

PhD course "From coordination polymers to nanoparticles: design strategies and characterization for new magnetic materials"

SYLLABUS

1 Lecturer information

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2 Title of the course

From coordination polymers to nanoparticles: design strategies and characterization for new magnetic materials

3 Course program

- Basics of coordination chemistry
- Crystal-field and Ligand Field theories
- Magnetic properties of free ions
- Diamagnetism and paramagnetism
- Magnetic anisotropy
- Magnetic exchange interaction
- Design and synthesis of 1D coordination polymers
- Magnetic properties of 1D coordination polymers
- Single-chain magnets
- Synthesis and application of nanometric colloids
- Ultrasmall nanoparticles
- Magnetic properties of nanoparticles and 0D Molecular clusters

4 Course content detailed per lesson of two hours (possibly with dates and room real and virtual)

- Lesson 1 – aula 186 Zvi Jolles, 13-02-2024 - from 14:30 to 17:00h – Basic principles of coordination chemistry: coordination environment of transition metal ions, kinds of ligands, chelate effect, Crystal-field and Ligand Field theories, Ligand Field Stabilization energy and

effect on Kinetics of reactions, Hard Soft Acid Base applied to complex, coordination polymers and applications.

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Lesson 2 – aula 186 Zvi Jolles, 15-02-2024 – from 14:30 to 17:00h - kinds of 1D coordination polymers, magnetic properties of free ions, diamagnetism and paramagnetism, magnetic anisotropy, magnetic exchange interaction, magnetic properties of 1D coordination polymers, relevance of magnetic behaviour of 1D coordination polymers to Molecular Magnetism field, spin topology in magnetic chains.

Lesson 3 – aula 186 Zvi Jolles, 20-02-2024 – From 14:30 to 17:00h- Metal-radical strategy, ferrimagnetic chains, single chain magnets, magnetic relaxation in single chain magnets.

Lesson 4 – aula 186 Zvi Jolles, 22-02-2024 – From 14:30 to 17:00h - methods of synthesis and characterization of nanometric colloids, ultrasmall nanoparticles, Magnetic properties of nanoparticles and 0D Molecular clusters

5 Suggested reading

- Huheey, James E.; Keiter, Ellen A.; Keiter, Richard L.; Inorganic Chemistry: Principles of Structure and Reactivity, 4th Ed., HarperCollins College Publishers, (1993), ch. 11-13.
- Kahn, Olivier; Molecular Magnetism, VCH Publishers, Inc., New York, (1993).
- Gatteschi, Dante; Sessoli, Roberta; Villain, Jacques; Molecular Nanomagnets, Oxford University Press, USA (2006).
- Günter Schmid – Nanoparticles: From Theory to Application, 2nd Edition-Wiley-VCH (2010), ch. 3.
- Magnetic Relaxation in Fine-Particle Systems, J. L. Dormann, D. Fiorani and E. Tronc, Advances in Chemical Physics,
- Papers related to the topics.

6 Learning Objectives

In this course we shall study basic principles of magnetic properties at molecular level and present how molecular magnetic properties depend on the chemical structure of molecules. It will be focused on 1D coordination polymers and its historical contribution to the field of Molecular Magnetism as well as challenges in reducing dimensionality to 0D such as large magnetic molecular clusters and nanoparticles.

7 Knowledge and Skills to be acquired

Introduction to magnetic properties of coordination compounds, notion of historical evolution of Molecular Magnetism Field; challenges and research developed in the synthesis and study of magnetic properties of 1D coordination polymers and 0D nanoclusters.

8 Prerequisites

- coordination chemistry (transition metal ions) and introductory quantum mechanics

9 Teaching Methods

MODE 1 - Pre-recorded lessons uploaded on the moodle platform (a meeting must be organized with PhD students in order to clarify eventual doubts)

MODE 2 (preferred) - Lessons delivered in-person and in remote with simultaneous recording by the Google Meet platform

(The lessons must be recorded and available to all the students that cannot take part to the lessons in streaming. The Webex platform must be used. All course content should be uploaded to the Moodle platform on the Chemical Sciences PhD page "Courses and Seminars of the PhD in Chemical Sciences 2022-2023")

10 Further information

In this course we shall study basic principles of magnetic properties at molecular level and present how molecular magnetic properties depend on the chemical structure of molecules. It will be focused on 1D coordination polymers and its historical contribution to the field of Molecular Magnetism as well as challenges in reducing dimensionality to 0D such as large magnetic molecular clusters and nanoparticles

11 Type of Assessment

Presentation and discussion of papers in seminar

12 Period

13-02-2024 – From 14:30 to 16:30h

15-02-2024 – From 14:30 to 16:30h

20-02-2024 – From 14:30 to 16:30h

22-02-2024 – From 14:30 to 16:30h