



Universidade do Minho



8. Curricular Unit

Advanced Physics Topics 1

Module

Nanomagnetism (NM)

Type

Lecture course

Contact hours

18

Professor/Researcher in charge

João Pedro Araújo, U. Porto, Vitor Amaral (U. Aveiro)

Summary of Contents

Magnetism: basic macroscopic concepts. Magnetic moment, diamagnetism, paramagnetism. Macroscopic description: field and temperature dependence of a spin $\frac{1}{2}$ paramagnetic system.

Spin, orbital and magnetic momentum. Electronic configurations, Hund rules, 3d and 4f atoms/ions

Brillouin function, Curie law, Pauli paramagnetism. Perturbation theory and Van Vleck paramagnetism. Magnetic interactions, microscopic description, ferromagnetism, ferrimagnetism, antiferromagnetism. Electronic correlations. Mean field models. Curie-Weiss law

The Landau theory of phase transitions: order parameters, equation of state, critical temperature and exponents, Arrott-Belov plots, coupled magneto-volume phase transitions, the magnetocaloric effect.

The Bean-Rodbell model, scaling plots, critical phenomena, the Ising and Heisenberg models, the Arrott-Noakes equation of state.

Magnetic domains. Magnetostatic energy, anisotropy energy. Domain walls.

Magnetic nanoparticles, Stoner-Wolfhart model.

Superparamagnetism, relaxation, Néel and Brown mechanisms. Energy distributions, dipolar interactions, surface effects. Exchange bias. Applications: recording, hyperthermia and magnetic resonance imaging.



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Evaluation

Written essay on selected topics. Oral presentation (15') followed by discussion (10').

Jury

João Pedro Araújo, Vitor Amaral, João Ventura