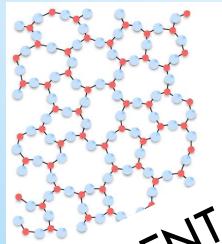
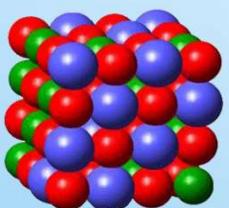


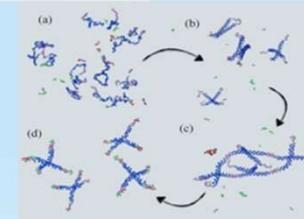
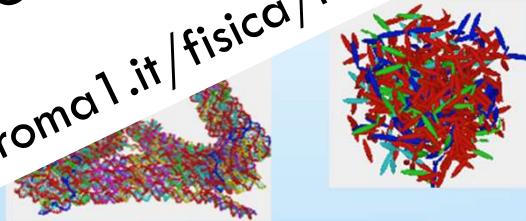
CONDENSED MATTER PHYSICS

HARD CONDENSED MATTER



DEPARTMENT OF PHYSICS
SCIENTIFIC REPORT
<https://www.phys.uniroma1.it/fisica/ricerca/scientific-report>

SOFT C



DEPARTMENT OF PHYSICS
January 2014-December 2016

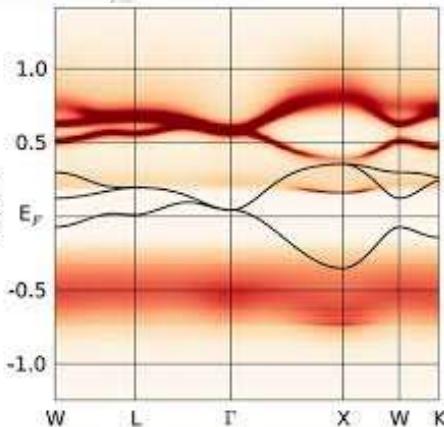
SCIENTIFIC REPORT



DIPARTIMENTO DI FISICA
SAPIENZA
UNIVERSITÀ DI ROMA



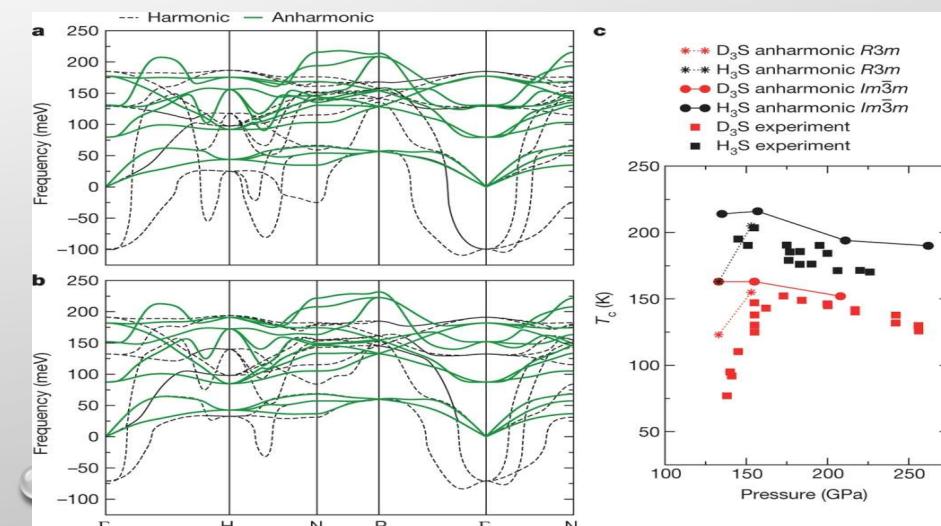
What hard condensed matter theorists do?



- What is the electronic structure of the different solid-state materials?
- Can electronic states be ‘topologically non trivial’?
- What are the resulting physical properties? Insulator, metal, superconductor,...
- How electrons and other degrees of freedom (e.g. ions) interact?

For instance new techniques can be invented to treat the anharmonic effects in solids and investigate the stability of **high-temperature superconductors under very high pressure**

F. Mauri



Quantum Materials Modelling

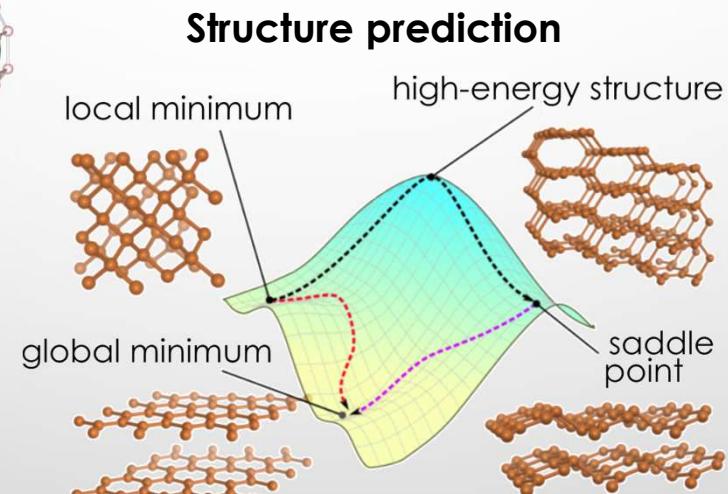
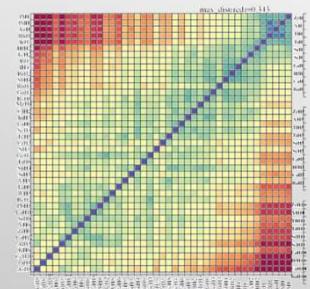
(Bachelet, Boeri, Flores, Moroni)

Research Goal = theory & design of complex solids, use & development of theoretical-computational methods based on quantum mechanics.

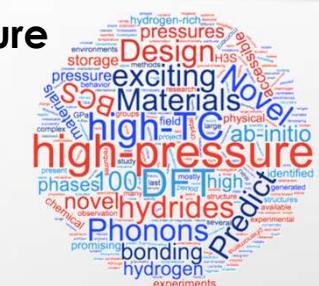
High-Tc superconductors



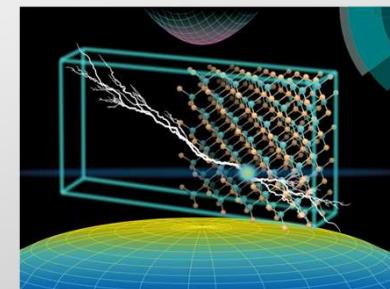
Machine learning



High-Pressure Physics



Transparent conductors



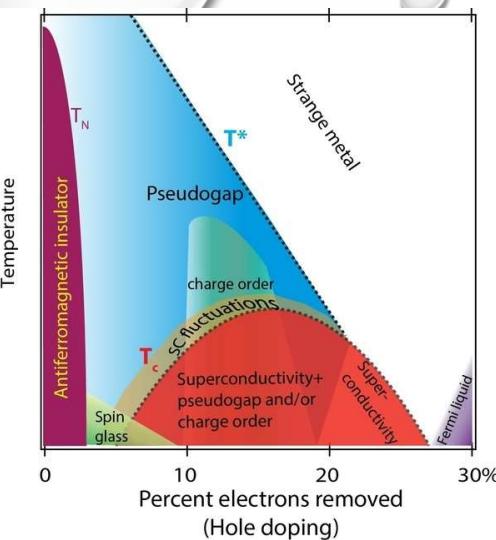
Keywords = Superconductors; Transparent conductors; Magnetic Materials; Ab-initio crystal structure prediction; Machine Learning; DFT; QMC; Pseudopots.

MODELLING SUPERCONDUCTIVITY AND ITS ENEMIES (DISORDER, CDW, ...)

L. Benfatto, S. Caprara, M. Grilli,...

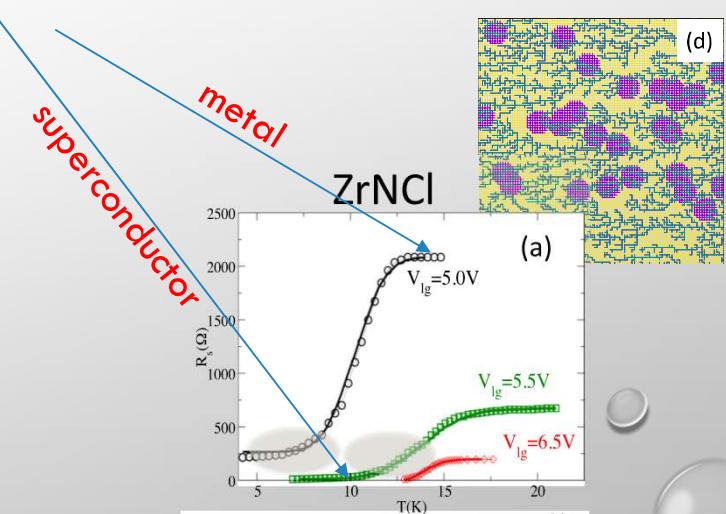
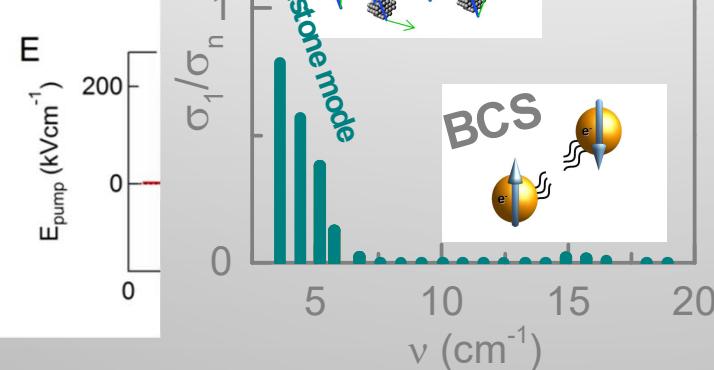
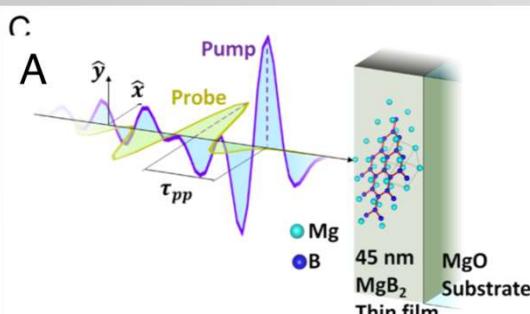
Some materials change a lot their properties by varying some parameter (e.g. electron density) and have strange properties. Why? Which ingredients are important and should be kept in a model?

Competing phases are very interesting and new features can emerge...
One of the aspects of complexity...

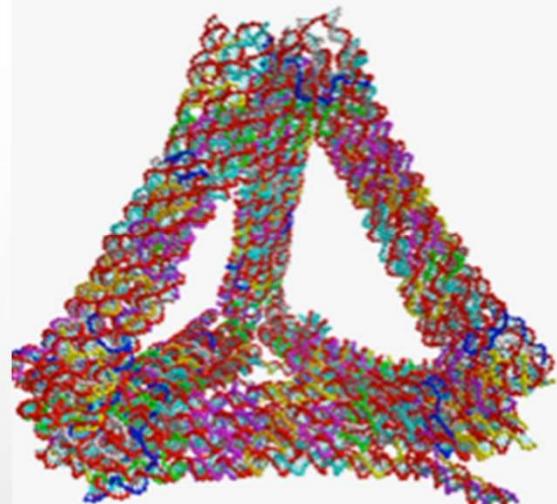


How electrons oscillate collectively in a superconductor?

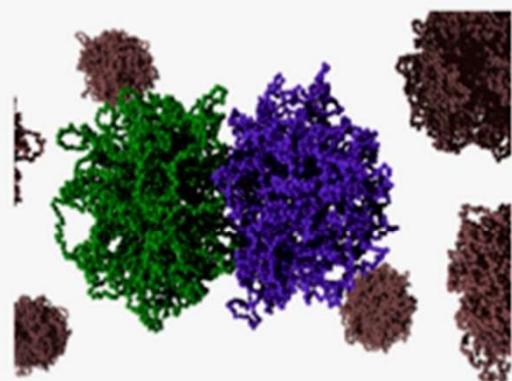
Analogy with high-energy stuff....
(Higgs, Goldstone and so on...)



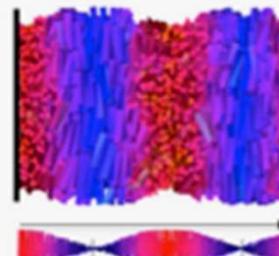
Soft Matter Modeling



DNA-made origami particles

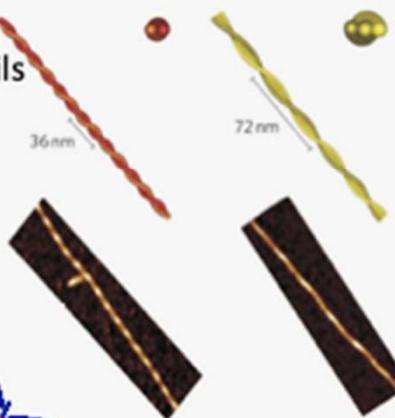


Polymeric microgels

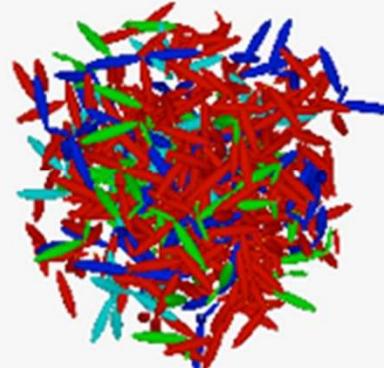


Modeling nematic phases of biological macromolecules and colloidal particles

Amyloid fibrils



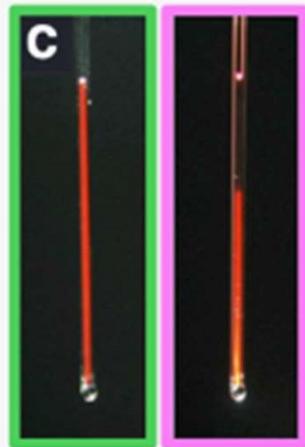
Epoxy resin glues



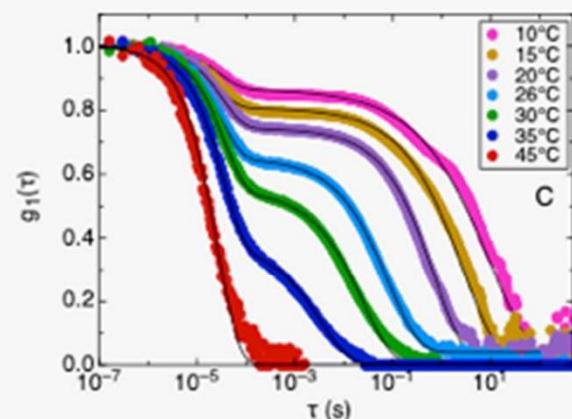
Cristiano De Michele
Lorenzo Rovigatti
Francesco Sciortino

Soft Matter Experiments

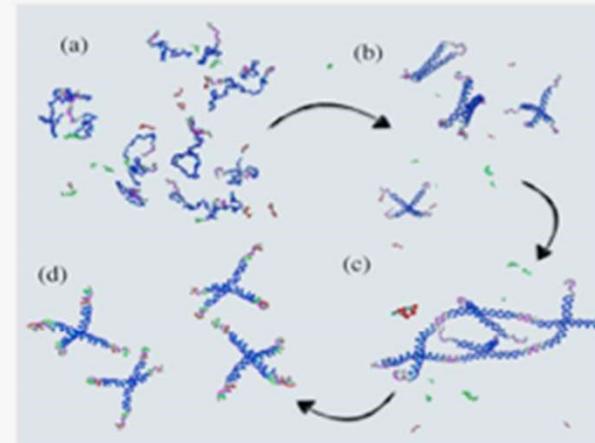
Designing and creating functional gels of DNA



Measuring the
gel phase behaviour

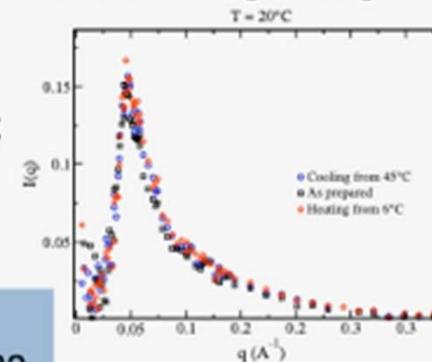


Measuring the gel density fluctuations
via dynamic light scattering



Mechanism behind the re-entrant gel design

Using small angle
neutron scattering
to quantify the gel
structure



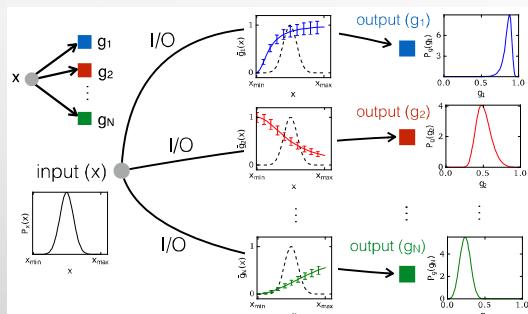
Federico Bordi
Francesco Sciortino

Condensed Matter Theory spin offs:

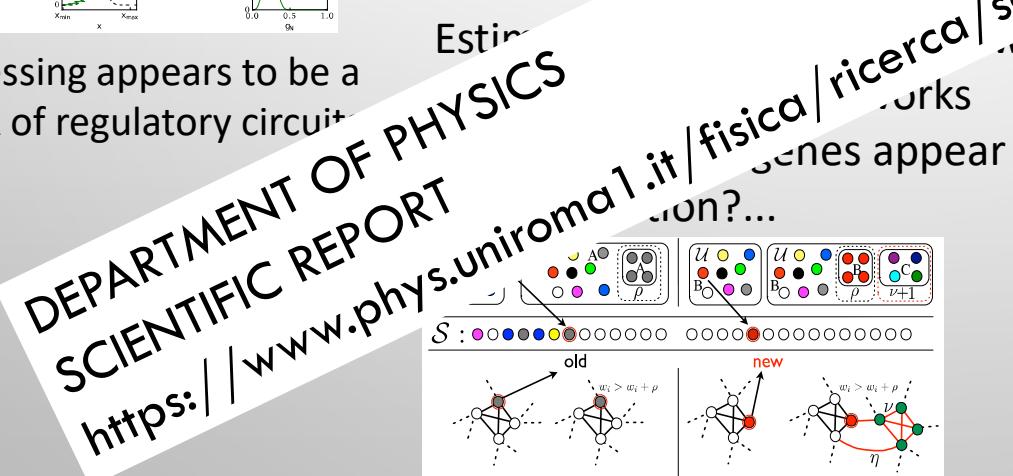
The physics of 'a lot of things'!

A. Crisanti, V. Loreto, L. Pietronero, F. Tria

Gene expression is a complex process that should be regulated via networks of molecules (proteins or RNAs) that interact with each other



noise processing appears to be a central task of regulatory circuits

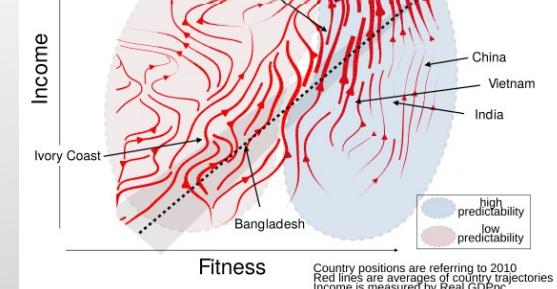


Growth of complex systems

Planning of infrastructure, containment of epidemics, impact of political information



Estimating the growth of complex systems



quantitative assessments of countries' competitiveness and potential of growth, through the concept of **Fitness**, and products' sophistication and technological content,