



Adam Mickiewicz University in Poznań

Doctoral School of Exact Sciences AMU

Molecular magnets: fundamentals and applications

Scientific lectures, workshops

Field of science	Physics
Teaching method	lecture
Language	English
Numbers of hours	20
Aims of the course	To acquaint students with: a class of magnetic materials based on non-interacting magnetic molecules, experimental and theoretical methods used in molecular magnetism and potential applications of magnetic molecules.
Course contents	<ol style="list-style-type: none"> 1. Historical introduction, reasons for investigating molecular magnetism, field overview 2. The origin of magnetism in molecules: spin and orbital magnetic moments, dipolar, exchange, super exchange and double exchange interactions, crystal field 3. Experimental characterization of molecular magnets: DC and AC SQUID, EPR, INS, NMR, torque magnetometry, calorimetry 4. Molecular magnets based on transition metals 5. Single ion magnets based on lanthanides. 6. Molecular magnets with mixed valence and itinerant electrons and hybrid molecular magnets 7. Relaxation phenomena: Quantum tunneling of magnetization, Raman, direct and Orbach processes 8. Electronic/spin transport through molecular magnets 9. Single molecule magnets and application in quantum computing 10. Application in: electronics/spintronics, molecular refrigeration,...
Prerequisites and co-requisites	Knowledge of: <ol style="list-style-type: none"> a. basic quantum physics b. calculus c. basic knowledge on the undergraduate level on electricity and magnetism d. basic notions from quantum chemistry

Learning outcomes

On completion of the course PhD candidates will be able to:	Assessment mode
Understand the origin of magnetism in molecules and the difference between the bulk and molecular magnetic materials.	exam
Know and understand experimental techniques that can be used to characterize molecular magnets.	exam
Know and understand different phenomena, such as for instance	exam

relaxation processes, responsible for peculiar properties of molecular magnets.	
Recognize main types of molecular magnets	exam
Know and understand potential applications of molecular magnets in spintronics/electronics, quantum information processing, magnetic refrigeration, and other	exam
Read with understanding and refer the literature on molecular magnetism.	exam
Literature	<p>[1] D. Gatteschi, R. Sessoli, J. Villain, Molecular Nanomagnets, Oxford University Press, 2006.</p> <p>[2] J.F. Bartolomé Fernando Luis Julio Fernández ed., Molecular Magnets Physics and Applications, Springer, 2014.</p> <p>[3] J. Tang, P. Zhang, Lanthanide Single Molecule Magnets, 2015th ed., Springer-Verlag Berlin Heidelberg, 2015</p> <p>[4] C. Benelli, D. Gatteschi Introduction to molecular magnetism. From transition metals to lanthanides, Wiley-VCH Verlag, 2015</p>
Additional information	E_W01, E_W02, E_U01, E_U02, E_U05, E_K01