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Types of magnetism

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All magnetic materials contain *magnetic moments*, which behave in a way similar to microscopic bar magnetis. In order to define a ferromagnetism as a class of magnetism, it is easiest to compare the various properties of different possible types of magnetic material. These are principally: paramagnets, ferromagnets, antiferromagnets and ferrimagnets.

Paramagnetism

In a paramagnet, the magnetic moments tend to be randomly orientated due to thermal fluctuations when there is no magnetic field. In an applied magnetic field these moments start to align parallel to the field such that the magnetisation of the material is proportional to the applied field.

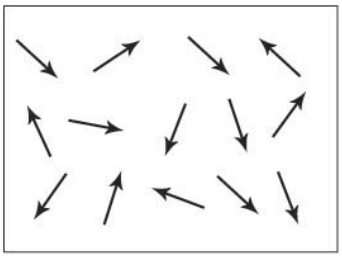

Figure A. Schematic showing the magnetic dipole moments randomly aligned in a paramagnetic sample.

Ferromagnetism

The magnetic moments in a ferromagnet have the tendency to become aligned parallel to each other under the influence of a magnetic field. However, unlike the moments in a paramagnet, these moments will then remain parallel when a magnetic field is not applied (this will be discussed later).

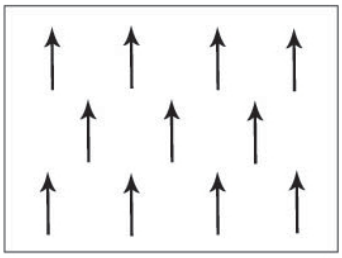

Figure B. Schematic showing the magnetic dipole moments aligned parallel in a ferromagnetic material.

Antiferromagnetism

Adjacent magnetic moments from the magnetic ions tend to align anti-parallel to each other without an applied field. In the simplest case, adjacent magnetic moments are equal in magnitude and opposite therefore there is no overall magnetisation.

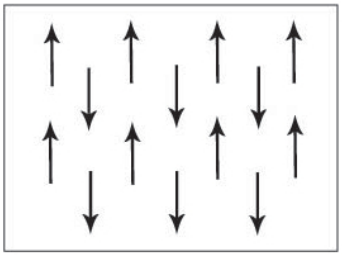

Figure C. Schematic showing adjacent magnetic dipole moments with equal magnitude aligned anti-parallel in an antiferromagnetic material. This is only one of many possible antiferromagnetic arrangements of magnetic moments.

Ferrimagnetism

The aligned magnetic moments are not of the same size; that is to say there is more than one type of magnetic ion. An overall magnetisation is produced but not all the magnetic moments may give a positive contribution to the overall magnetisation.

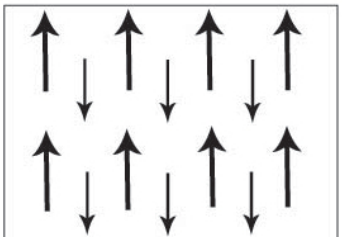

Figure D. Schematic showing adjacent magnetic moments of different magnitudes aligned anti-parallel.

Below is a periodic table showing the elements and the types of magnetism at room temperature:

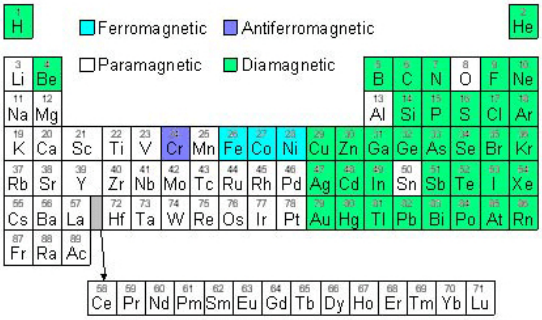

Figure E. Diagram of a periodic table showing elements coloured according to the type of magnetism they show at room temperature.

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