Dipartimento di Matematica e Fisica dell'Università degli Studi Roma Tre
Verbale del Consiglio di Dipartimento n. 2/2015
Seduta del 9 febbraio 2015

Ordine del Giorno:

1. Comunicazioni.
2. Approvazione del verbale della seduta del 19 gennaio 2015.
3. Scheda SUA-RD (Scheda Unica Annuale - Ricerca Dipartimentale)
4. Personale Docente.
5. Assegni di Ricerca.
6. Contratti e convenzioni.
7. Emissione bandi di selezione per personale a contratto.
8. Questioni riguardanti la Didattica.
9. Nuovo Accordo Didattico con il Dipartimento di Filosofia Comunicazione e Spettacolo.
10. Varie ed eventuali.

3. SCHEDA SUA-RD (SCHEDA UNICA ANNUALE – RICERCA DIPARTIMENTALE)

Il Consiglio, all'unanimità, delibera l'approvazione delle proposte per i quadri A1, B1, B2 e B3 relativi alla SUA-RD 2011-2013, delegando il Direttore ad apportare eventuali modifiche che si rendano necessarie.

6. CONTRATTI E CONVENZIONI.

Il Consiglio, udita la relazione del Direttore, all'unanimità, delibera l'approvazione della Convenzione con A*MIDEX-AAP Méditerraneé 2014 per il progetto di ricerca HYPATIE (Allegato n. 6.1) che comporterà per il Dipartimento un cofinanziamento di € 165.000,00 (centosessantacinquemila,00) cosi suddivisi: € 135.000,00 per il costo convenzionale del personale coinvolto per un totale di 3.000 ore; € 15.000,00 per il costo convenzionale delle spese di gestione del progetto; € 11.500,00 per il cofinanziamento di un assegno di ricerca; € 3.500,00 per scambi e visite dei ricercatori di Marsiglia che graveranno sui fondi di ricerca dei docenti del Dipartimento coinvolti nel Progetto e sui fondi dedicati della Sezione di Matematica.

7. EMISSIONE BANDI DI SELEZIONE PER PERSONALE A CONTRATTO.

Il Consiglio all'unanimità delibera l'emanazione di un bando di selezione pubblica per l'affidamento di n. 1 borsa di studio sul tema "Crittografia delle curve ellittiche" per la durata di n. 2 mesi, con un compenso di € 2.000,00 (duemila/00), che graverà sui fondi del Dottorato di Ricerca in Matematica, responsabile prof. Luigi Chierchia.

8. QUESTIONI RIGUARDANTI LA DIDATTICA

Il Direttore comunica che il presidente della Commissione Didattica in Fisica, prof. Mario De Vincenzi, ha inviato lo stralcio del verbale della seduta della Commissione del 22 gennaio u.s., con la comunicazione delle dimissioni del prof. Vittorio Sgrigna da membro della Commissione Didattica in Fisica a far data dal 22 gennaio u.s. La Commissione, sentito anche informalmente il Presidente della Sezione di Fisica prof. Filippo Ceradini, ha proposto di non procedere a individuare un sostituto del prof. Vittorio Sgrigna, come recita il comma 4 dell'art. 25 del Regolamento di Funzionamento del Dipartimento, ma di applicare i commi 1a e 1b e quindi di confermare la composizione con i soli precedenti membri. Il Consiglio, con un voto contrario e due astenuti, delibera l'approvazione della seguente composizione della Commissione Didattica in Fisica:

Prof. Mario De Vincenzi (Presidente)
Prof. Fabio La Franza (Membro)
Prof. Vittorio Lubicz (Membro)
Prof.ssa Domizia Orestano (Membro)
Prof. Mauro Rovere (Membro)
Dott.ssa Valentina Felicello (Segretario Didattico)
Sig.ra Marina Mongiorgi (invitata permanente con delega del Segretario Didattico in caso di sua assenza).

9. NUOVO ACCORDO DIDATTICO CON IL DIPARTIMENTO DI FILOSOFIA COMUNICAZIONE E SPETTACOLO

Il Consiglio all'unanimità delibera l'approvazione dell'Accordo Didattico con il Dipartimento di Filosofia, Comunicazione e Spettacolo, in vigore a partire dall'a.a. 2015/2016, per la copertura degli insegnamenti della Laurea triennale in Filosofia: Istituzione di Matematica per Filosofi – S.S.D. MAT/05 e Istituzione di Fisica per Filosofi – S.S.D. FIS/02.

Seguono nell'ordine gli allegati citati

A*MIDEX -AAP Méditerrané 2014

I Project PI

Pierre Picco, (DR CNRS)
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I2M, Institut de Mathématiques de Marseille
UMR AMU-CNRS 7373
39 rue F. Joliot Curie
13453 Marseille cedex 13, France

II Acronym of the project: LABHYP

III Project title: Laboratoire Hypatie

IV Priority themes : Sciences & Advanced Technologies

V Type of Project : UMI, LIA or LMI-type bilateral collaboration

VI Research units involved : Institut de Mathématiques de Marseille, UMR 7373

VII Mediterranean partners:

GSSI Grand Sasso Science Institute, L'Aquila, Center of Advanced studies, l'Aquila
DISIM Dipartimento di Ingegneria e Scienze dell'informazione e Matematica, l'Aquila
Dipartimento di Matematica Guido Castelnuovo, *La Sapienza* Roma
Dipartimento di Matematica Università degli Studi di Roma Tor Vergata
Dipartimento di Matematica e Fisica Università degli Studi di Roma Tre

VIII Requested funding: 400 000 euro

IX Experts suggested

Cédric Vilani (Lyon. Analysis)
René Carmona (Princeton, Probability)
Eric Carlen (Rutgers, Statistical Mechanics)

I Table of contents

II Non-confidential executive summary

The aim of this project is on the one hand to strongly support already existing collaborations in Logic, Number Theory, Probability, Mathematical Physics, Partial Differential Equations between the mathematicians that working at I2M and the ones that are working in the three mathematics departments of Rome, the mathematics department of l'Aquila and the recently created Grand Sasso Science Institute in l'Aquila. On the other hand and complementarily to the fisrt point to create a network of Master programs and Doctorate programs to allows master students and doctorates students to follow binational programs.

III Context, international position and objectives of the project

Geographical and scientific context

Three mathematics departments in Rome and two in l'Aquila are involved in this project: There are around 320 mathematicians in these 5 entities.

In the Dipartimento di Matematica of the Univerità degli Studi di Roma "*La Sapienza*" there are around 100 mathematicians with a permanent position; the director is Vincenzo Nesi, all the mathematics are present in this department with a very large group in Partial Differential equations, Mathematical Physics and Pure Mathematics.

In the Dipartimento di Matematica of the Univerità degli Studi di Roma Tor Vergata there are around 85 mathematicians with a permanent position, the director is Domenico Marinuci. The following subjects are very well developed: Analysis, Algebraic Geometry and Number theory, Complex Analysis, Mathematical Physics, Probability, Representation Theory

In the Dipartimento di matematica e Fisica of the Univerità degli Studi di Roma Tre, there are around 41 mathematicians with a permanent position, the director is Lucia Caporaso. The following subject are very well developed Commutative Algebra, Analytic Theory of Numbers, Non-linear Analysis and Dynamical Systems Algebraic Geometry, Differential Geometry, Evolution Problems in Mathematical Physics, Interacting Particles Systems, Special Functions, Combinatorics, Numerical Analysis, Logic.

In the Dipartimento di Ingegneria e Scienze dell'informazione e Matematica of the Univerità degli Studi dell' Aquila there are around 83 mathematicians with a permanent position. The director is Bruno Robino. The following subjects are very well developed : Algebraic Geometry, Applied Partial Differential Equations, Algebra, Differential Geometry, Evolution Equations, Control Theory, Calculus of Variations, Topology, Hyperbolic problems, Mathematical Method in Economy and Finance, Computational Method, Statistics, Stochastic Analysis and Statistical Physics, Non-linear Differential Equations.

The GSSI (Gran Sasso Science institute) is a recently created center for advanced studies is linked to the INFN (Istituto Nazionale di Fisica Nucleare) but has already as Joint institutions: the University of l'Aquila together with the SISSA (Scuola Internationale Superiore di Studi Avanzati, Trieste) for Mathematics and Physics, the Scuola Superiore Sant'Anna (Pisa) for social sciences and the institute for advanced studies Institutions Markets Technologies (IMT) of Lucca for Computer Science. It is an international PhD school and a center for research and higher education. The director is Eugenio Coccia. The coordinators of Mathematics and Informatics are respectively Pierangelo Marcati and Rocco De Nicola.

In the Institute of Mathematic of Marseille (I2M) there are around 200 mathematicians, the Director is Bruno Torresani and the developed subjects are similar to the Italian ones with the notable exception of

Mathematical Physics that for historical reasons has moved in France into Applied Analysis, Probability or Theoretical Physics.

Historical Context from the point of view of scientific collaborations

The scientific collaborations between Marseille and Rome in Mathematic in particular in Analysis, Mathematical Physics, and Logic have a long history. We can quote the historical collaboration : Gallavotti-Miracle-Solé; Scoppola-Bellissard; Cassandro-Olivieri-Orlandi-Merola-Picco; Valdinoci-Sire (This last one being now in Milano); Boccardo–Gallouët, and more recently Scoppola-Caputo-Faggionato-Gaudillière- and Faggionato-Mathieu.

Moreover the number of publications in Mathematics starting from 2000 between the three universities of Roma (La Sapienza, (rm1) Tor Vergata, (rm2) and Roma Tre (rm3)) and french mathematicians is around 118 (respectively rm1: 28 , rm2: 20 , rm3: 70). Among them 20 are between mathematicians that are or was in Marseille and mathematicians that are or was in Roma or l'Aquilla.

Historical Context from the point of view of bilateral agreements

Various international agreements were established between France and the 4 Departments of Mathematics in Rome and l'Aquila. (The GSSI being 1 year old, we do not mention it):

1 Agreement CNR-CNRS In the period 2000-2005 an agreement CNRS–CN with as main scientific themes Probability and Statistical Mechanics with as scientific coordinators Enza Orlandi (Italia) and Pierre Picco (France) was created. The scientific collaborations were mainly between Roma, Padova, Marseille and Rouen.

2 GDRE *Grefi mefi* In the period 2005-2013 the INdAM (Istituto di Alta Matematica) and the CNRS, created the GDRE *Grefi Mefi*, also financially supported by the Italian Embassy in Paris. Pierre Picco was the main coordinator, with Sandro Vaienti as french coordinator and first Carlangelo Liverani and then Dario Bambusi as italian coordinator. *Grefi Mefi* involved 80 laboratories in France and Italy. The main scientific themes were Statistical Mechanics of in and out equilibrium, Probability theory, Particles systems, Dynamical systems. Despite the very low budget, we were able to support 22 conferences in France and in Italy and 88 missions for collaborations that have produced around 80 publications that are genuinely French-Italian.

3 Europeen project Training and Mobility of Researchers : "Linear Logic in Theoretical Computer Science (1998-2002), Coordinator Laurent Regnier (Institut de Mathmatiques de Luminy), another partner is l'Equipe Preuves Programmes et Systèmes (CNRS UMR 7126-Universit Paris 7), the scientific coordinator in rm3 was Michele Abrusci.

4 Project of a PhD program " Logique mathématique et informatique théorique " between the Università di Roma TRE, Aix marseille 2 and IML, within the programm "Vinci" (2002–2004), the scientific coordinator in rm3 was Michele Abrusci(rm3).

5 Project " Echange de Professeur, chercheurs et personnel administratifs" between the Università di Roma TRE and the laboratories "Equipe Preuves Programmes et Systèmes" (CNRS UMR 7126-Université Paris 7), the "Laboratoire d'Informatique de Paris-Nord" (CNRS UMR 7030-Université Paris 13) and the IML within the "Vinci" (2002–2004), the scientific coordinator was Patrick Baillot (CNRS-Paris 13).

6 Agreement CNR–CNRS " Interactions et complexité (2004–2005) The italian coordinator was Marco Pedicini (rm3) the french coordinator was Patrick Baillot (CNRS Paris 13).

7 Agreement CNR–CNRS " Interactions et complexité (2006–2007) The italian coordinator was Marco Pedicini (rm3) the french coordinator was Olivier Laurent.

8 Project MIUR : internationalisation du système universitaire " French-Italian network in Logic and geometry of computation (1 Janvier 2006–31 Décembre 2008). The scientific coordinator in rm3 was Michele Abrusci (rm3) The network was made of the team of logic in rm3, "l'Equipe Preuves Programmes et

Systèmes" (CNRS UMR 7126-Université Paris 7), the "Laboratoire d'Informatique de Paris-Nord" (CNRS UMR 7030-Université Paris 13) and l'Institut de Mathématiques de Luminy,

9 Project PICS Logique Linaire et applications (1 Janvier 2010– 31 Décembre 2012), The scientific coordinator was Patrick Baillot (CNRS-Ecole Normale Supérieure de Lyon)

10 Projet " Curriculum binational de Master en Logique" between l'Università di Roma TRE, the 'Unversité d'Aix Marseille 2 and the Institut de mathématiques de Luminy. This project was supported by the programm "Vinci 2009" The scientific coordinator was Lorenzo Tortora de Falco (rm3) (years 2010/2011 et 2011/2012).

11 Project ANR "LOCI " (locativité et interactivité en logique, linguistique et informatique), 2010–2014, French scientific coordinator Alain Lecomte. Michele Abrusci (rm3) was an Italian participant.

Historical context form the point of view of jointly supervised PhD students, sojourns of Post-Doc and Master students

We have already participated to jointly supervised PhD thesis and received Post-Doc and Master students in Marseille as the following 13 examples show:

1 In 1997 Paolo Buttà spend a one year PostDoc to work with P. Picco (AMU), he is now Professor at the Università di Roma La Sapienza

2 In 1999-2002 Michele Gianfelice make a PhD thesis under the joint supervision of M. Campanino (Bologna) and P. Picco (AMU), he is now Ricercatore at the Università della Calabria and work currently with Sandro Vaienti (AMU).

6 Master students use the AMU-Roma Tre agreement for Master students in Logic :

3 Mateo Acclavio 2011

4 Gabrielle Muciaccia 2011

5 Maria Rengo 2011

6 Eugénia Sironi 2011

7 Francesca Ferrante 2012

8 Sara Tassone 2013

2 master students used a Erasmus exchange program

9 Alessandra Albanese 2012-2013 under the supervision of David Kohel, master 2 diploma in rm3

10 Annamaria Iezzi 2011-2012 that becomes PhD student with Yves Aubry using the Archimede Labex PhD Fellowship

There are currently two PhD students coming from Italy that used an agreement between Roma Tre and AMU:

11 Eugénia Sironi, (Advisors Myriam Quatrini (AMU) and C Fouqueré (Paris 13)

12 Matteo Acclavio, (Advisors Yves Lafont (AMU) et Lorenzo Tortora de Falco (Roma 3)

Main scientific themes

a Partial Differential Equations

b Mathematical Physics

c Dynamical systems

d Probability.

e Number Theory and Cryptography

f Algebraic geometry

g Logic

Objectives of the project

There are mainly 2 objectives in this project:

The first one is to reinforce and facilitate the strong scientific bonds that already exist between Marseille, Rome and l'Aquila in the thematics mentioned above. Sharing our various expertnesses will give us the possibility to create the first step of an authentic mediterranean network. The high level of the already published joint works between the Italian and the French part shows that the scientific collaborations already exist and will continue.

The second one is to allow PhD students and Post doctorates to share a part of their time between Marseille, Rome and l'Aquila by using the already existing PhD program in the 6 mathematical departments. For example the GSSI PhD program include courses that are given outstanding mathematicians that will certainly not be able to be absent form his/her university for more than a short period. I think about Y. Sinai (Abel Prize, Princeton & Moscow) that promised to give lectures at the GSSI. We plan also to have exchanges of professors between the various PhD programs. This is already done at the GSSI. This will be a second step in our project that is not limited to a two years project but merely to a long term approach of the international cooperation between Marseille and Roma/l'Aquila. In this long term approach we plan to make agreements between the 6 PhD program in Mathematics, perhaps to create an international PhD program common to the 6 entities. There is already a project of a Master *Curriculum binational de Master en Logique* also mentioned in section VI that will be extended to Number theory.

These two objectives are complementary, in fact the best way to implement the second one is that the first one works efficiently. The periodic presence of mathematicians from Marseille in Rome or l'Aquila is extremely important to help the students to decide to choose Marseille as a possible place for a PhD that could be a jointly supervised PhD with the two supervisors that are already scientific collaborators. This will give to the students the feeling to belong to an international community.

IV Scientific and technical program, project organization

Scientific program, management, tasks, tasks schedule, deliverables and milestones

A part of the team are planning to work under the general theme of Interacting particles systems. Let us mention some problems and lines of research that we are planning for the future. The are ordered around some main scientists that are working in l'Aquila-Roma-GSSI. Other collaborations with less precise program are mentioned in the next section V.

Around Fabio Martinelli

-Kinetically constrained models. Out-of-equilibrium dynamics of interacting particle systems with kinetic constraints, a class of stochastic models which play a key role to describe some of the main features of the dynamics of real glasses, can be extremely rich and complex, with connections with bootstrap percolation, coalescence processes and dynamical phase transitions. In a broad sense we aim at studying the relaxation process at low temperature, the phenomenon of time scales separation, dynamical heterogeneities and coarsening. Recent very promising advances have been obtained recently and times are mature to attack some of the hardest problems.

- Mixing times for reversible Markov chains. We plan to (a) prove tight bounds on the mixing time of reversible Markov chains for hard combinatorial structures including uniform lattice triangulations, polymers, discrete random surfaces and dimer-lozenge tilings, (b) develop a local Bakry-Emery calculus for Markov chains using the discrete Ricci curvature for Markov chains.

-Classical discrete random interface models. We plan to investigate certain large deviation properties of models from classical statistical mechanics describing random surfaces interacting with a wall. We will also analyse the behavior of the interacting random lines ensemble describing the macroscopic contour levels together with dynamical phenomena (e.g. aging and metastability) for some reversible Markovian evolution of the surface.

Around Alessandro Giuliani

In the context of equilibrium statistical mechanics, many of the known properties of the ground or low temperature states follow from exact solutions (2D Ising model, 6 or 8 vertex model, XXZ chain, Luttinger model, 1D Hubbard model, just to mention a few), on the one hand; and from sophisticated approximation schemes or phenomenological theories (renormalization group, conformal field theories, Fermi liquids Landau theory, BCS theory for superconductivity, Bogoliubov Bogoliubov theory for the dilute Bose gas, spin wave theory, bosonization), on the other. The goal of our research is to rigorously justify these approximation schemes in non solvable many body problems (possibly "close" to a solvable model, in a sense to be defined), and derive new predictions, unaccessible to the approximate methods and/or to the known exact solutions. In particular, we propose to: (i) study the ground states of classical spin systems with competing interactions, short range ferromagnetic plus long range antiferromagnetic; (ii) investigate and justify the low density/weak coupling expansion for the thermodynamic and correlation functions of the interacting Bose gas or, similarly, the spin wave approximation for classical and quantum Heisenberg models;

(iii) study the ground and low temperature properties of interacting electron systems on the 2D hexagonal lattice (graphene model), including its conductivity and qauntum Hall properties;

(iv) understand the scaling limit of non-integrable dimer models at the critical point, including boundary effects, the fluctuations of the height function, and the electric correlators. The methods that we plan to use are partly analogous to those used in the dynamical systems context (multiscale analysis, renormalization group), partly specific of the new problems (reflection positivity, functional variational estimates) or combinations of both.

Around Elisabetta Scoppola

Convergence to equilibrium of non reversible dynamics.

Non reversible stochastic dynamics are important from different points of view. For instance they can be applied as efficient randomized approximation schemes and they can be considered as interesting models of non-equilibrium statistical mechanics as well.

We plan to proceed in particular in the following directions

1) Metastability for non reversible Markov Chains with large state space, exponential asymptotic law for the tunneling time and convergence of the quasi-stationary measure.

2) Fast mixing for non reversible parallel dynamics at low temperature, a polynomial approximation scheme. We plan to further develop promising results recently obtained for the Ising model.

3) Diffusion limitated aggregation models on complete graphs.

Around Anna de Masi, Marzio Cassandro, Enzo Olivieri, Enza Orlandi, Errico Presutti, Livio Triolo

In the last decade a lot of progresses was done on the study of phase transition for one-dimensional long range system, both classical (the Ising model) or quantum (the XXZ model). There are however a lot of problems that remains to be solved. In particular concerning the large deviations principle for these model (Ising case) in the regime of phase transition, *i.e.* a first part is the equivalent of the Minlos-Sinai theory that was done for the short range Ising model in two dimension for these long range systems and the second part is the Dobrushin-Kotecky-Shlosman & Pfister theory. For the second part, collaboration with people working in analysis, more precisely in calculus of variations for systems with fractional norm that are well represented in Rome and Marseille will be rather crucial. Another important problem concerns the optimality of conditions on the two body potential for the existence of phase transition in the XXZ model in one dimension with long range interactions. Optimal estimates for the multiple points correlation functions for the XXZ model is also an important question. Interfaces problems in one dimensional quantum system with long range interactions are not studied until now, only very recently the interfaces problem for the case of (classical) Ising model with long range interactions has been studied. Another fundamental question is about the XY model (plane rotator) in one dimension with long range interactions that decay as 1 over the distance between two sites to the square. Here we have no breakdown of the symmetry as proved by Barry Simon in 1981, however for the moment the convergence of a cluster expansion valid at all temperature is problematical since the corresponding case of the Ising model presents a phase transition. Therefore the fact that after some blocks summation the effective interactions decay a little faster should be used. Until now there is only two models where such a phenomenon occurs, as proved by Campanino-Olivieri-Van Enter and in Olivieri-Campanino in 1987 in the case of the Edwards and Anderson model, however it was the presence of random interactions that was responsible of the better decay. Here we expect that it is the local Gibbs measure that will depressed the bad spin configurations to get a faster effective interaction. Similar phenomenon occurs however in unbounded spin systems but in this case it is the superstable property of the hamiltonian that depressed the bad configurations as shown by Campanino-Capocaccia-Olivieri in 1983.

Another part of the program concerns the disordered systems with long ranged interactions. A first case is the random fields Ising model always with long range interactions where existence of a phase transition was proved by Cassandro-Orlandi-Picco in 2009 and where typical configurations where exhibited by Cassandro-Orlandi-Picco in 2012 in the regime of absence of phase transition. A large deviation principle, even in a weak form as it was done for the Kac model by Orlandi-Picco in 2009 is a problem that we are planing to study.

A large part of all these problems have counterparts in 2 dimensions, for the random field Ising model for example that will be important to study. We cannot avoid to mention two fundamental problems in two

dimension with short range interactions that are the classical Heisenberg model and Edwards and Anderson model where respectively exponential decay of the correlation functions at all temperature and uniqueness of the Gibbs state at all temperature are long time expected results.

V Description of the teams involved and of the international partnerships added value

I Partial Differential equations: The italian school in Partial differential equations following the groundbreaking works of De Giorgi, has been highly influential in the last decades. Several collaborations in Roma could be developped with Marseille: in regularity theory (Boccardo, Birindelli, Orsina, Porretta for instance), semilinear PDEs and concentration phenomena (Pacella, Tarantello,...), dispersive equations (D'Ancona, Fanelli,...)... The cornerstone of these topics is the link between several areas of PDEs: time-dependent equations, elliptic equations, harmonic analysis. In Marseille among mathematicians that are strongly interested by the project, we have Lorenzo Brasco, Thierry Gallouet, François Hamel, Maxime Haurey, Enea Parini, Pieralberto Sicbaldi and Yannick Sire.

II Mathematical Physics: The italian school of mathematical physics is certainly internationally an outstanding one, it includes two Boltzmann medals (G. Gallavotti and G. Jona-Lasinio in the Physics Department), but also an important number of very high level scientists. There are a lot of already established or possible interactions between Marseille, Rome and l'Aquila concerning Equilibrium statistical mechanics around G. Benfatto, M. Cassandro, A. De Masi, G. Gentile, A. Giuliani, R. Marra, E. Olivieri, E. Presutti, L. Triolo but also non equilibrium statistical mechanics in particular in Kinetic limit with C. Marchioro, M. Pulvirenti, E. Caglioti, P. Buttà even if this last subject was not developed as it should have been in Marseille but this could be a possible thematic left for the future. In Marseille among mathematicians that are strongly interested by the project, we have Sacha Bufetov Alexandre Gaudillière, Véronique Gayrard, Maxime Haurey, Pierre Picco, Pierre Mathieu, Bruno Schapira.

III Dynamical systems: The study of Anosov flows, billiards flows and related flows in geometrical context by method of ergodic theory are developed around C. Liverani, C. Boldrighini. While Dynamical Systems and KAM theory, Classical mechanics and renormalization group are developed around G. Gentile. In Marseille among mathematicians that are strongly interested by the project, we have Nicolas Bedaride, Sacha Bufetov, Pascal Hubert, Paul Mercat, and Sandro Vaienti.

IV Probability: There is a very strong and highly internationally recognized group involved in interacting particles systems and probability in Rome in particular around G. Jona–Lasinio and E. Olivieri, and also N. Candrini P. Caputo, F. Cesi, A. De Masi, E. Faggionato, B. Giada, R. Mara, M. Mariani, F. Martinelli, E. Presutti B. Scoppola E. Scoppola, in particular about large deviations, metastability, functional inequalities, random matrices. In Marseille among mathematicians that are strongly interested by the project, we have Alexandre Gaudillière, Véronique Gayrard, Maxime Haurey, Pierre Picco, Pierre Mathieu, Bruno Schapira.

V Number theory: (Number Theory and Cryptography) The research groups ATI and GDAC include Yves Aubry, David Kohel, Joël Rivat, Christian Mauduit, who have close ties to René Schoof (PR, rm2) and Francesco Pappalardi (PR, rm3), in research that spans algebraic and analytic aspects of number theory and applications to cryptography. René Schoof is and expert on group schemes, abelian

varieties and modular forms, and the author of "Schoof's algorithm" in 1985, which made possible the introduction of elliptic curve cryptography by Koblitz and Miller in 1986. René Schoof is a frequent visitor of the CIRM in Luminy, and was invited professor of The University of Aix-Marseille (2) in 2008. More specifically Christian Mauduit and Joël Rivat are planning to cooperate with Francesco Pappalardi on the following problems: Application of average Frobenius distribution techniques to problems connected with the enumeration of primes with digits in a given base having some given properties.

VI Logic: The collaborations between the teams *Logica e Geometria della cognizione* (rm3) and *Logique de la Programmation* (I2M) are located around the concepts of Linear Logic for studying Proof Theory and its applications, mainly computation, but also natural language. They concern: – the problems of confluence and of normalization in some rewriting systems, among them: proof nets and lambda calculi; – the exploration and the development of relevant concepts for studying interactive systems, at the interface: Game semantics/Ludics/Process Algebra; – the denotational semantics of computation models coming from logical systems, in general, the semantics of typed and untyped lambda-calculus. In Marseille among mathematicians that are strongly interested by the project, we have Laurent Regnier, Myriam Quatrini, Yves Lafont that have already strong links with the Logic team in rm3. In particular with Lorenzo Tortora de Falco and Marco Fontana

VI Planned actions to ensure the sustainability of the collaboration

To ensure a real sustainability of the collaboration a first part is about research: We are also planing to involve for the future the INSMI (CNRS) from the french part and the INdAM from the italian part. A second part is related to the already existing PhD Programs.

We plan to make in the future a global agreement with the PhD programs mentioned below and the *Ecole Doctorale de Mathématiques et Informatique ED184*. The two years preliminary part of the collaboration program should be used to launch a European project similar to an European Joint Doctorates (EJD) within the MARIE SKLODOWSKA-CURIE ACTION: INNOVATIVE TRAINING NETWORKS (ITN). If a third partner belonging to a country different from Italy and France is required to make such a EJD, we have a lot of choices by just taking into account the already existing agreement in Mathematics at the master level between AMU and Lebanon, Senegal and Vietnam with a regular flux of students that come to Marseille and more generally to France for making a PhD. The extension to Italy of such already existing agreements are certainly extremely important to develop high level research for these three non european countries (Lebanon, Senegal and Vietnam).

Let us describe some of the various master programs and Phd programs that are already present among our Italian partners, to exhibit the complementarity of these programs:

1 In l'Aquila :

Mathematics and Models under the direction of Anna De Masi.

The PhD program in Mathematics and Models focuses mainly on applied mathematics. More specifically the main topics of research are: partial differential equations with applications to continuum mechanics and quantum mechanics, dynamical evolutions deterministic and stochastic with applications to statistical mechanics and biology. Numerical methods for PDE. Particular emphasis in given to the study of the physics where microscopic and macroscopic scales merge. The analysis involve either a large scale limit in microscopic models or a micro-analysis in a continuum mechanics framework. The mathematical techniques are in the first case mainly probabilistic-combinatorial and analytical in the second case, PDEs and calculus of variations. The general aim is to exploit synergies between the two. The research is essentially theoretical even though numerical studies are also scheduled.

2 In Roma La Sapienza **Vito Volterra School of Astronomical, Chemical, Physical, Mathematical and Earth Sciences. under the direction of Paolo Piazza**

There is a huge PhD program in Mathematics in rm1 that covers almost all the various subject of the mathematics. Very important lecturers was present this year in particular :

Stefano Olla (CEREMADE/Universit de Paris Dauphine) Thermodynamics
Roberto Ferretti (rm3) Optimal control, Dynamic Programming
Hasnaa Zidani (ENSTA & INRIA Saclay) Optimal control, non linear systems
Olivier Bokanowski (Parigi 7) Optimal control, Hamilton-Jacobi equations
Vladimir Veliov (TU Wien) Optimal control applications to economics
Pierre Albin (University of Illinois at Urbana-Champaign) Introduction to Microlocal Analysis
Giovanni Cerulli Irelli (Univesity of Bonn): Introduction to quiver representations and cluster algebras

3 In Roma TRE

There is a specific program for master students **Curriculum franco-italien de master en Logique** : Coordinators

1 Lorenzo Tortora de Falco (Universit Roma Tre).

2 Marco Fontana (Universit Roma Tre).

3 Laurent Regnier (Institut de Mathmatiques deMarseille).

4 Myriam Quatrini (Institut de Mathmatiques deMarseille).

There is the already mentioned agreement between Roma Tre and AMU: *Curriculum franco-italien de master en Logique* also partially funded by the *Università Italo-Francese* that allows Master students to have a double diploma, *Master en mathématiques de l'Université d'Aix-Marseille* and *Laurea magistrale in Scienze Filosofiche* or *Laurea magistrale in Matematica dell'Università Roma Tre.*

There is a project to extend this agreement to include in a first step Number Theory and Cryptography in the program with the participation of C. Mauduit (AMU), J. Rivat (AMU), D. Kohel (AMU) on the french part and F. Pappalardi (rm3), René Schoof (rm2) on the italian part. and then all the team ATI (*Arithmétique et théorie de l'Information*) that would like to participate.

The departments of mathematics of AMU and Roma 3 have a joint masters degree program in logic, which is in the process of being extended to number theory and cryptography, in consultation with Francesco Pappalardi at Roma 3. He currently supervises a doctoral student on the subject of Sato-Tate distributions, an active area of research around which Kohel and Morlet Chair Igor Shparlinski recently organized a winter school and conference at CIRM. Since inception of the joint degree program in 2010 with AMU and rm3, eight masters students from Roma 3 have studied in Marseille, in both logic and number theory.

Ph. D. program in mathematics, under the direction of Luigi Cherchia

This program covers Complex analysis, Partial Differential Equations, Mathematical Physics, Algebraic Geometry, Logic, Probability, Differential Topology, Graph Theory, Ordinary Differential EQuations, Cryptography, Set Theory, Linear Logic.

4 In Roma 2 Tor Vergata

Dottorato di Ricerca in Matematica under the direction of Filippo Bracci

Very important lecturers was present this year

Prof. S. Donkyn, Univ. York On the calculation of the cohomology of line bundles on flag varieties in characteristic p

Prof. A. Khapalov, Washington University Swimming phenomenon and controllability.

Dr. R. Conti: Nodi, trecce e algebre . (Knots, Braids and Algebra)

Prof. F. Murat: Homogeneization and compensated compactness.

Prof. J. Noguchi: Analytic function theory in several variables

Dr. A. M. Benini: Introduction to 1 dimensional complex dynamics.

Prof. B. Scoppola: Sampling of Gibbs measure: single spin-flip dynamics and probabilistic cellular automata.

Prof. F. Sukochev: (UNSW, Sydney) Introduction to noncommutative analysis Minicourse,

Prof. J. Weyman: (Univ. Connecticut) Local Cohomology supported in determinantal varieties

5 At the GSSI

PhD in Mathematics in Natural, Social and Life Sciences under the direction of Pierangelo Marcati

The PhD curriculum in Mathematics of Natural, Social and Life Sciences at Gran Sasso Science Institute will lead the students to deal not only with the more traditional aspects of this discipline, such as Pure Mathematics, Partial Differential Equations and Mathematical Physics, but also with entirely new problems, requiring the development of the most appropriate tools to deal with the complexity, such as stochastic analysis and computational mathematics. The curriculum consists of 3 years of study and research. During

the first year, after initial training classes, students will be offered three main courses and a wide number of short courses, covering a large spectrum of topics. By the beginning of the second year students select a research project under the supervision of one (or more) of the mathematicians affiliated to GSSI.

Committee: Luigi Ambrosio (SNS Pisa), Stefano Bianchini (SISSA), Gianni Dal Maso (SISSA), Camillo De Lellis (Universitt Zrich), Antonio De Simone (SISSA), Pierangelo Marcati (Chair, University of L'Aquila and GSSI), Errico Presutti (GSSI), Gigliola Staffilani (MIT)

VII Exploitation of results (if necessary)

VIII Potential impact of the project for the site

In this two years project, we are planning to create an entity with almost 500 mathematicians and we can expect to have a same order of magnitude of master students, PhD students and PostDoc. This means that we will have the possibility to be a lot more attractive that we are for hiring high level mathematicians. This will allows us to create larger groups with more collaborations between groups than we have already. There are some complementary expertnesses between Marseille and Roma-L'Aquila, in particular at the level of applications of mathematics that could have a strong impact, for example applications to Medical sciences in particular Neurobiology, Genomic, Biology are well or in the course of being developed in Marseille, less in Roma-l'Aquila also for historical reasons, Signal and Image processing have not too much representatives in Rome. On the other hand, as already mentioned above the Mathematical physics group in Rome-l'Aquila is extremely well developed.

IX Distribution of the inputs of each partner and scientific justification of required means

The inputs will be divided according to the following table:

Secretary : part time secretary for two years ($1500 \times 24 = 36\,000$)

2 studentships for Doctorate students for three years : $2 \times 3 \times 33\,000 = 200\,000$

1 years of Postdoc $1 \times 50\,000 = 50\,000$

32 months of long term missions $32 \times 3500 = 112\,000$

The first line correspond to an part time employment of a secretary to treat, the necessary administrative part of the project. The actual situation in the I2M does not allow the possibility to give extra work to the present secretaries. If it happens that there are not enough works for such a part time secretary, the corresponding part will be moved to the long term missions.

Since a part of the project is for the PhD students and Post-Doc the second and third line are necessary.

Concerning the fourth line, (32 months of long term missions). We have already around four strong demands for long term missions, at least 5 months in Roma-L'Aquila for mathematicians of Marseille. These long term missions are rather important, on the one hand as we mentioned above, for creating a environment where the students will feel natural to make a binational PhD. On the other hand, from the scientific point of view, some hard problems as the ones mentioned in section IV need certainly more than 15 days (a typical short term mission) of shared time to be solved, it will be more efficient to have such long term missions. We add 12 months of one month missions, that could be divided into 15 days and 1 months to be able to go

beyond the existing collaborations. Since it represent 6 months for each years this is certainly not excessive.

Taking into account of the financial situation of the Italian universities, we cannot expect to have a complete reciprocity of involved means approved within the one month period of the A⋆MIDEX project calls. We can however expect to have some means that come form the various departments on the form of stipends for doctorate students from Marseille. As mentioned above we can expect means within the INdAM program of visiting professors.

X Bibliographical references

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