Superconductors

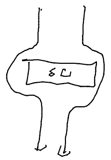
At or below some temperature T_c
lose all resistance to current.

Currents last indefinitely,
without a voltage drop,
because no energy loss $P = I^2 R = 0$,

- Super diamagnetic
  - repelled by magnets
  - magnetic field inside always zero.

Compare conductor where $\vec{E} = 0$ inside
because charges rearrange to cancel
any external field

In superconductor currents form
naturally to ~~block~~ cancel external $\vec{B}$ field.

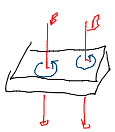


Meissner effect

There is a critical
field B_c strong
enough to "break through"

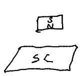
Type-I superconductors
sharp transition from normal to S.C.
$T_c \sim 1\text{–}9K$ $B_c \sim 0.01 - 0.1\,T$
when $B > B_c$, S.C. breaks & becomes normal

Type-II superconductor
allow field lines to pass through
in discrete bundles



Vortices form:
currents surround
bundles & "protect"
rest of material

Type-IIs are less fragile & can
survive to higher temperatures
"high-T_c superconductors"



magnets float over super-conductors
maglev

At low T, 2 electrons in a positively
charged lattice can be attracted to each
other, mediated by a phonon
(sound wave)

2 electrons form a Cooper pair

momenta are strongly correlated that no scattering

Nucleons held together by

strong force

strong until nucleons are 2fm apart
then disappears

works better when spins are aligned

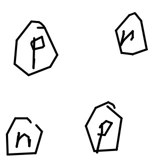
$\uparrow\uparrow$ $\uparrow\uparrow$

$\underbrace{n\ \ p}$ $n\ n$

deuteron is a boson spin 1

can't be as close because of Exclusion Principle

Which has more energy?



He-4 nucleus

$2p^+, 2n^0$

$$B.E. = E_{parts} - E_{whole}$$

$$= (m_{parts} - m_{whole})c^2$$

$$B.E. = (Zm_H + Nm_N - M_{atom})c^2$$

stability is determined by $\frac{B.E.}{A}$

energy per nucleon

Fe has largest U - very low