Topological Gauge Fields & The Composite Particle Duality

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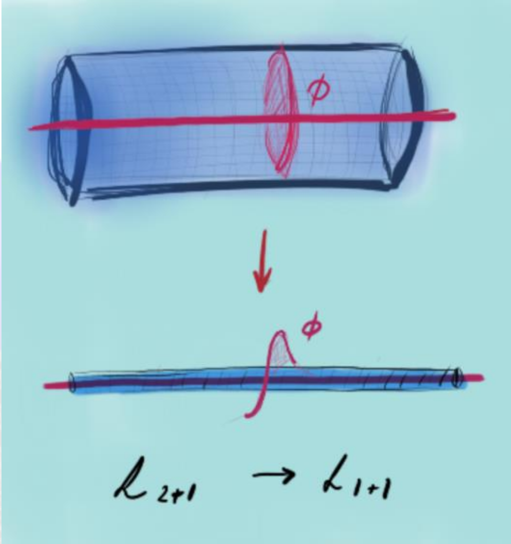
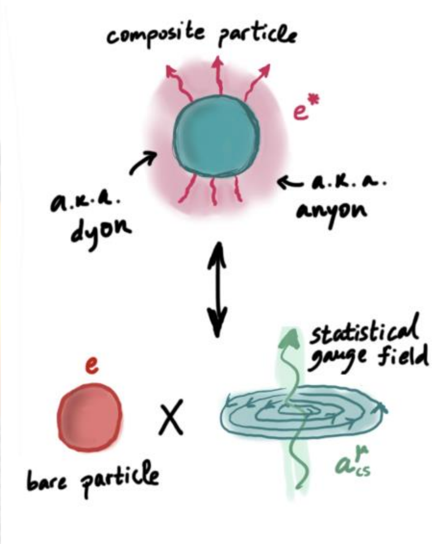
Funder(s): EPSRC CM-CDT

Abstract

Flux attachment is a physical mechanism where charged particles capture magnetic flux quanta and become composite entities, this induces a fractionalisation of certain quantum numbers. In planar (2+1D) systems, this picture allows to understand the low-energy effective description of some topologically ordered phases of matter. The *composite particle duality* encapsulates all the above as part of a Bose-Fermi correspondence in which dynamical gauge fields play a pivotal role. Yet, an explicit microscopic picture for their emergence remains elusive, and little is known about whether such a mechanism can exist in other dimensionalities.





Project Description

We explore the idea of a "dimensional reduction" of flux attachment. We find an analogous mechanism in which the rationale in terms of the underlying topological gauge fields is still applicable. A local density-dependent gauge potential seems to appear as a remnant of the statistical gauge field. Due to the simplicity of the model considered, we suggest a microscopic origin for emergent topological gauge fields out of conventional interparticle interactions. Finally, we show that experiments in ultracold atoms could smoothly interpolate between different sides of the composite particle duality by tuning the statistical angle. This can be done both in continuum and in the lattice. Evidence from the lineal case, and comparison with the usual planar counterpart, also enables us to make general conjectures by induction.

General Conjectures

- The notion of a topological gauge field generalises that of flux attachment. Thus, the composite particle duality survives in arbitrary dimensions.
- Such Bose-Fermi correspondences are not only formal but can, in fact, be probed in experiments by tuning the coupling constant of the gauge field, if accessible.
- Topological terms may arise from conventional interparticle interactions, showing that the associated gauge fields can be physical as opposed to *fictitious* (as they are often regarded in literature).