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# Advanced Topics in Magnetism and Superconductivity

Part I (3 cfu): José Lorenzana

Part II (3 cfu): Paolo Barone & Maria Navarro Gastiasoro

20 hours + 20 hours

Tentative starting date: January 10

The course will cover aspects of magnetism and superconductivity often not covered in undergraduate programs. The tentative program will be adapted according to the interests of the students.

Part I: From principles of magnetism to topological insulators

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# Detail Program Part I

- Orbital and spin magnetism spin-orbit interaction.
- Exchange, superexchange and double exchange
- Goodenough-Kanamori-Anderson rules
- Models by Zener and De Gennes
- Ferromagnetism and Antiferromagnetism
- Spin waves
- Magnetism in Metals, Itinerant Ferromagnetism. Stoner criterion
- Landau levels and quantum Hall effect
- Topological Insulators
- Kosterlitz-Thouless transition

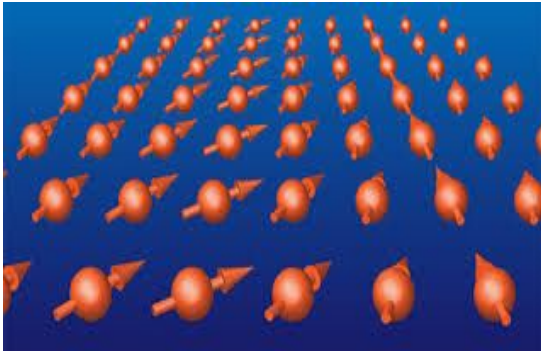
Bibliography:

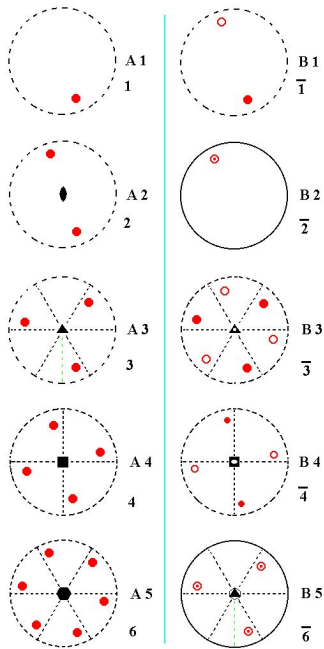
- Quantum Theory of Solids, C. Kittel
- Magnetism in Condensed Matter, S. Blundell
- Lecture Notes on Electron Correlation and Magnetism, P. Fazekas
- Hasan, M. Z. & Kane, C. L. Colloquium: Topological insulators. Rev. Mod. Phys. 82, 3045–3067 (2010).
- Many Particle Physics, G. Mahan
- Principles of Condensed Matter Physics, P.M. Chaikin and T.C. Lubensky

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# Detail Program Part II

Info:

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Part II

Paolo Barone:

- Symmetry and Group Theory in Condensed Matter
- Ferroic systems (ferroelectrics, ferroelastics, ferromagnets) and multiferroicity
- Ferroelectrics and the modern theory of polarization
- Landau theory and symmetry considerations for ferroic systems
- Spin-splitting effects (Rashba and Dresselhaus effects)

Maria Navarro Gastiasoro:

- Superconductivity and dynamical interactions (Migdal-Eliashberg theory & code)
- Unconventional superconductivity: anisotropic pairing

Bibliography:

- Group Theory: Applications to the Physics of Condensed Matter, M.S. Dresselhaus, G. Dresselhaus, A. Jorio
  - Introduction to ferroic materials, V. K. Wadhavan
  - Physics of Ferroelectrics - A Modern Perspective, eds K.M. Rabe, C.H. Ahn, J.-M. Triscone
  - Spin-orbit Coupling Effects in Two-Dimensional Electron and Hole Systems, R. Winkler
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