Notes for Classification of topological quantum matter with symmetries

Taper

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Abstract

As title suggests.

Contents

Asks

1. Page 6. Why the scalar in Schur's lemma becomes of unit lenght.
2. page 9. What does it mean by:

   > Note that unitary symmetries, which commute with the Hamiltonian, allow us to bring the Hamiltonian into a block diagonal form.

3. page 9, table I. When he talks about *codimension*, what is the dimension of the whole space? (3? 3+1?). Similar problem also exists in page 10. Note, he mentions codimension of gaples modes on page 11. He asserts that codimension 1 means 1 dimension less than the bulk. But it should be strange to compare the dimension of defects with the dimension of the bulk.

   Possibly related resources:Online notes about Imperfection:

   - 0D (zero dimension) – point defects: vacancies and interstitials. Impurities.
   - 1D – linear defects: dislocations (edge, screw, mixed)
   - 2D – grain boundaries, surfaces.
   - 3D – extended defects: pores, cracks.

   Note: it is finally defined on page 12. that is: codimension of defect $d_c := d_{\text{bulk}} - d_{\text{defect}}$.
4. page 6, what does it mean by saying *"unitary symmetry"*.
5. page 10, what is a *"quantum phase diagram"*.

6. page 11, what does he says, *"Topological properties of adiabatic cycles can also be discussed in a similar manner."*. Does this mean that all previous classification does not concern the adiabatic cycles? What is *"adiabatic cycles"* exactly in his language?

   Note: "adiabatic cycle" may refer to a cycle in phase space (most likely argumented by time t parameter). "Adiabatic" describes the process to be adiabatical, i.e. vary very slowly. The detailed criterion is on page 12, just above equation 3.6:

$$\xi|\Delta_r H(k,r)| << \varepsilon_g \tag{0.0.1}$$

7. page 12, "disinclination" is what kind of defect? Any books on crystall defects?
8. page 12, is the *"mass gap"* a massive gap or a gap composed of mass?
9. page 12, about the D: if $d_c = 1$ (line defect in a $2d$-bulk), then $D = 0$. So a line is wrapped by a point? also, on fig. 2, the $(D = 2, d = 1)$ gives a $d_{\text{defect}} = -1$! Judging from this graph, a $d_{\text{defect}} = -1$ means a temporal defect. Is this true?

Ask friends

1. page 13. What is a homotopy type?

Doubts

1. page 10. Amazingly, he says, *"all TIs and TSCs in the ten AZ symmetry classes are stable against disorder, and hence the assumption of translation invariance is not at all necessary"*. How can translational invariance be ignored?
2. page 12, he mentions:

   > As in the case of gapped TIs and TSCs, we are interested in the highest dimension strong topologies of the defect that do not involve lower dimensional cycles

   I don't get what "strong topologies" and "lower dimensional cycles" mean.
3. page 13 right column, again he mentioned the strong topology and compactify the space into a S^{d+D}. I don't get why:

   > Physically this means the defect band theory are assumed to have trivial winding around those low-dimensional cycles.

4. page 13, What does this mean:

   > It deformation retracts from the defect complement of space-time.

Revisit

1. page 12, bottom. How this procedure of relating real and complex classification is done?

1 Anchor

References

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