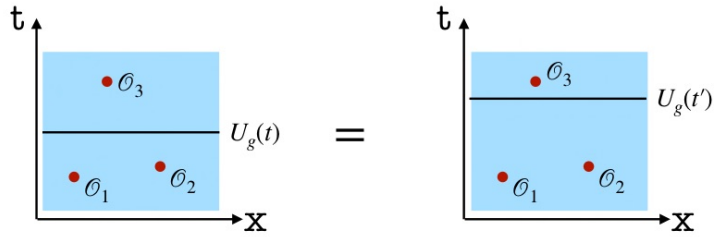


Landau Classification

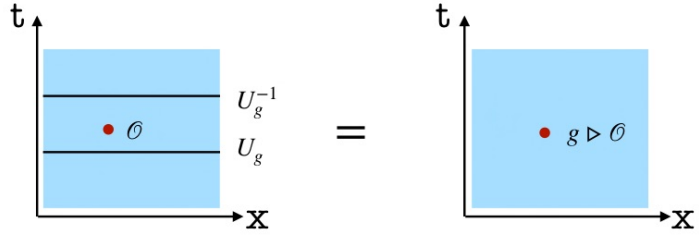
Global Symmetry old and new

Conventional picture

- Symmetry operators commute with the Hamiltonian.



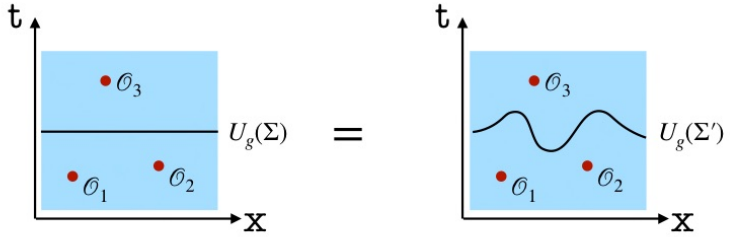
- Symmetry operators act on local operators by conjugation.



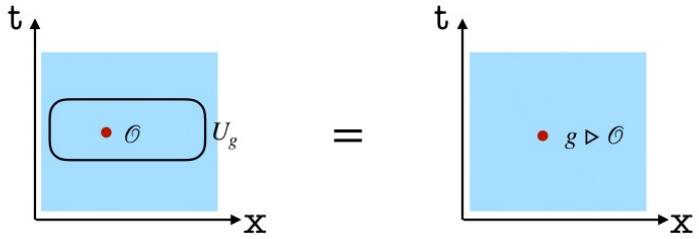
- Symmetry operators satisfy group like fusion rules.

Modern picture

- Symmetry operators are topological.

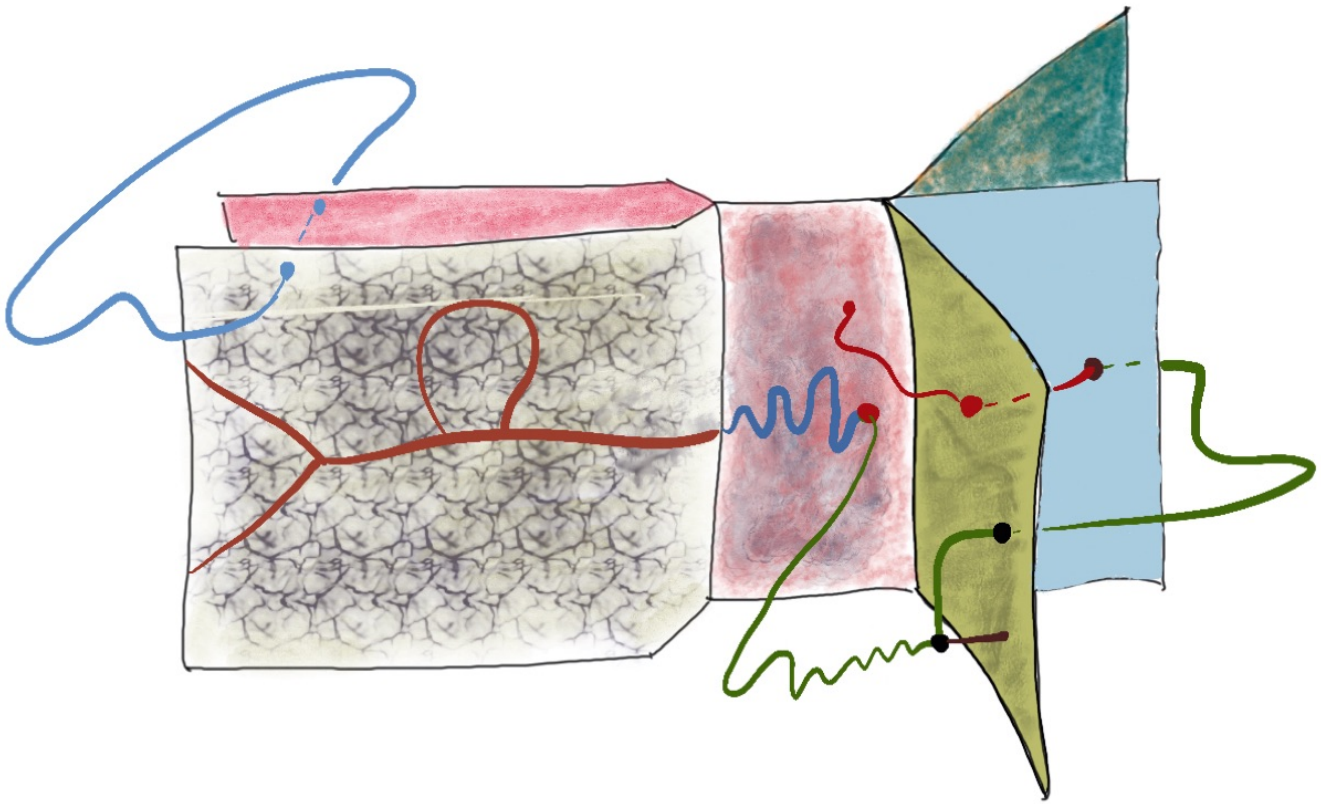


- Symmetry operators act on local operators by linking.



- Symmetry operators need NOT satisfy group like fusion rules.

Generalized symmetries

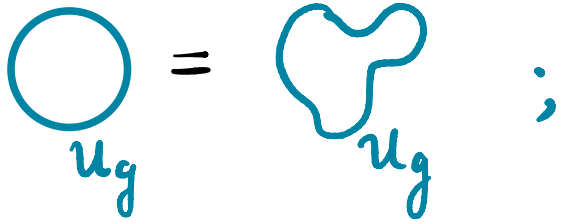


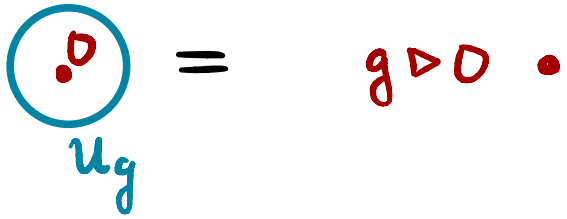
Examples: Many recent realizations of theories with generalized theories e.g., Lattice gauge theories, QCD, Topological orders, spin liquids, …

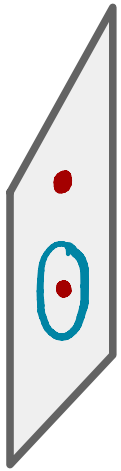
Why? Can extend Landau's paradigm, constrain strongly coupled theories, new insights for topological quantum computation.

Mathematical description:
Higher Fusion Categories

Holographic Symmetry

Recall (1) 

; (2) 



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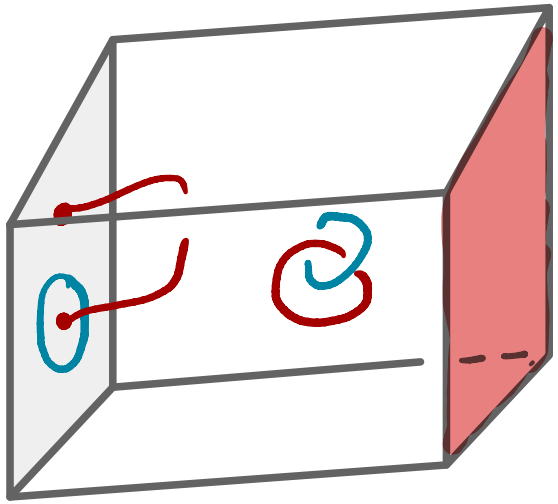
Physical boundary



Reference boundary

Physical system

Fictitious (topological field theory)

Why useful? Organizes spectrum of symmetry charges, quantum dualities, provides a full classification of phases of symmetric matter.

Many many unexplored interested puzzles!