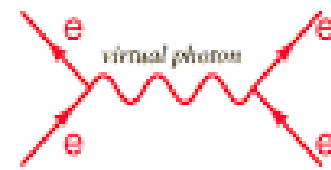


Magnetolectrics

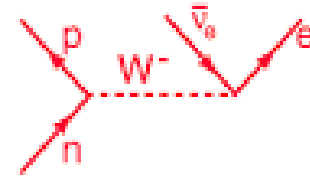
The big picture

Why? (the science)

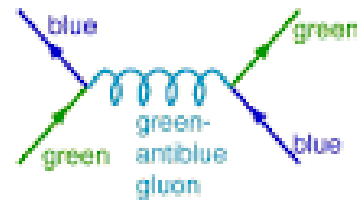
- Physics study interactions
 - Four basic interactions (strong, weak, E-M, gravitation)



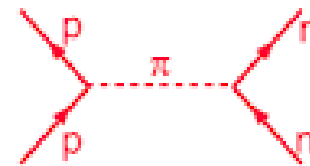
Electromagnetic



Weak



between quarks



between nucleons

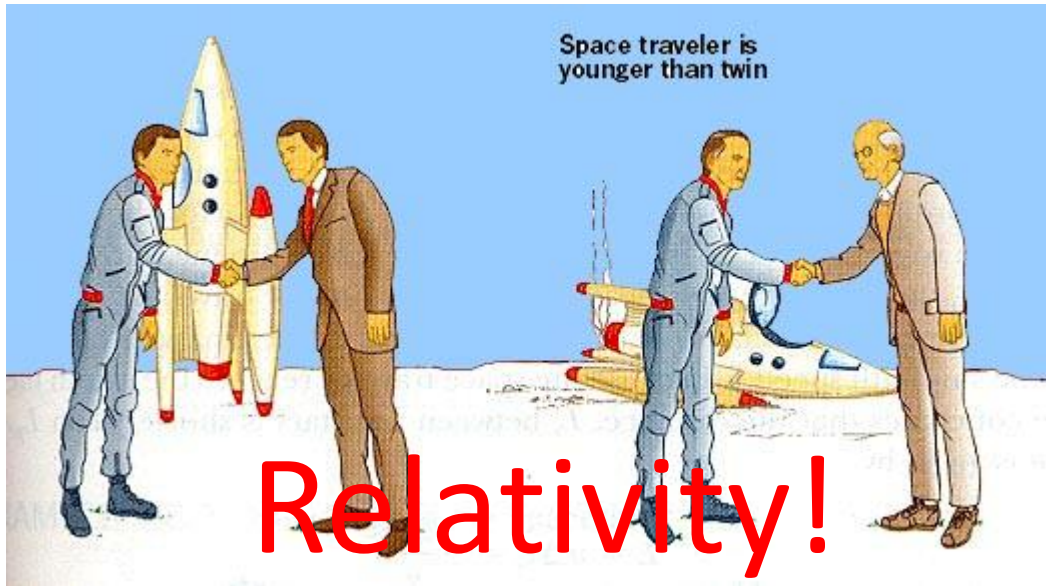
Strong Interaction

At different (as functions of) Time and Space



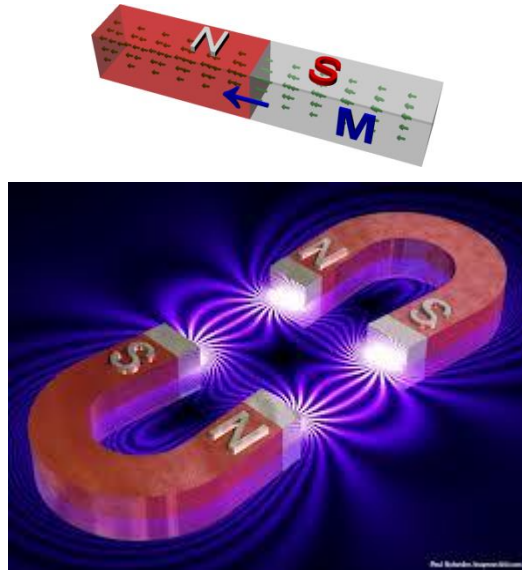
Why? (the science)

- How does time and space interact?



Why? (the science)

- How does time and space interact in a material?

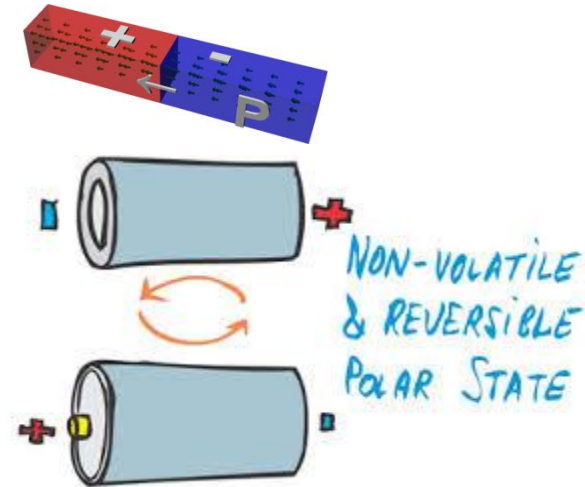


Magnetism

$$M = \hbar\mu_B$$

Angular momentum: $\hbar = I\omega$

Broken **time** reversal symmetry!



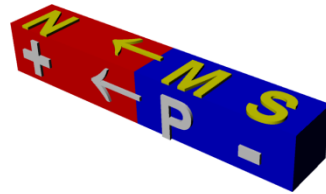
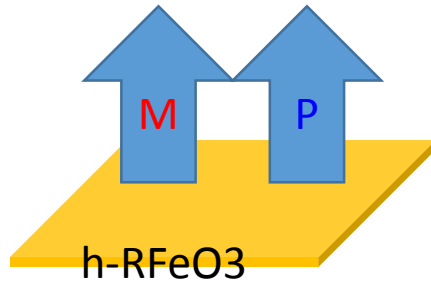
Ferroelectricity

$$P = \sum x_i q_i$$

Broken **space** inversion symmetry!

Why? (the science)

- Examples of materials
 - Single phase



Hexagonal ferrites:
RFeO₃, ferromagnetic and
ferroelectric

- Heterostructures

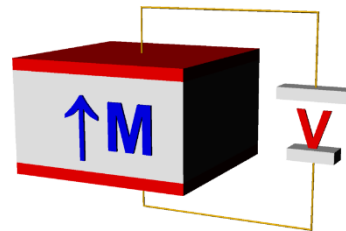
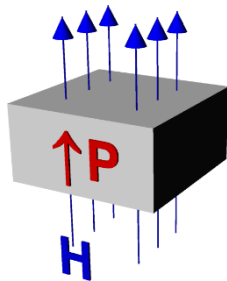


BaTiO₃

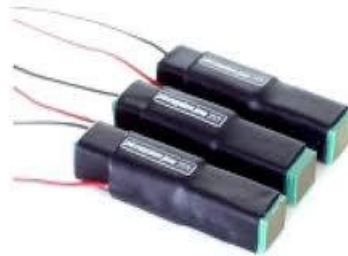
ferroelectric

SrRuO₃

ferromagnetic



Why? (the application)

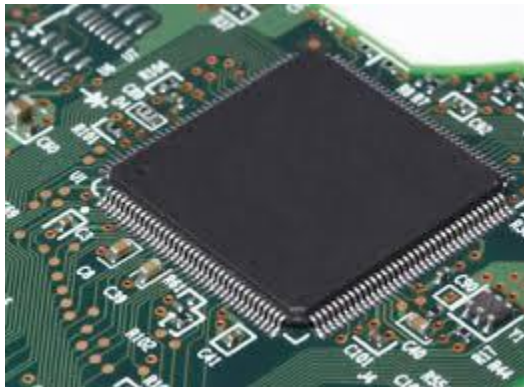
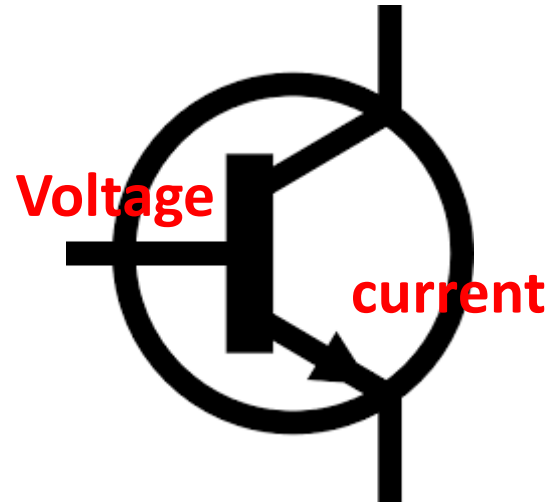


Why? (the application)

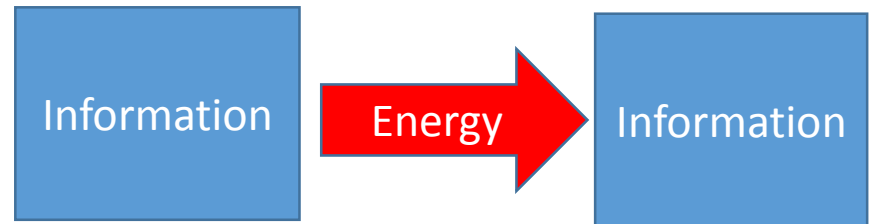
Information processing and/or storage (spintronics)



Transistor



Integrated circuit



Energy/Information ratio ?

