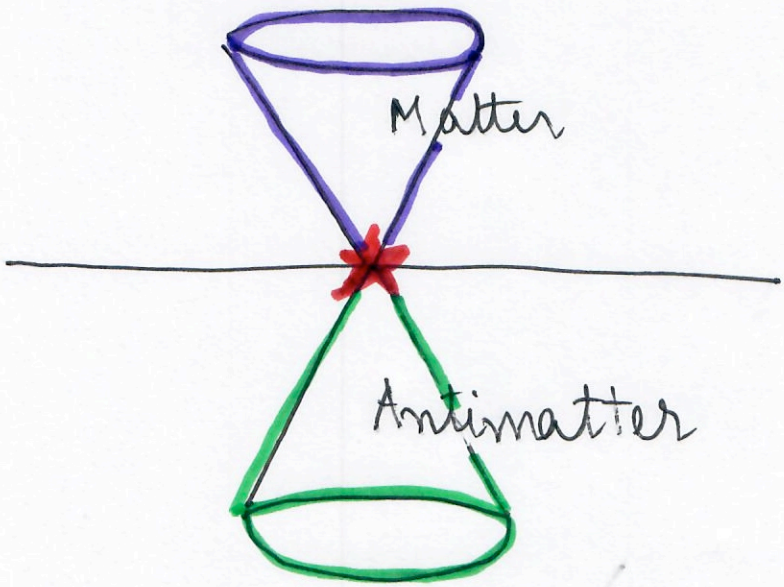
3/25. The Recent Majorana Saga / Retraction

Background

Majorana Fermions

Particle = Antiparticle

$$\gamma = \gamma^{+}$$



Condensed Matter

"Building Blocks": electrons

holes

Majorana (Bound States)

equal superpositions of

electrons and holes

$c^\dagger$

c

$$\gamma_1 = \frac{1}{2}\left(c + c^\dagger\right) \qquad c = \gamma_1 + i\gamma_2$$

$$\gamma_2 = \frac{i}{2}\left(c - c^\dagger\right) \qquad c^\dagger = \gamma_1 - i\gamma_2$$

γ_1

γ_2

$$\gamma_1 = \gamma_1^\dagger$$

$$\gamma_2 = \gamma_2^\dagger$$

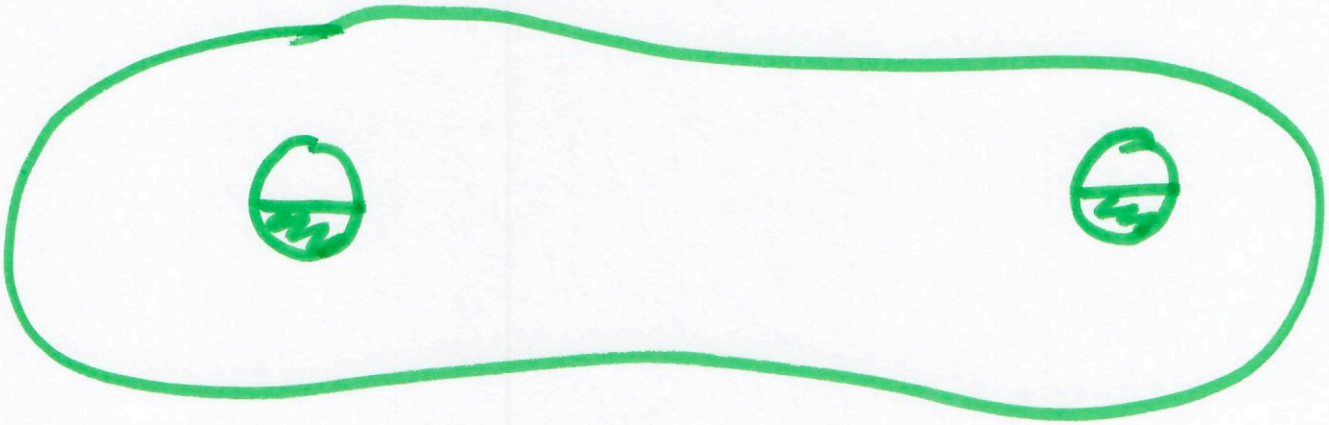
- Two Majorana fermions form an ordinary (Dirac) fermion
- In cm systems they must come in pairs

Connection to qubits

 $|0\rangle$  $|1\rangle$

Problem: Very Sensitive to Local Perturbations.

A topological qubit from Majoranas



$|0\rangle, |1\rangle$

Fermion encoded in a nonlocal way

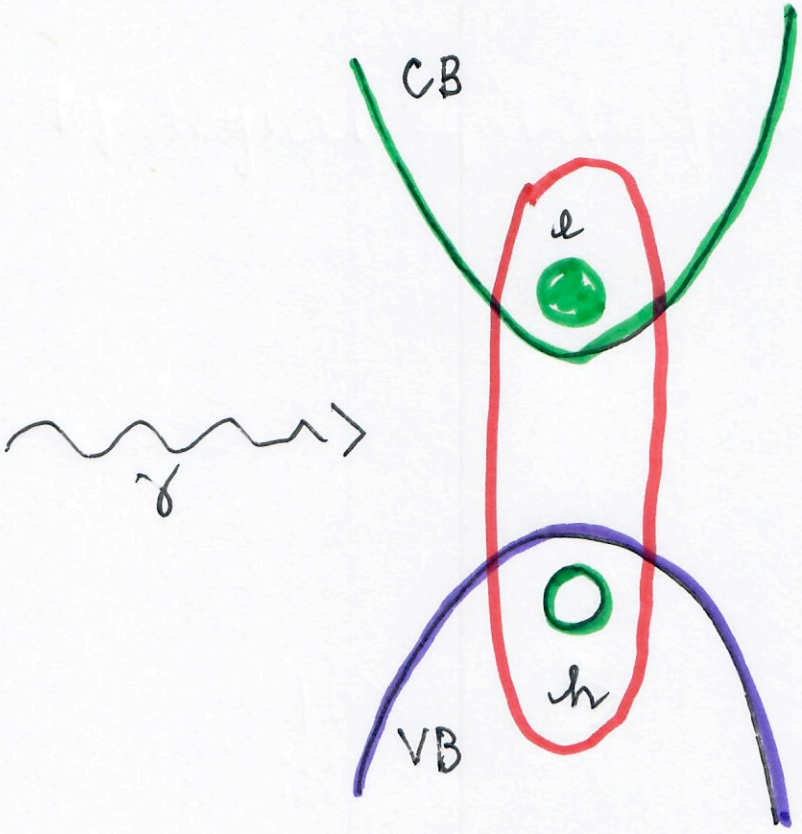
Protected from local perturbations

Where shall we look ?

Would like superposition of

electron and hole

Exciton ?



Two Fermions

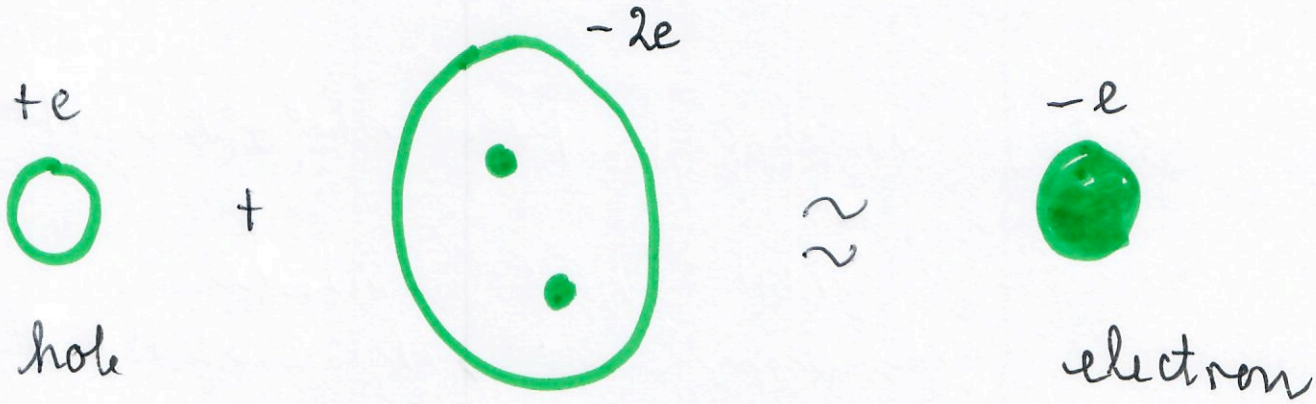
⇓

Integer Spin

Boson

We would like a Fermion !

Superconductor



Cooper pair

Cooper pairs

not well-defined

Particle - hole symmetry !

$$\gamma^{+}(E) = \gamma(-E)$$

At $\underline{E = 0}$ Majorana

$$\gamma = \gamma^{+}$$