

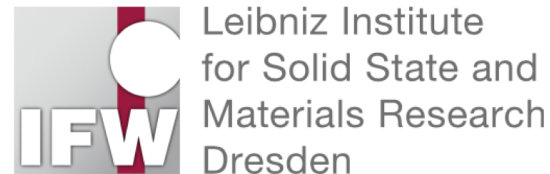
Fasi Topologiche della Materia alla SIT

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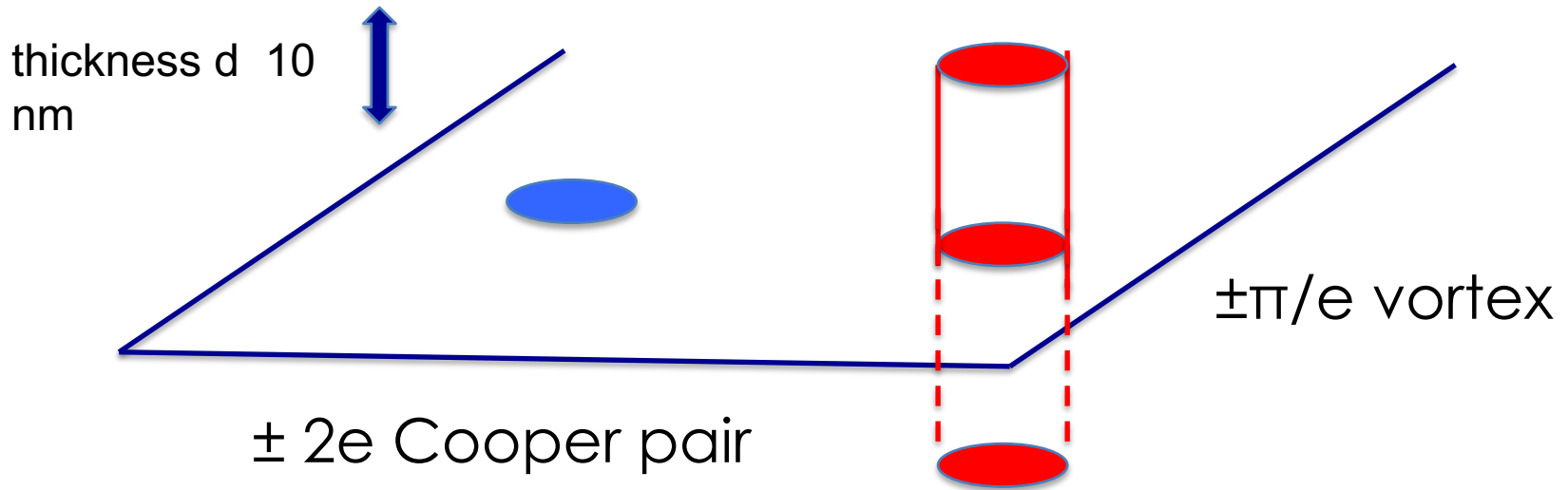
Topological States of Matter

Different states of matter are distinguished by their internal structure \approx orders associated with symmetries (breaking of)

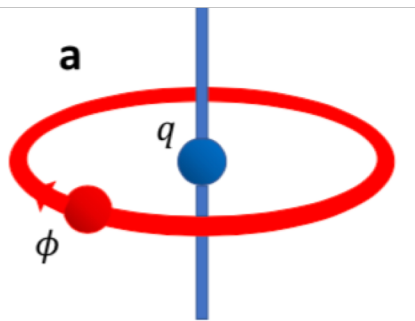
1982 FQE states: no symmetry breaking \rightarrow
new quantum order, **topological order** (Wen 1990)

Low energy effective field theories for such states involve topological field theories: **Chern-Simons, BF**

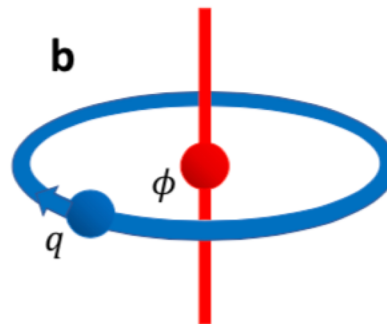
Superconductor to insulator transition (SIT) in 2d films TiN NbTiN



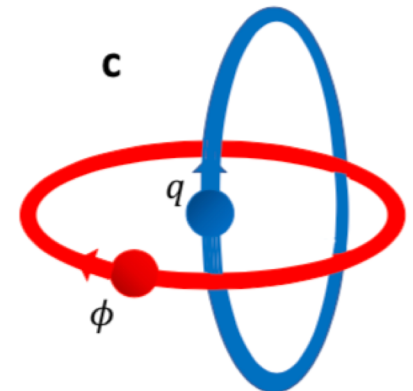
SIT is driven by the competition between **charge** (Cooper pairs) and **vortex** degrees of freedom: **topological interactions**



Aharonov-Casher

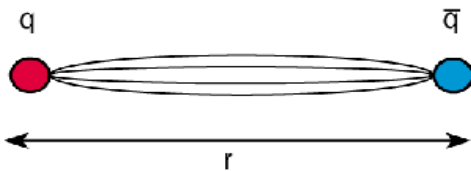
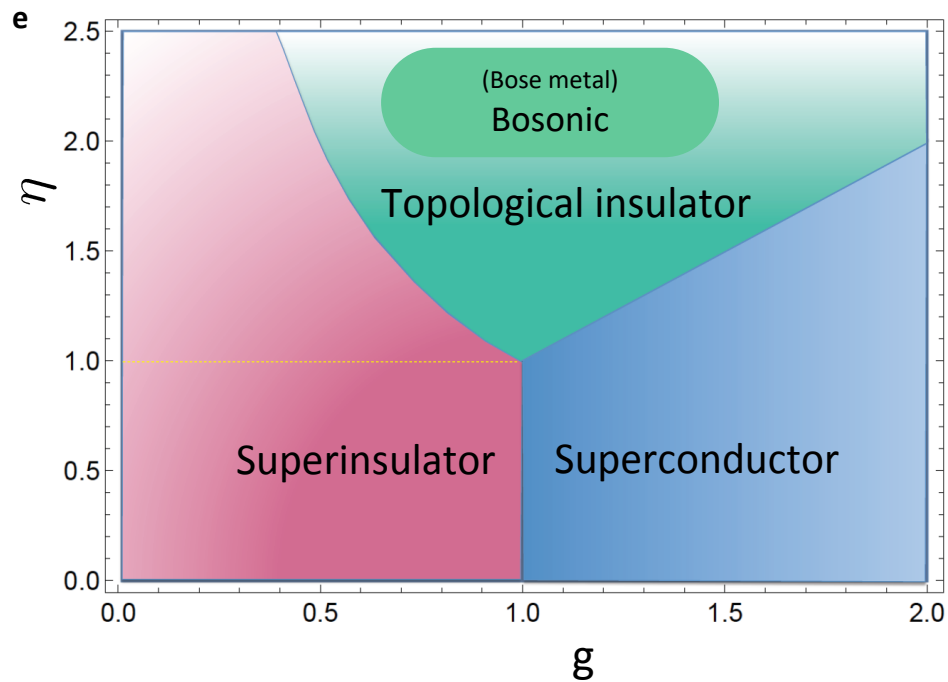


Aharonov-Bohm

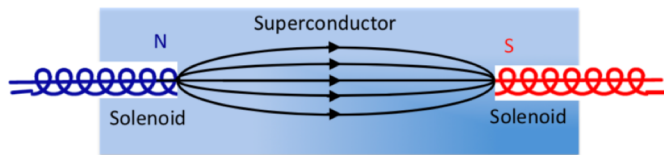


linking: Aharonov-Bohm-Casher

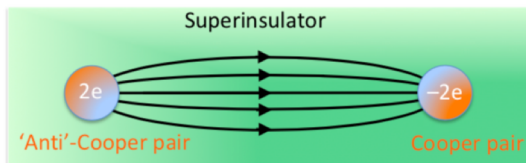
T=0



quarks bound by (chromo)- electric strings in a condensate of (chromo)-magnetic monopoles (Mandelstam, 't Hooft, Polyakov)



mirror analogue to vortex formation in type II superconductors



Polyakov's magnetic monopole condensation \Rightarrow **linear confinement** of Cooper pairs

superinsulating phase

- confining string action in $(2+1)d$ using a lattice regularization
- deconfining properties at $T=0$ and at finite temperature

$(3+1)$ d case

- topological insulating phase
- boundary excitations
- transition to the superconducting phase ($T=0$ and $T \neq 0$)
- superconducting phase