

# Magnetic interaction

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We learned that some materials spontaneously magnetize below the Curie temperature. In this lecture, we dive deeper into the interaction between the atoms in the crystal.

## Lecture topics:

1. Exotic magnetic materials
  - a. Anti-ferromagnets
  - b. Ferrimagnets
2. Anisotropy
  - a. Phenomenological (crystal, magnetostriction, interface)
  - b. Pair model
  - c. Spin orbit interaction
  - d. One ion model

## Recommended reading:

- [1] Feynman, Leighton, Sands “The Feynman lecture notes on physics” Chapter 36 (Ferromagnetism), 37 (Magnetic materials). Addison Wesley. Available online: <http://www.feynmanlectures.caltech.edu>
- [2] Charles Kittel “Introduction to solid state physics” Chapter 11 Diamagnetism and Paramagnetism, Chapter 12 “Ferromagnetism and anti-ferromagnetism” John Wiley.
- [3] Chikazumi, Charap “Physics of Magnetism” John Wiley, Chapter 3-5 or Chikazumi, Graham “Physics of Ferromagnetism”, Oxford Chapter 5-7

## Additional instructions

In the lectures we will use Peer instruction as a lecture form. This means **there will be no presentation by a lecturer**. Instead, we expect you to come prepared. At the session, we will discuss the theory guided by concept questions. (This form of education is called Peer instruction [https://en.wikipedia.org/wiki/Peer\\_instruction](https://en.wikipedia.org/wiki/Peer_instruction), it is not meant to relief the lecturer, but based on the idea that you only learn when you are active).

## Pre-class study

For this session, we would like you to **study** the following (we will use flipped classroom, there will be no lecture). Depending on your interest and choice you make, it will be 9-24 pages. This will take you up to 4 hours.

### 1. Anti-ferro and ferri-magnetism

- a) Either Feynman 37.5 (Extraordinary magnetic materials) 3 pages
- b) Or get more detail in Kittel Ferrimagnetic order (8<sup>th</sup> edition page 336-339), Antiferromagnetic order (340-344). 9 pages

### 2. Anisotropy- phenomenological

- a) Either: Chikazumi/Graham 12.1 page 249-256 (7 pages) or Chikazumi/Charap chapter 7.1, page 128-132 (3 pages)
- c) Or if you lack time: Kittel "Anisotropy Energy", 348-9 (1 page)
- d) Or if you really lack time: Blundell 6.7.2 (0.5 page)

### 3. Anisotropy- pair model/ion model

Than we are stuck with Chikazumi:

- a) Chikazumi/Charap 7.2 and 7.3 (12 pages) or
- b) Chikazumi/Graham 12.3 (6 pages)