MSE-432: Flipped classroom on Online seminars

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École polytechnique fédérale de Lausanne

Expectation from the Group Presentations

- Understand and explain to your fellow classmates at least one key concept introduced in the seminar
- Each member of the group is expected to present a part of the presentation and answer questions related to that
- Cite the references, literature, and any online material you use in your presentations thoroughly
- Questions and discussions from the fellow classmates is highly encouraged

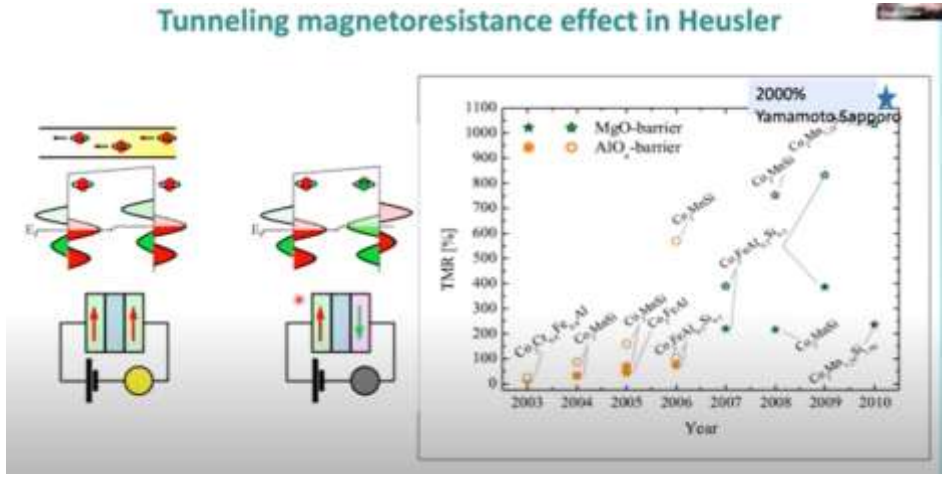
Presentation guidelines:

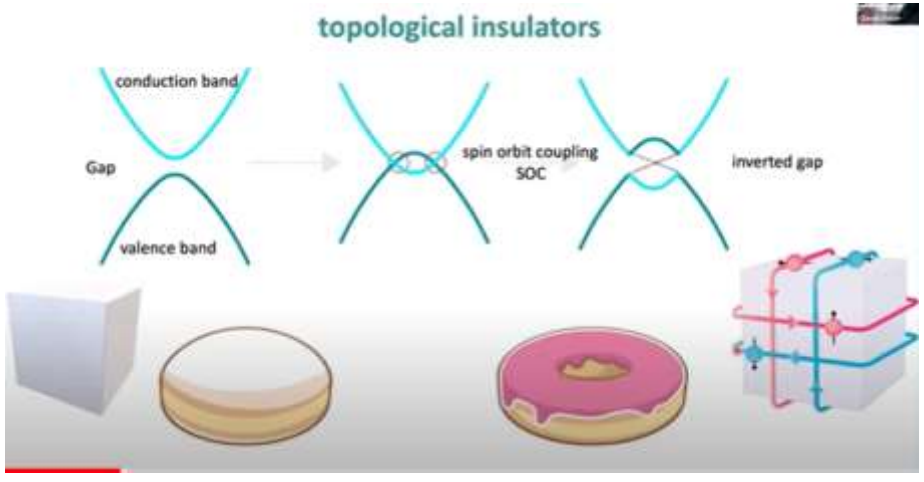
- Duration: 15 minutes (5 mins per participant)
- Abstract: limit to max. half page

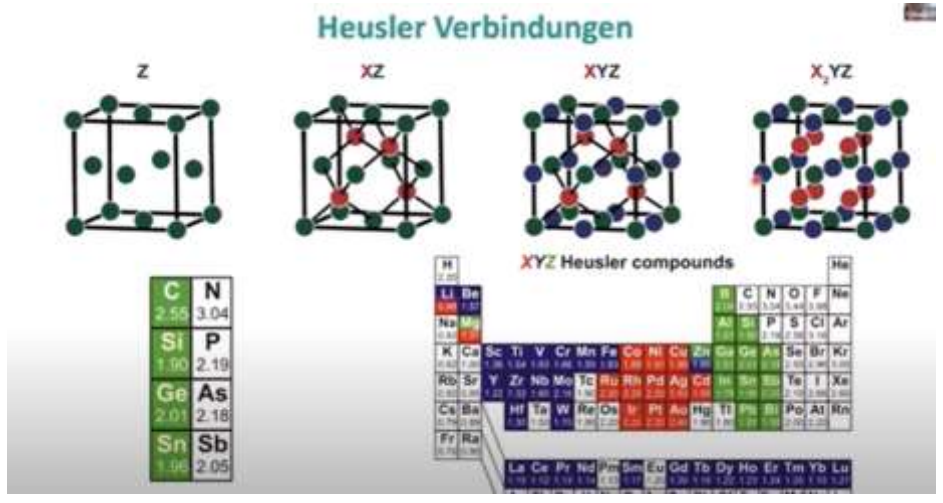
1. Magnetic Materials and Topology - Prof. Claudia Felser

https://www.youtube.com/watch?v=QEhufYx-pdo

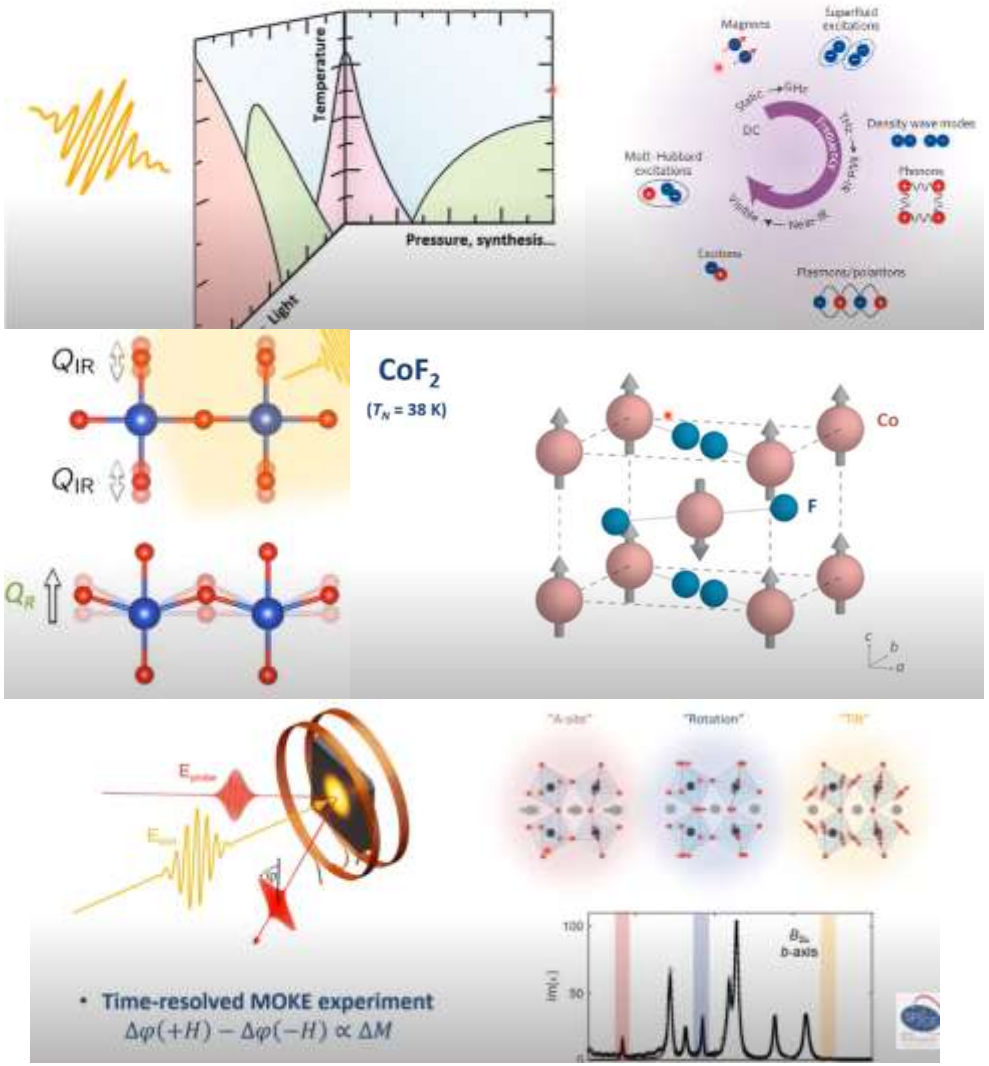
- What is topology and how does it affect the electronic properties of the material ?
- What are the different types of topology in magnetic materials ? Take the example of Heusler compounds.
- Give two examples of your choice for the applications of Heusler compounds in spintronics :
  - Magnetic Heusler alloy, half metallic Heusler compound and its application – tunneling magneto resistance effect
  - Heusler compounds with anisotropy – anti skyrmions
  - Antiferromagnetic topological materials







2. How to engineer non-equilibrium crystal and magnetic structures with light - Dr. Ankit Disa



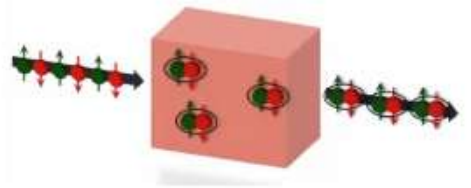
- Use of light to control phases and induce new properties in the system
  - Why and how?
- How to control ordering in a antiferromagnet
  - Example of a material
  - Experimental setup
- Enhancing ferromagnetism at high temperature
  - Example with a material - $YTiO_3$
  - Experimental setup

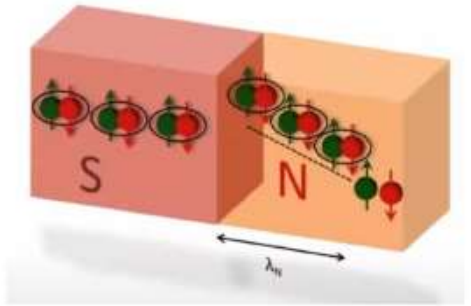
https://www.youtube.com/watch?v=Kc6QXk_SvtM

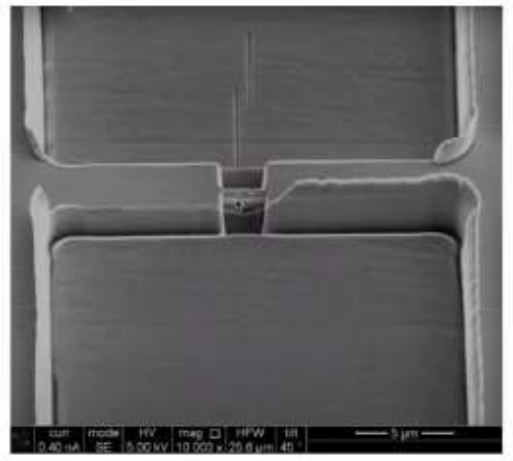
3. Superspintronics: towards ultra-low dissipation spin-electronics – Dr. Niladri Banerjee

https://www.youtube.com/watch?v=fUWwDoYhavI

- Outline the motivations behind spintronics as well as its concept (spin-dependent density of states, spin valve, etc.)
- Present the key concepts of superconductivity (phase transition, bandgap, Cooper pair, etc.) and relate them to a standard ferromagnet.
- Super(conducting) spintronics: what happens when one get a S/F system (spin triplets, proximity effect) ? What makes it interesting with respect to standard spintronics ?
- How do we detect spin triplets ? Choose a method and discuss it.
- Select a superspintronic system and explain how such device would work.

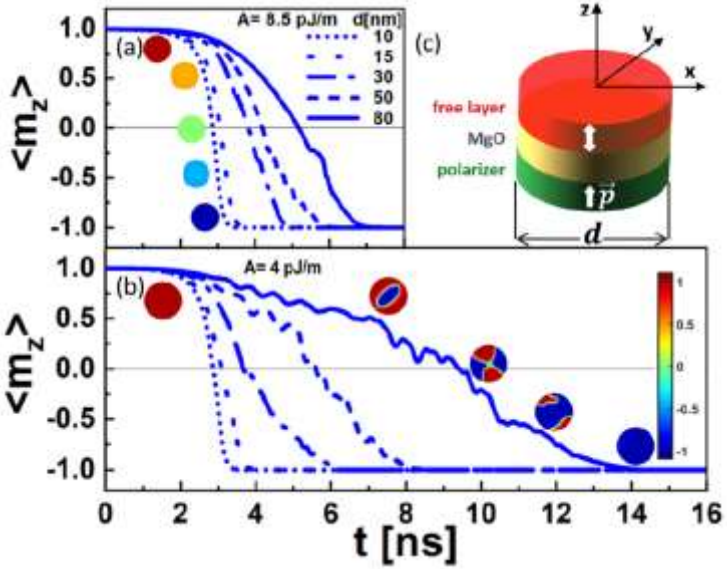






4. Spins, Bits, and Flips: Essentials for High-Density Magnetic Random-Access Memory - Dr. Tiffany S. Santos, *Western Digital*

- History of magnetic tunnel junctions (MTJ)
- Application of MTJs in hard disk drives and MRAM
- Introduction to STT-MRAM
- Towards high density STT-MRAM
  - Lowering the switching current density with ultrathin free layers
  - Working MRAM bits at 50 nm full pitch



https://www.youtube.com/watch?v=VLKRgsw5ne4

Appl. Phys. Lett. 118, 132407 (2021)

5. Opportunities from single magnetic adatoms on superconductors – Prof. Katharina Franke

https://youtu.be/LGuVTZs4Nac?si=cD_cto--kaiWjzMl

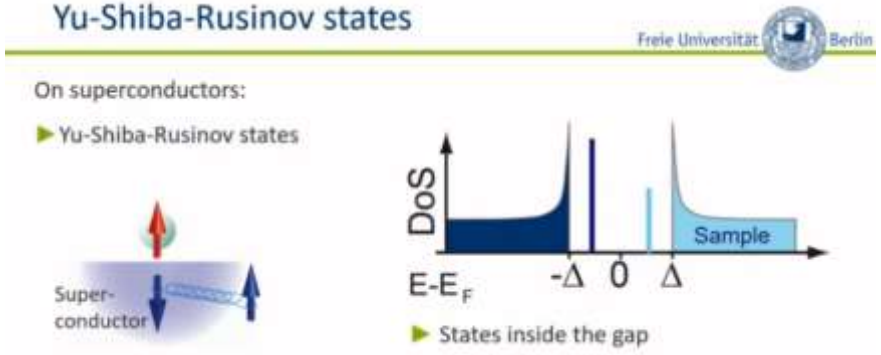
- Explain the magnetic behavior of a superconductor.

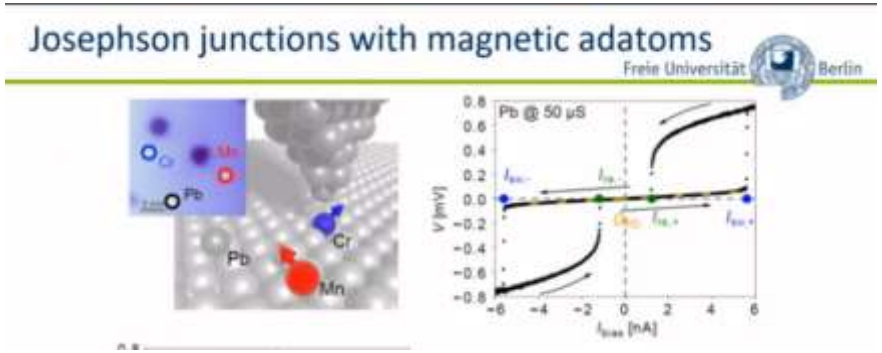
- Why is it interesting to study the influence of a single magnetic atom on a superconductor ? (Yu-Shiba-Rusinov states…) Give examples of applications.

- Example of Fe on NbSe2 (focus on **one** aspect):
  - Explain what is the link between the charge density wave CDW (maxima, minima) and the placement of single magnetic atoms
  - What is the interaction between two of these magnetic atoms ? (Fe dimers) For a chain ?
  - How can we use symmetry considerations to enhance the hybridization ?
  - Explain the application of YSR states for Josephson diodes

- Why is Voltage-Biased Scanning tunneling microscopy STM used as a probing technique of those states ? Explain the experimental procedure.

- What behavior do we expect for Josephson junctions with magnetic adatoms ?

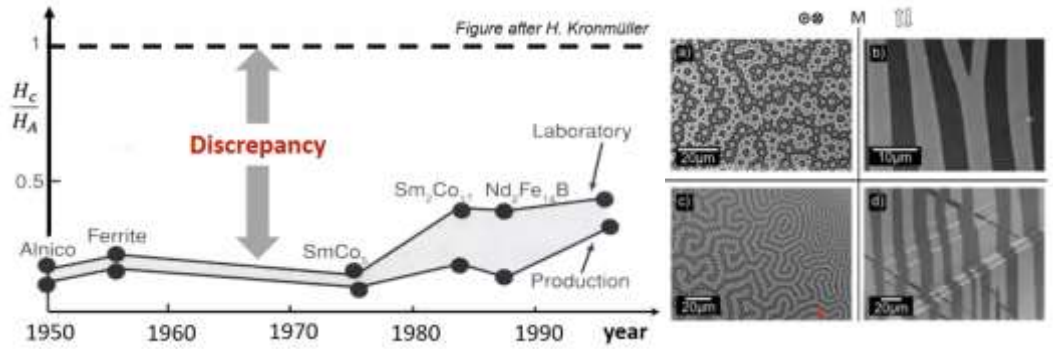




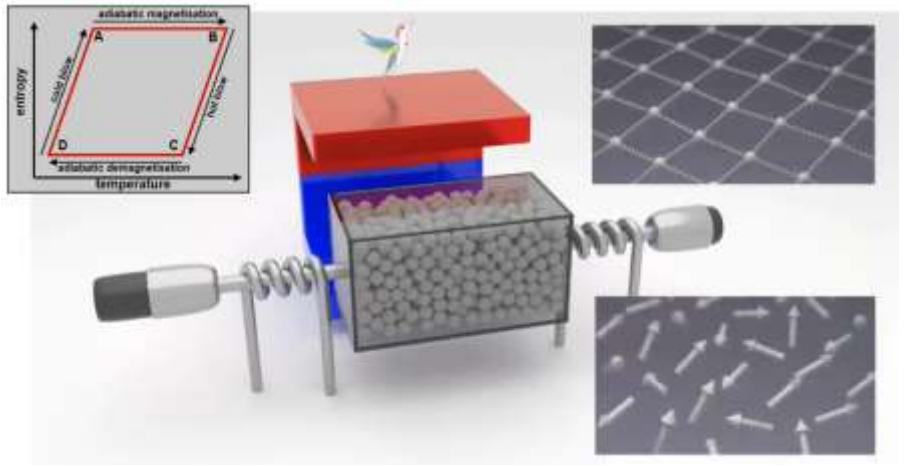
6. Prof. Oliver Gutfleisch: Hysteresis design of magnetic materials for efficient energy conversion

- Criticality of the need in magnetic material in modern technologies: what order of magnitude are we talking about (key figures of consumption, availability, occurrence etc.) ?

- Strong and soft magnets - address the following points:
  - Types of applications
  - Key magnetic concepts (hysteresis, coercive and anisotropy field, magnetocaloric effect, etc.)
  - How to increase their efficiency ? Relate it to their microstructure.



- Select and discuss a new device and/or fabrication process that integrates such newly improved efficiency



https://vimeo.com/554231928

7. Visualizing Spin Currents with X-ray Microscopy - Dr. Hendrik Ohldag, *Lawrence Berkeley National Laboratory*

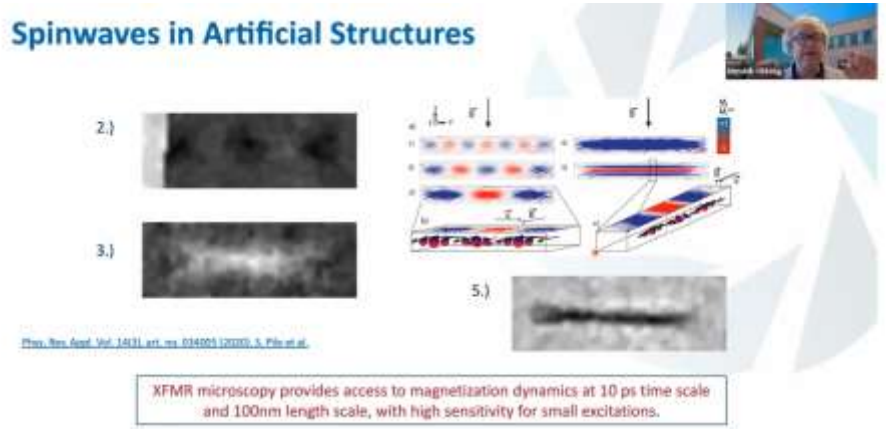
Key points:

Measurement techniques:

- XMCD (X-ray Magnetic Circular Dichroism) working principle
- STXM (Scanning Transmission X-ray Microscopy): working principle

(any) application of interest:

https://www.spintalks.org/talks/hohldag



Evaluation criteria

Evaluation Form MSE-432 (Student Talk, Presentation, Q&A session, Summary)

Presenter: _____

Topic: _____

Part: _____ Duration: _____

The Presentation:

		1	2	3	4	5	6
1	The presentation was concise and informative.						
2	The presentation contained practical examples and useful technical aspects explaining the methodology, and its pros and cons.						
3	The layout of slides, letter sizes, visual aids and timing were effective.						

The Presenter:

		1	2	3	4	5	6
4	The presenter delivered the material in a clear and structured manner.						
5	The presenter was knowledgeable about the topic and any related issues.						
6	The presenter maintained the interest of the audience during the entire presentation.						
7	The presenter answered questions effectively.						
8	The presenter was enthusiastic about the topic.						
9	The presenter was well organized and prepared.						

The Summary:

		1	2	3	4	5	6
10	The summary contained the main aspects to be covered in the individual presentation.						