**Tesi disponibili presso il gruppo AFN/NMR per laurea triennale e magistrale in Fisica, e per dottorato di ricerca**

**Available BD, MD, PhD thesis at AFM/NMR group**

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**Fisica biomedica /dello Stato Solido**

1. Studio di proteine di membrana naturali ed artificiali per mezzo di Microscopia a Forza Atomica - AFM
2. Nuovi agenti di contrasto nanometrici per Imaging con Risonanza Magnetica (MRI) : caratterizzazione AFM e rilassometria NMR
3. Nuovi agenti nanometrici per Ipertermia Magneto-Fluida : caratterizzazione magnetica e misure di Specific Absorption Rate (SAR)
4. In collaborazione con Strutture sanitarie : (a) La Radiomica in MRI; (b) Diffusion-MRI

**Magnetismo - Fisica dello Stato Solido**

Effetti quantistici e dinamica di spin in nanomagneti molecolari

1. **RESEARCH PROJECT ON “****MAGNETIC NANOPARTICLES IN BIO-MEDICINE” (BIOPHYSICS/SOLID STATE PHYSICS)**

The thesis activities presented below belongs to a more general research line about magnetic nanoparticles (and molecular nanomagnets) studied as multifunctional materials, with special attention devoted to applications in bio-medicine. In this framework, fundamental problems of quantum mechanics and classical physics could also be addressed.

1. **Study and characterization of magnetic nanoparticles as contrast agents for Magnetic Resonance Imaging**

Recently the scientific community paid a lot of attention to the synthesis of multifunctional magnetic nanoparticles with the aim of obtaining compounds with different applications in the field of bio-physics. Among these applications the possibilities to obtain new contrast agents for Magnetic Resonance Imaging (MRI) and to reveal (with magnetic techniques) the success of the local application of a “pathology specific drug” via the use of a delivering molecule (drug delivery), were evidenced. The success of these applications could help in prevention and care of diseases.

The proposed reasearch activity will be focused on the characterization of newly synthesized magnetic nanoparticles to be used possibly as MRI contrast agents, by means of Nuclear Magnetic Resonance (NMR), SQUID magnetometry and Atomic/Magnetic Force Microscopy (AFM/MFM). By AFM/MFM, the morphological and (surface) magnetic structure of new compounds will be studied. By SQUID magnetometry, the magnetic properties will be determined through magnetization and susceptibility measurements. By NMR, the relaxivity curves of new nanosize magnetic materials will be investigated. A heuristic model that could explain the physical mechanisms involved in the nuclear relaxation will be also proposed. The structural and morphological properties of novel systems will be put in connection with their physico-chemical properties.

This research will be developed in the framework of national (INFN Hadromag) and international (EU-COST Eurelax and EU-COST Radiomag) projects.

1. **Investigation of magnetic nanoparticles as agents for Magnetic Fluid Hyperthermia**

Recently, many multifunctional magnetic nanoparticles with theranostic abilities have been synthesized. Among different bio-medical applications, the possibilities offered by Magnetic Fluid Hyperthermia (MFH) to treat solid tumours have stimulated big efforts among many research groups in the synthesis of new nanosized magnetic compounds. In the proposed research, by AFM the morphological structure of new compounds will be studied, while by SQUID magnetometry and NMR the static and dynamic magnetic properties will be determined. By measuring the specific absorption rate (SAR) at different fields and frequencies, the current theories of heat release in nanosized magnetic materials will be tested. Finally, the heating efficiency in conditions similar to clinical ones will be measured.

**B. RESEARCH PROJECT ON “****BIOPHYSICS WITH ATOMIC FORCE MICROSCOPY” (BIOPHYSICS/SOLID STATE PHYSICS)**

**I. Observing structure, characteristics and assembly of membrane protein by Atomic Force Microscopy”**

The unique property of AFM to observe directly single proteins in their native environment allows to obtain detailed information concerning the interactions of proteins that give rise to functional domains. The use of force-distance curves of single molecules matched with their imaging, opens new possibilities to analyze intra and inter molecular forces.

The objective of the research project is the visualization and the characterization with the AFM of two membrane proteins belonging to the super family of neurotransmitters (Na + -Cl - dependent) directly on the plasmatic membrane of Xenopous Laevis oocytes. Information concerning their location, their density distribution and their oligomeric structure allows to correlate their biological functionality to the morphological modifications.

The work is supported by a FIRB of MURST and developed with the teamwork of prof.Muller (Dresda) and prof.Boekema ( Groningen ). A group of physiologists and biochemists of the same Institute works inside the project and guarantees the expertises and the cooperation in the respective fields.