Riorganizzazione Scientifica di SPIN:
Analisi della configurazione attuale e proposta genovese

La discussione sul processo di riorganizzazione scientifica di SPIN è avvenuta in due riunioni a cui sono stati invitati tutti i componenti di staff dell' Unità oltre che in vari incontri «singoli».

Sono anche stati tenuti contatti molto stretti con le altre unità in modo da avere informazioni sulle iniziative in corso nelle altre sedi.

Sono stati presi in considerazione quali documenti pertinenti alla discussione il documento dell'IAB circa la riorganizzazione dell'Istituto, le bozze di regolamento sinora a disposizione e la suddivisione in programmi del Dipartimento

Perché cambiare organizzazione scientifica?

- Problemi nella struttura attuale
- Possibilità di intercettare più facilmente finanziamenti a livello internazionale, nazionale, locale
- Modifica dei regolamenti CNR
- Migliorare immagine esterna dell'Istituto

Analisi della situazione

Analizzando la situazione attuale per quanto riguarda i tre moduli genovesi appartenenti alle commesse:

1) Materials and mechanisms of superconductivity and its power applications

4) Functional materials and novel devices for electronics and energy applications

5) Dynamical, electronic and transport properties of complex systems and functional materials

i ricercatori genovesi non ravvedono problematiche tali da richiedere una profonda revisione dello status attuale, soprattutto in assenza di chiare indicazioni provenienti dal nuovo regolamento CNR.

Tuttavia, alcuni aggiustamenti migliorativi potrebbero essere richiesti anche alla luce dalla sparizione della suddivisione in moduli delle commesse o nel caso in cui altre commesse presentassero problemi maggiori.

In caso di modifiche della struttura attuale vengono individuati i seguenti punti principali:

1) **La presenza di commesse «metodologiche» a fianco di quelle «tematiche» non viene vista come un problema**

2) **Si conviene che la struttura che meglio rappresenta le attività dell'Istituto sia quella attuale dei "moduli" e delle interazioni tra di essi.**
   Si propone quindi di cominciare una riflessione su una struttura basata sui moduli, in modo da effettuare una ricostruzione più vicina alla realtà dei gruppi di ricerca e delle collaborazioni tra di essi. Si è però consci che una organizzazione troppo locale è contraria allo spirito di unitarietà di SPIN

3) **Si esprime una chiara preferenza per la possibilità di afferire a più Commesse soprattutto nel caso in cui la riorganizzazione porti ad una maggiore specificità delle stesse.**

Proposta di eventuale modifica organizzazione SPIN

1) **Superconductivity: mechanisms and applications for energy**

2) **Innovative materials with entangled spin, orbital and charge degrees of freedom**

3) **Materials and systems for energy conversion**

4) **Materials and devices for biomedical and sensing applications**

5) **Materials and devices for future electronics: quantum electronics and spintronics**

6) **Electronic and thermal transport from the nanoscale to the macroscale: from fundamentals to applications**

7) **Light- matter interaction for the understanding and control of equilibrium and non-equilibrium physics on innovative materials**

In caso di commesse molto grandi e fortemente delocalizzate (ad esempio 5) si possono prevedere declinazioni locali delle stesse

1) Superconductivity: mechanisms and applications for energy

- Synthesis of superconducting materials and precursors in form of powders, bulks, thin films, crystals.
- Investigation of mechanisms of superconductivity in novel superconductors
- Exploring the potential of novel superconducting materials (Bi2212, MgB2, iron-based superconductors) for power applications.
- Realization of magnets for biomedical and energy storage applications
- Topological effects in MultiBand superconductors

2) Innovative materials with entangled spin, orbital and charge degrees of freedom

- Synthesis of ferroics and multiferroics materials in form of sintered bulk pellets or single crystals;
- 4d and 5d transition metals with perovskite and double layer structures with strong spin orbit interaction;
- Metal-insulator transitions induced by charge/spin/orbital ordering;
- Non conventional spin-textures and Skyrmion physics in novel ferromagnets and artificial heterostructures;
- Multiferroic effects based on Giant Rashba spin orbit in semiconducting systems and Topological insulators;
- Multiferroics effects under external pressure and epitaxial strain, artificial multiferroics and improper multiferroics

3) Materials and systems for green energy and environment

- Ink-jet deposition of chalcogenides for energy applications.
- Solid Oxide Fuel Cells
- Thermoelectric materials
- Carbon-based systems, chacogenides for photovoltaic
- Transition metal NP for plasmonics (enhancement of photovoltaic cell efficiency)
- Anti-bacterial activity of oxide nanoparticles
- …

4) Materials and devices for biomedical and sensing applications

- All-Oxide MEMS
- Carbon based sensors
- Innovative devices for ultra low MRI
- Computational methods for MEG analysis
- …

5) Materials and devices for future electronics: quantum electronics and spintronics

- Interfaces between oxides, organic-organic interfaces, hybrid organic-inorganic interfaces
- New 2D systems (graphene, sulfides, selenides, ..)
- Spin injection in 2DEGs and spin polarized 2DEGs
- Low-Temperature Transport and magneto-transport
- Surface and interface electronic and magnetic states
- Topological insulators
- Micro and nanodevices for electronics and spintronics
- Quantum electronics: Single Electron Transistors, Josephson junctions

6) Electronic and thermal transport from the nanoscale to the macroscale: from fundamentals to applications

The controlled and reproducible design of new functional devices for energy transport and conversion is an emerging and rapidly developing research field. The nature of the basic interactions governing the fundamental processes in these devices is far from being understood, because electronic, lattice, spin and optical (photon) processes occur and can interfere with each other. Moreover, at the macroscopic level, other phenomena, such as the effects of energy exchange and scattering against the boundaries might take place. The fundamental phenomena span a length scale that ranges from the nanoscale (nanodevices, nanoscale circuits, nanowires and nanotubes, etc.) to the macroscale (composite materials, organic compounds, amorphous blends, etc.), so that their investigations require a multi-scale approach and a variety of different competencies. Emerging materials, such as graphene, topological insulators, semiconductors with helical and chiral edge states, hybrid organic-inorganic perovskite materials, layered compounds, nano- and micro-composites, and so on have been shown to be good candidates for energy applications, each with its own advantages and drawbacks. Moreover, the increased accuracy in the control and manipulation of quantum systems has brought us close to realistic implementations of quantum heat engines. Driven quantum systems are emerging as a valuable alternative in designing new and powerful microscopic devices with complex and rich thermodynamical behavior. These systems could offer the possibility to manipulate heat on a quantum scale with numerous applications extending from quantum information to technological and biological device design. In view of applications for low-power (nano)electronics, energy harvesting and conversion, one needs a better understanding of heat production, and energy transport, dissipation and conversion from the quantum to the macroscopic scale. The scope of the present activity will be the study, from the classical to the quantum level, of the fundamental processes involved in the motion of carriers, lattice vibrations and other excitations in a large variety of materials and devices (including new generation solar cells, thermoelectrics, nanoelectromechanic devices, etc.) of interest for energy transport and conversion. For this purpose, different approaches will be available, able to provide adequate description from the atomistic to the microscopic level, from quantum mechanics to molecular dynamics.