School of Physical Sciences – Physics of Quantum Materials group

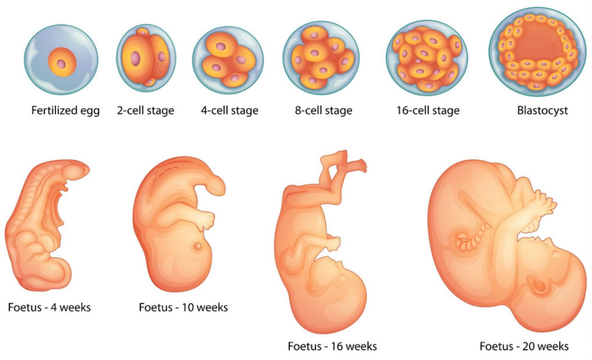
TIME-REVERSAL SYMMETRY BREAKING IN SUPERCONDUCTORS

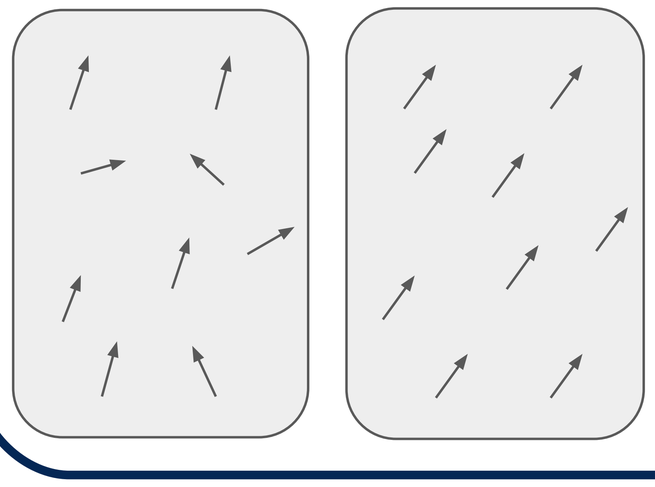
Henry Sheehy (H.J.Sheehy@kent.ac.uk), Sudeep Ghosh, James Annett, Jorge Quintanilla

SYMMETRY-BREAKING

Artwork of the Minoans of Crete during the Bronze Age. The cup breaks the bilateral symmetry.

During early development, we break our spherical symmetry through cell differentiation.





Orientational symmetry is broken below a ferromagnet's critical temperature.

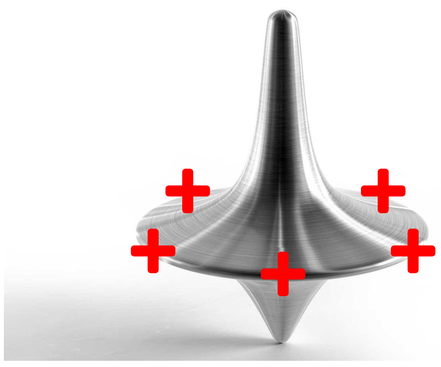
SUPERCONDUCTIVITY

A superconductor at high temperatures is a normal metal, with a finite resistance to current. Below a certain critical temperature, the resistance drops to zero. This phase transition occurs when a symmetry is broken.

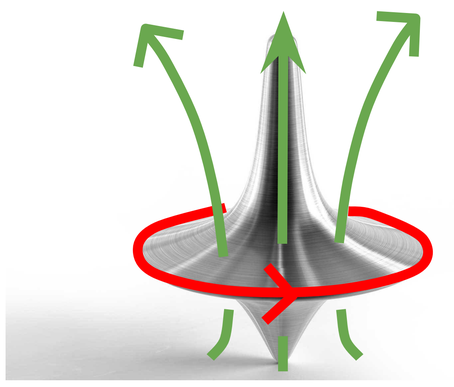
Superconductors spontaneously expel magnetic fields below their critical temperature, a consequence of which is magnetic levitation.

TIME-REVERSAL SYMMETRY

A charged and static spinning top has "time-reversal symmetry".



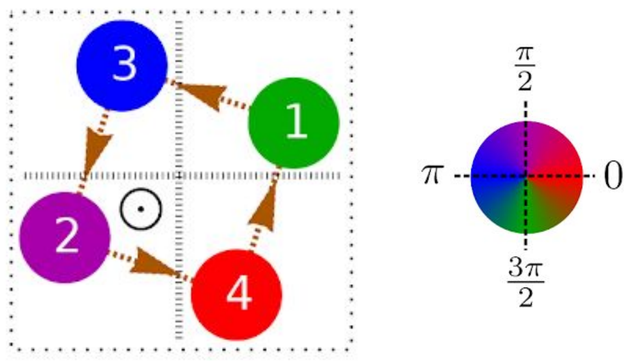
Spinning the top forms a loop current, which gives rise to a magnetic field.



Reversing the rotation of the top reverses the magnetic field. The charged spinning top breaks time-reversal symmetry.

UNCONVENTIONAL THEORY OF SUPERCONDUCTIVITY

We hypothesise a theory of superconductivity with unconventional symmetry-breaking.



When the superconductor is warm, it behaves like a normal metal and obeys time-reversal symmetry.

However, below a certain critical temperature, loop currents emerge like charged spinning tops. These give rise to magnetic fields and the time-reversal symmetry is broken.

https://research.kent.uk/pqm
School of Physical Sciences, University of Kent, Canterbury, Kent CT2 7NH, UK.

Physics of Quantum Materials