Statistical Mechanics

and Complexity

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A Proposal for an INFM Research and Development Center in Rome, directed by Giorgio Parisi (OFFICIALLY APPROVED last WEDNESDAY IN ITS FINAL FORM!).

Next I start with a summary (trying to be not too much of a bore: from Webster, a person or thing that wearies by prolixity or dullness).

Madrid, April 2001

Summary

A few words about history, as far as here history can indeed be relevant.

Physics has been (and hopefully is) important in Italy. Probably of higher quality and more advanced, because of historical accident, than many of the other branches of science.

Fermi and friends tradition. Via Panisperna. Amaldi legacy: CERN and INFN.

INFN model as opposed to CNR (very centralized) model (in Italy that works very better: not an universal recipe, obviously).

Recently: CNR $\longrightarrow$ INFM, from the success of the INFN model as opposed to the CNR centralized model.

Rome: evolution to new and complex physics related to solid state physics (to start with), applications, biology...

Many different groups (see later) with different but related interests.

La Sapienza is a very big University (close to 200.000 students...).

For some potential (and crucial) activities of the Center: logistic problems connected to being in a large and disordered town (Rome...). Potential problems mainly with medium term visitors.

Physics Department is a very Department: more or less 60 full professors, 50 associate professors, 40 assistant professors, plus post-doctoral fellows. Theory group is large: close to 60 members.

Most relevant groups in the Department: particle physics, theoretical and experimental, solid state physics, biophysics, geophysics, astronomy.

The new INFM, its style and Centers for Excellence.

INFM follows the path of INFN, but it is trying to make the best of the experience that has been built in these years. INFM is more dynamical than INFN: its structure is less rigid and hopefully will turn out to be less centralized (INFN was born around very monolithic high energy experiments).

INFM will be a new national institution to which permanent positions will be attached (like for INFN).

Main INFM funding channels, among others:

- post-doctoral fellowships.
- PRA (applied research projects).
- Co-funding together with the Research and Education Ministry.

And now, the Centers for Excellence.

INFM has decided to group in a selected locations fundings and permanent jobs related to different research areas. This is to maximize cost effectiveness, visibility, synergies. Looks reasonable!

Call for pre-proposals (July 2000 deadline). 3 to 5 Centers expected in Italy. Proposers were requested to select a well defined area, and a quite precise spatial localization (no networks).

Order of magnitude of funding: up to 3/4 MEuro per year per center (not a huge budget), plus budget for permanent research positions attached to the Centers.

Pre-proposal phase was quite detailed. Our proposal: Statistical Mechanics and Complexity. We have been the only Center for Theory that did the first round, together with 5 experimental proposals (Nano-technologies, Bose Einstein Condensation, Liquid Crystals).

Deadline for proposal was on December 2000. Final decision was 2 days ago, and it was positive for us (when I write that I do not know the practical details yet).

I will start discussing the details of our Center by telling about the main interests of the groups that have proposed the Center.

- Dynamical Structures: Enzo Marinari, Giorgio Parisi, Luciano Pietronero, Angelo Vulpiani.
- Strongly Correlated Quantum Systems: Giovanni Bachelet, Claudio Castellani, Ferdinando Di Pasquale, Carlo Di Castro, Luciano Pietronero.
- Systems with Very Slow Dynamics: Daniel Amit, Enzo Marinari, Giorgio Parisi, Piero Tartaglia.

Statistical Mechanics of Systems with Very Slow Dynamics (typically structural glasses and spin glasses)

- Slow Dynamics and Equilibrium Properties of Spin Glasses.
- Complex Systems and the Glassy State.
- Glassy Behavior of Granular Materials.
- Other Complexities.

Physics of Strongly Correlated Quantum Systems.

- New Concepts from Novel and Old Materials.
- Kinetic Energy, Correlation and Instabilities.
- Theoretical Issues.
- High Temperature Super-conductors and Super-conductivity in Novel Materials.
- Numerical Approaches to Strong Correlation.
- Parallel Activities in Quantum Strong Correlation and Interfacing Topics to Complexity.

Dynamical structures (the ones appearing for example in turbulence and in surface growth).

- Turbulence.
- Transport and Diffusion.
- Reacting Flows.
- Chaos and Complexity.
- Granular Matter.
- Fractals and Non-Equilibrium Critical Phenomena.

What do we want to do?

- Synergies. Have people working together. Try and improve on a typical pathology of European Academic system.
- Workshops (see Santa Barbara). Here problems with Rome: space, housing, personnel (we will get some new space from La Sapienza University, but probably not enough).

- Postdoctoral fellows.
- Postdoctoral school.

- Enhance European Collaborations.
- Seed activities, relations with industry and market.

Seed Activities, i.e. Seed Funding of Emerging Areas

- On the Internet
- Physics and Finance
- Effective Global Optimization
- Vehicular Traffic Improvement, and you surely understand how good an idea this is in Rome
- Earthquakes

Our Budget

First a table (sorry, this is in italian liras):

ACTIVITY DESCRIPTION	YEAR1	YEAR2	YEAR3	YEAR4	YEAR5	TOTAL
Disorder and Complexity	190	150	130	140	160	770
Strongly Correlated Quantum Systems	150	110	100	100	120	580
Chaos,Fractals,Non-Equilibrium	170	130	115	120	140	675
SEED FUNDING	**YEAR1**	**YEAR2**	**YEAR3**	**YEAR4**	**YEAR5**	**TOTAL**
Applied Statistical Mechanics	50	50	50	50	50	250
JOINT EXPERIMENTAL FACILITIES	**YEAR1**	**YEAR2**	**YEAR3**	**YEAR4**	**YEAR5**	**TOTAL**
	0	0	0	0	0	0
EDUCATION AND HUMAN RESOURCES	**YEAR1**	**YEAR2**	**YEAR3**	**YEAR4**	**YEAR5**	**TOTAL**
	390	645	720	645	570	2970
OUTREACH	**YEAR1**	**YEAR2**	**YEAR3**	**YEAR4**	**YEAR5**	**TOTAL**
	20	40	50	50	50	210
ADMINISTRATION	**YEAR1**	**YEAR2**	**YEAR3**	**YEAR4**	**YEAR5**	**TOTAL**
	50	50	50	50	50	250
TOTAL INFM FUNDING	**YEAR1**	**YEAR2**	**YEAR3**	**YEAR4**	**YEAR5**	**TOTAL**
	1020	1175	1215	1155	1140	5705

To make the story a bit shorter, we have a budget of basically $600kEuro$ per year. Close to half of that will be dedicated to PhD students and schools, $150kEuro$ to visitors and workshops, 50 to administration and 100 to seed activities and outreach.

More on the Budget

Part of the budget is allocated directly to our three different activities. We have allocated to the three different activities an average sum of 400 ML per year. Most of this amount will be dedicated to running the programs and to inviting long term visitors. We also plan to organize a Conference to start the Center and one after five years.

The amount of money dedicated to seed activities is low: we are using only 50 ML per year. They should fund themselves mainly by a direct relation with the outside world.

Education and human resources is the other main budget entry.

- We will fund at least three PhD scholarships per year.
- We plan to have of the order of 7 postdoctoral fellows on INFM funds. We are confident that at least five additional postdoctoral positions per year will be funded from other sources.

The organization of the Statistical Mechanics School will require 75 ML per year, that will be used to contribute to the stay and travel expenses of the students (and to support the speakers coming from out of Rome).

The funds we have destinated to the outreach will help in enhancing the visibility of our Center and the quality of its impact.

The funding for Administration includes one full time person that will be running the Center together with the INFM Roma Unity.

Management

The Director of the Center will have the responsibility of running the Center, under the guidelines of the Advisory Scientific Committee (ASC), that will have a very prevailing role. The ASC will draw the main Scientific lines that the Center will follow, will verify that such lines have been properly implemented, will judge the validity of the different Center programs.

The ASC will have 12 members: at least 6 of them will not be from Italian institutions. The Director of the Center will propose a list of potential members of the ASC to the INFM Scientific Council. The INFM Scientific Council will nominate the ASC after modifying, integrating, approving the list.

The ASC will meet once every year. After each meeting the ASC will send a written report to the INFM President and Scientific Council for evaluation.

The Center Director will be assisted by an Executive Board (EB). The EB will be composed by the Director and by four more scientists of the Center, nominated by the Director.