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PART A

1 - Research Project Title

Large Scale Random Structures

2 - Duration (months)

36 months

3 - Main ERC field

PE - Physical Sciences and Engineering

4 - Possible other ERC field

5 - ERC subfields

1. PE1_13 Probability
2. PE3_15 Statistical physics: phase transitions, noise and fluctuations, models of complex systems, etc.
3. PE1_16 Mathematical aspects of computer science

6 - Key Words

1. GLASSY DYNAMICS AND METASTABILITY
2. RANDOM GRAPHS AND RANDOM MATRICES
3. RANDOM GEOMETRY AND RANDOM MEDIA
4. STOCHASTIC PARTICLE MODELS

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7 - Principal Investigator

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8 - List of the Research Units

nº	Associated Investigator	Category	University/Research Institution	E-mail address
1.	MARTINELLI Fabio	Professore Ordinario	Università degli Studi ROMA TRE	martin@mat.uniroma3.it (adesione completata il 13/01/2016)
2.	FAGGIONATO Alessandra	Professore Associato (L. 240/10)	Università degli Studi di ROMA "La Sapienza"	faggiona@mat.uniroma1.it (adesione completata il 21/12/2015)
3.	CARAVENNA Francesco	Professore Associato confermato	Università degli Studi di MILANO-BICOCCA	francesco.caravenna@unimib.it (adesione completata il 11/01/2016)
4.	DAI PRA Paolo	Professore Ordinario	Università degli Studi di PADOVA	daipra@math.unipd.it (adesione completata il 12/01/2016)

9 - Research project abstract

Large scale random structures consist of a large number of mutually interacting random components. Even if the interaction is local and simple, their collective behavior typically shows a host of intriguing phenomena like universality, anomalous fluctuations, phase transitions, complex time evolution. Their mathematical analysis requires the development of new powerful probabilistic ideas and techniques, combined with inputs from other branches of mathematics, notably analysis, geometric measure theory and combinatorics. In the last decade the field witnessed a stunning growth, with multi-year research programs (cf. NETWORKS in the Netherlands), outstanding ERC funding (cf. the ERC-AdG awarded to the PI in 2009-2012) and international yearly workshops (Oberwolfach).

We have selected some high impact problems where we expect to make a breakthrough. As it occurred already in the past, our findings will also impact other fields (e.g. statistical physics, theoretical computer science and economics). The team will consist of selected probabilists with a record of key achievements, a well established mutual collaboration and international recognition. Four main research lines have been chosen:

A: Glassy Dynamics and Metastability. The focus is on large scale stochastic dynamics, in particular interacting particle systems with constraints, bootstrap percolation and metastability. This is a very exciting and active field of research, with a wealth of applications across mathematics, physics, and biology.

B: Random Graphs and Random Matrices. The main themes are random walks on random graphs (mixing time,cutoff and invariant measure) and spectral analysis of random matrices associated to random graphs (universality and large deviations). The focus is on the, largely unexplored, non-reversible case corresponding to directed graphs.

C: Random Geometry and Random Media. This part of the project concerns the large scale behavior of specific random systems. Topics include basic disordered systems, random interfaces and random triangulations. We expect important outreach towards analysis, statistical physics and theoretical computer science.

D: Stochastic Particle Models. This section is articulated in two parts: the first, more analytical, features stochastic particles systems as random solutions to deterministic Burgers equations, scaling limit and KPZ universality; the second, more probabilistic, studies synchronization phenomena and stochastic games. Outreach towards biology and economics is expected.

Seminars and working groups will be run on a regular basis in order to impact on the scientific formation of young researchers (postdocs and graduate students). They will also be exposed to top international research environment in specific events (workshops and lectures) featuring outstanding international specialists. Special efforts will be made to have such key events across all the units.

10 - Total cost of the research project, per single item

Associated Investigator	item A.1	item A.2.1	item B	item C	item D	item E	item F	Total
MARTINELLI Fabio	60.000 €	24.000 €	50.400 €	8.000 €	15.000 €	20.000 €	50.334 €	**227.734 €**
FAGGIONATO Alessandra	40.000 €	0 €	24.000 €	8.000 €	15.000 €	20.000 €	€	**107.000 €**
CARAVENNA	25.000 €	48.000 €	43.800 €	8.000 €	10.000 €	20.000 €	€	**154.800**

Francesco								€
DAI PRA Paolo	55.000 €	0 €	33.000 €	8.000 €	15.000 €	20.000 €	€	**131.000 €**
Total	**180.000 €**	**72.000 €**	**151.200 €**	**32.000 €**	**55.000 €**	**80.000 €**	**50.334 €**	**620.534 €**

- item A.1: enhancement of months/person of permanent employees
- item A.2.1: cost of contracts of non-employees, specifically to recruit
- item B: Overheads (flat rate equal to 60% of the total cost of staff, A.1 + A.2.1, for each research unit)
- item C: cost of equipment, instruments and software
- item D: cost of consulting services and similar
- item E: other operating costs
- item F: prize (to take advantage of the prize it is mandatory to attach to the project a declaration signed by the Rector of the university, according to the outline of section B2.7)

PART B

B.1

1 - State of the art

A. Kinetically constrained particle systems modelling real glasses (KCM) and bootstrap percolation processes (BP) represent a very active area (awarded with a ERC-SG this year). We refer to (Martinelli et al [2,3,4,9,10,12,15,16,18]), [A. Smith et al. AoP '15] , [T. Bodineau et al. CMP '12], [O. Blondel AAP '15] and to the recent breakthroughs on universality for BP by B. Bollobas, H. Duminil-Copin et al. A main motivation is to mathematically understand a fundamental open problem: how, in a variety of large scale random systems, the dynamics is quasi-halted in a metastable dynamics referred to as "glassy dynamics". Main features of glassy dynamics are: the emergence of a hierarchy of energy barriers and relaxation time scales, metastable behavior, heterogenous evolution and mixed-order phase transitions. The difficulty to simulate glassy systems has sometimes suggested wrong conjectures, disproved by rigorous investigations (Martinelli et al. [9,10]).
Very active is also the topic of metastability for stochastic lattice gas with mutual attraction between the particles and no exclusion. The interaction may force a positive fraction of the particles to concentrate on a single vertex. While the hypotheses under which the condensation occurs are well understood [S. Grosskinsky et al., JSP '11], the full analysis of the characteristic time scales of the condensate is still largely an open problem [S. Grosskinsky et al. EJP '13]

B. Random matrices and random graphs represent one of the most rapidly growing research branches in mathematics in general, and in probability theory in particular. Spectral properties of the matrices associated to a graph, such as the adjacency or the laplacian matrix, yield crucial information on the structure of the graph itself and on the asymptotic behavior of the associated random walks. The classical theory has been mostly concerned with the case of independent edge weights with finite variance. Important progress on the convergence of the empirical spectral distribution has been recently obtained in the following cases: (i) heavy tailed random weights [Caputo et al. CMP '11, AoP '11], (ii) random Markov matrices [Caputo et al. PTRF '12], (iii) sparse random graphs [Caputo et al. CPAM '14].
A theory of large deviations has emerged in the case of dense random graphs after the works of S.R.S. Varadhan and S. Chaterjee. For the sparse case a complete theory is still missing. Recent progress in this direction was presented in [Caputo et al. AoP '14, PTRF '15].

C. Motivated by recent work on directed polymers and the stochastic heat equation [Alberts et al. AoP '14], a unified framework was provided recently (Caravenna et al. [1]) to study the weak disorder scaling limits of random systems that are "disorder relevant" (i.e. arbitrarily weak disorder is able to change the large scale behavior). The approach exploits convergence of "polynomial chaos expansions" based on a Lindeberg principle, extending earlier work by Mossel et al. [Ann. Math. '10].
Important breakthroughs also occurred for models of random surfaces. Among the main results: the full scaling limit and Wulff shape construction for the level curves of the SOS model above a wall, including sharp large deviations and mixing time computations (Martinelli et al. [1,7,8,]), optimal mixing time bounds via "mean curvature motion" for monotone surfaces corresponding to random tilings (Martinelli et al. [14,17]) and the proof [H. Lacoin et al. CPAM,'15, JEMS '14] that at zero temperature Ising droplets shrink following a mean curvature motion.
Progresses have been made also on the problem of sampling large random lattice triangulations (Martinelli et al. [6,19]), a difficult and fascinating problem with several facets, at the intersection between probability theory, theoretical computer science, combinatorics and algebraic geometry.

D. Besides the weakly asymmetric exclusion process [Bertini et al. CMP '97], the KPZ equation is conjectured to describe the scaling limit of several random growth models. Recently its analytical treatment witnessed spectacular progresses [Hairer, Ann.Math. '13] as well as the attempts [Corwin et al. JSP '15] to construct the "KPZ fixed point" describing the large time behavior of growth models in the KPZ universality class. A full proof of the existence of the KPZ fixed point as a two-dimensional random field is still missing.
Synchronization phenomena emerge in the form of "collective periodicity" in certain Markovian dynamics with many degrees of freedom [Bertini et al. PTRF '14] and in biological modeling (see e.g. [S. Mischler et al. '15] and [S. Ditlevsen et al. '15]). Synchronization also appears in systems with long memory and reinforcement, e.g. interacting urn models [R. Pemantle, Prob. Surveys '07] and (Dai Pra et al. [5]), and in systems with self-organization arising from strategic behavior of single units, as in mean-field games [O.Gueant et al. ’10].

2 – Detailed description of the project: methodology, targets and results that the project aims to achieve and their significance in terms of advancement of knowledge

The project will be articulated around the main topics A, B, C and D described in the abstract. Each research line has its own targets (listed for convenience as A.1, A.2, etc), methodology and sought results. The high risk/high gain feature of the whole project, its possible outreach as well as its international relevance and its significance in terms of advancement of knowledge in fundamental research will emerge clearly.

A. We will mostly concentrate our efforts to push forward the mathematical analysis of Kinetically Constrained Models (KCM) and metastable dynamics in general. KCM pose extremely challenging mathematical problems because the constraints induce the existence of clusters of blocked sites, ergodicity breaking transition, multiple invariant measures, non-attractiveness and the failure of classic coercive inequalities. Moreover their numerical simulation is very delicate and produced in the past wrong conjectures and approaches as proved by the PI, A. Faggionato et al. There is therefore a strong demand of mathematical results in the physics community studying glasses. The main goals are as follows:

A.1 In '01 D. Aldous and P. Diaconis formulated a conjecture for the scaling limit of the stationary East model, a basic KCM in one dimension, as the vacancy density tends to zero. In different terms the conjecture appeared also in the physical literature [Evans et al. '13] motivated by Monte Carlo simulations. Implicit behind the conjecture there is a form of time scale separation for the relaxation times of the model. Time scale separation is now fully understood (Martinelli et al.[9]) and thanks to that we are confident to be able to resolve the conjecture, probably in the negative direction. Such a result would have a great impact also because it would show, once more, that numerical simulations of KCM's could be quite misleading.

A.2 In the East model on the integers a shape theorem holds: if at time t=0 the system has no vacancies then the set of vertices which have been updated within time t grows linearly in t [Blondel SPA '13], with normal fluctuations (Martinelli et al. [3]) around the front. In higher dimensions a shape theorem has been proved when the vacancy density is one [J. Martin, AoP '04]. In this case the East process becomes a last passage percolation problem. Proving an analogous result when the vacancy density is strictly below one is extremely challenging. In this context a first highly non trivial step is to prove that the speed of the front along any ray from the origin is larger than the speed along the coordinate axes. A partial result in this direction appeared already in [Martinelli et al. [2]].

A.3 It has been conjectured [J.P. Garrahan, J. Phys.: Cond. Matter. '02, M.J.Newman, Phys Rev. E '99] that the Glauber dynamics of certain ferromagnetic spin systems with multi-spin interaction, behave like a KCM at low temperature. However, the heuristic analysis suggesting this conjecture completely neglected key features of the dynamics and there is no consensus on the details of the analogy. Our aim is to put the above conjecture on firm mathematical grounds. We firstly plan to establish the correct Poincare' and logarithmic Sobolev inequalities by proving Dobrushin-Shlosman strong mixing conditions and secondly to nail down, via path techniques and capacity methods, the correct asymptotic of the relaxation times. Such a result would add important support to the assumption that KCM really capture several of the features of glassy dynamics.

A.4. A somewhat related metastable dynamics occurs also in the so called Inclusion Process (IP), an interacting particle system with mutual attraction between the particles. Because of the interaction the IP exhibits a condensation transition, with a positive fraction of all particles concentrated on a single site, randomly moving in space. The main goals are the following: in the reversible case we wish to describe the several relevant metastable time scales by means of potential theoretic techniques and to characterise the nucleation time using the martingale approach. In the non-reversible case we wish to analyse the condensation for a totally asymmetric dynamics on the torus.

Key tools will come from Markov chain theory, general metastability theory, interacting particle systems, functional inequalities, capacity methods, large deviation theory, percolation and cellular automata. We will also sometimes use numerics as a preliminary tool to investigate new directions.

B. Natural models of random matrices are obtained by taking the adjacency matrix or the Laplacian of a random graph. The analysis of these random matrices can be used to provide insight in the relaxation to equilibrium of the associated random walks, and to explore specific features such as the cutoff phenomenon. These topics recently experienced a very rapid development in the context of undirected sparse random graphs, especially after the works of Lubeztky, Peres, Sly and others. In particular, these works established the cutoff phenomenon for regular graphs and for the giant component of a supercritical Erdos-Renyi graph. When the graph has directed edges, the associated random walks are non-reversible. In this case even a description of the invariant measure of the process can become rather challenging and the problem has essentially never been explored before. The main goals are as follows.

B.1 Convergence to equilibrium and cutoff phenomenon for a class of random directed graphs (digraphs). A first step was recently taken in this direction in the special case of sparse digraphs with given bounded degree sequences. Other models to be investigated include: (i) the Erdos-Renyi random digraph, (ii) the weighted directed graph with heavy-tailed random weights.
As in the undirected case, we expect the analysis to be based on finding a suitable branching approximation for local neighborhoods. In the directed case however, the invariant measure being unknown, this seems to require a higher precision together with the development of refined martingale techniques. Given this state of affairs, even a small progress in any of the models mentioned above is likely to have a strong impact on the community.

B.2 Another related direction is concerned with the spectral analysis of the above mentioned random matrices. In this respect, we would like to make progress in the following directions: (i) convergence of the empirical spectral measure and (ii) proof of sharp estimates on the spectral radius. The first problem is related to an extension to the sparse case of the celebrated circular law for dense non-Hermitian matrices with i.i.d. entries. The second item aims at establishing a conjecture recently proposed by Bordenave, Caputo, Chafai indicating a sharp discrepancy in the behavior of the spectral radius between the Hermitian and the non-Hermitian setting. This line of research rests on more traditional random matrix theory techniques but the non-Hermitian character of the matrices associated to directed graphs makes it in many ways very challenging. As the recent spectacular developments around the circular law have shown, any tiny advancement in the non-Hermitian setting is predicted to have a very strong impact.

B.3 Large deviations for sparse random digraphs. This analysis was recently initiated by Caputo and Bordenave in the undirected case and their results have been used in the recent proof, after 25 years, of the satisfiability threshold for random k-SAT [J.Ding et al. '14]. We would like to explore the extension to the directed case. This requires in particular a detailed analysis of locally tree-like neighborhoods in directed random graphs, a topic that will certainly experience a rapid development in near future.

C. This line of research concerns the scaling limit of disordered systems and the large scale behavior of random surfaces and random triangulations. The main targets are:

C.1 As shown in Caravenna et al. [1], partition functions of "disorder relevant" random systems admit non-trivial scaling limits, in a continuum and weak disorder regime. This leads to the construction of "continuum disordered systems" which encodes universal properties for "directed models". We refer to (Caravenna et al. [2]) for pinning models and to [Alberts et al. JSP '14] for directed polymers. The analysis of "non-directed models" is more subtle and largely open. Our aim is to construct the "continuum 2d random field Ising model", extending to the disordered setting the work [Camia et al. AoP '15]. The groundbreaking results by [Hongler et al. Ann. Math. 2015] are expected to play a major role.

C.2 For "marginally relevant" system (characterized by logarithmic divergences) a common universal structure was recently revealed in [Caravenna et al., arXiv 2015], for both pinning models and directed polymers, in the "sub-critical regime". Our aim is to push the analysis to the very challenging "critical regime". This could be applied to the 2d stochastic heat equation, improving earlier results by [Bertini and Cancrini, J. Phys A '98]. Intriguing analogies with log-correlated random fields suggest that common techniques could be employed, alongside the more usual "polynomial chaos" expansions. Other relevant methodologies are expected to come from the theory of "noise sensitivity".

C.3 A natural class of random interfaces is characterized by a discrete height function on the vertex set of a box of the two dimensional lattice, together with a statistical weight for the heights configuration given by Exp[-ß ∑ |grad |^k.] Surfaces with discrete heights are quite hard to analyse and they behave very differently at low temperature (β>> 1) w.r.t. the continuous case . In (Martinelli et al. [7]) the exact asymptotics of the probability that a SOS surface (k=1) stays positive in a large box, an open question for many years, has been computed accurately using the scaling limit results of SOS [Martinelli et al. [1]]. We want to attack the same problem for the Discrete Gaussian model (k=2), for which, after more than twenty years, there has been recently important progress on concentration of its maximum and of the height above a floor [Martinelli et al. '15]. The main tools should be monotonicity, Peierls estimates, cluster expansion and local large deviations.

C.4 In the context of sharp interface limits, a somewhat related issue is the derivation of the motion by mean curvature from the (deterministic) Allen-Cahn equation. We consider the equation with a small random forcing term and we aim at finding its large deviations asymptotics in the sharp interface limit. The corresponding rate function should be the functional derived in [Kohn et. al. CPAM '07] in a purely variational setting. In particular, its zero level set consists of the motion by mean curvature in the Brakke's formulation.

C.5 Random lattice triangulations of boxes of the two dimensional lattice, with statistical weight λ^(length of triangulation), have been successfully analyzed in two cases: (i) λ<<1 and (ii) λ>1. The case of an arbitrary λ<1 has been recently attacked via Lyapunov function methods in [A. Stauffer, '15] and completely solved, for thin boxes, in [Martinelli et al. '15]. Still wide open is to provide a polynomial bound on the mixing time of the corresponding Glauber dynamics for any λ<1, our first target. Similarly, for λ>1 the goal is to get the correct exponential divergence of the mixing time, a problem related to finding the longest triangulation. Finally the third target is to investigate the Holy Grail for the subject, i.e. the uniform case λ=1, at least for thin rectangles.

D As anticipated, this line of research has two faces: a more analytic one around the wide subject of KPZ-Burgers equations and KPZ universality class, and a more probabilistic one focused on synchronization phenomena and their connection with mean field games. The main goals are as follows.

D.1 Many features (e.g. correlation functions, scaling properties, invariant measures, marginal distributions) of the so-called "KPZ fixed point" have been investigated by exploiting explicit formulas derived for processes that are believed to belong to the KPZ universality class [Corwin et al. JSP '15]. At least at a formal level, it is possible to interpret the KPZ fixed point as a random, distribution-valued solution of the deterministic Burgers equation.
Following the above approach, our main target is to better understand the KPZ fixed point by studying the long time behaviour of a new ad hoc interacting particle system, whose trajectories are in one-to-one correspondence with piecewise constant solutions of the deterministic Burgers equation. In this model particles are of two types, either repulsive or attractive, and are grouped in stacks. Stacks of particles perform a non-local deterministic dynamics, but they can also randomly split, merge and be created. As a first step we plan to study the long time evolution of the process (invariant measures, etc) and to define a numerical protocol for its simulation.

D.2 The first main target is to understand the emergence of rhythmic behavior in complex networks in some generality. Despite of the intense research on the subject, in particular for applications to neurosciences, a sufficiently wide picture indicating the origin of this phenomenon in some generality is still missing. Recent works indicate the role played by time delay ([J. Touboul 15], [S. Ditlevsen et al. '15]) and dissipation [Dai Pra et al. [1], [7]]; both may be interpreted as time-symmetry breaking of a reference stochastic dynamics. This point of view will be the subject of further investigation, including other possible origins of time-symmetry breaking, such as quenched randomness [L. Bertini et al., PTRF '14] and forecasting. The latter is related to stochastic dynamic games and in particular to mean-field games, i.e. limit models for symmetric non-zero-sum non-cooperative N-player games with interaction of mean field type [O.Gueant et al. '10]. This last topic, whose development has been formidable from the PDE point of view, still raises several open questions from the point of view of interacting particle systems, in particular for what concerns finite size effect [M. Fischer, '15]. In this direction we plan to study large deviations and fluctuation theorems for the convergence to the limit of infinitely many players.

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3 - Project development, with identification of the role of each research unit and research organizations involved, with regards to expected targets, and related modalities of integration and collaboration

Description of the team

The team consists of four research units, based at the universities of Rome Tre, Sapienza, Milan-Bicocca and Padua. All the people in the units (see section 5 below for a list) share a strong common background mainly in the theory of large deviations, mathematical statistical physics, Markov chains, random walks and interacting particle systems. At the same time there are important exclusive expertise in each unit and specific synergies among the units. More specifically we recall that:
(i) the mathematical theory of kinetically constrained models has been pioneered and successfully developed by the two

units in Rome,
(ii) several breakthroughs on the large scale behaviour of disordered systems, random surfaces and random triangulations have been made separately by the units in Rome and in Milan,
(iii) metastability and Markov chains mixing times have seen important advances by the (joint and separate) efforts by the units in Rome and in Padua,
(iv) the unit of the PI has contributed to several important recent progresses concerning the research line B, while line D is mostly developed within the units in Padua and Rome-La Sapienza.
We also emphasize that the four units are already quite well integrated among them, with a good record of scientific collaboration on specific research papers and on the organization of some very successful workshops and summer schools (cf. the series of probability workshops in "La Pietra, Florence", '04, '06, '08, '11).
In conclusion, the whole team has the perfect blend of diversity and integration to successfully carry out the proposed project. Part of the funding will be used to hire two postdocs in order to give a further boost to the project. These postdocs, based at the units of Rome Tre and Milan, will have the opportunity to interact with all the people in the team, providing a further element of synergy.

The role of each unit w.r.t. the expected targets

We will now describe more specifically the role of each unit with regards to the expected targets. For simplicity, the latter will be referred to according to the listing given in the previous section.

A. The main efforts towards the targets belonging to research line A will be done jointly by the units in Rome (the PI, A. Faggionato and N. Cancrini) for what concerns A.1, A.2 and A.3 and by the unit in Padua regarding A.4. Their efforts will also be supported by E. Scoppola, a leading expert in metastability for Markov processes. We forecast intense collaboration on A.1, A.2 and A.3 with P. Chleboun (Warwick), C. Toninelli (CNRS, Paris and PI of an ERC grant on Glassy Systems), O. Blondel (Lyon), R. Morris (IMPA), a leading figure in bootstrap percolation, and A.Smith (Ottawa). For the same targets we also intend to keep a strict contact with some group of physicists working in the field (most likely R. Jack and J. Garrahan in UK) in order to test our results and identify interesting possible new directions within the above research lines. For what concerns A.4 we forecast collaborations with S. Dommers (Bochum), C. Giardinà (Modena), A. Gaudilliére (CNRS Marseille) and S. Grosskinsky (Warwick)

B. The leading scientist for the core of this part of the project will be P. Caputo (Rome Tre) but we expect some pivotal contributions by F. Zucca and D. Bertacchi (Milan) for interesting random walks on Erdös-Renyi graphs (e.g the Frog and Rumor model) and by M. Campanino (Padua) . We forecast strong collaborations with two leading figures in the field, C. Bordenave (CNRS Toulouse) and D. Chafai (Paris), and with J. Salez (Paris), D. Petritis (Rennes), F.Machado et al. (San Paulo).

C. The leading scientist for the first two targets C.1 and C.2 will be F. Caravenna. We also expect some significant exchange of expertise with the units in Rome (the PI, P. Caputo, L. Bertini and M. Mariani), because of some substantial overlap of key results on random polymers and surface models. For this line of research we forecast collaborations with N. Zygouras (Warwick) and R. Sun (Singapore).
For what concerns C.3, C4 and C.5 most of the activity will be done by the units in Rome, with L. Bertini more focused on the dynamical part and P. Caputo together with the PI on the discrete Gaussian model. For what concerns C.3 we forecast collaboration with F.L.Toninelli (Lyon), a leading figure of the field and a close collaborator of the units in Rome and Milan, and with A. Stauffer (Bath) and A. Sinclair (Berkeley) for C.5. Finally we expect also some significant advance on the topic of "anomalous diffusion of random walks in a "Lévy" random environment" by the unit in Padua.

D. The leading group for the first part D.1 will be the unit in La Sapienza (L. Bertini and M. Mariani) while the responsibility for the second part D.2 will be instead taken by the unit in Padua. We forecast collaborations with A. Boritchev and C.E.Brehier (Lyon) for D.1 and with A. Asselah (Marseille), E. Locherbach (Cergy), M. Tolotti (Venezia), M. Formentin, F. Collet (Bologna), L. Campi (London) and F. Delarue (Nice), a leading international figure for stochastic games, for what concerns D.2. Several Ph.D students in Padua will also be somewhat involved in the second part.

Modalities of integration and collaboration

We plan to create a web site dedicated to the project and collecting all the related news, events (seminars, workshops, visitors), preprints and video recorded lectures. In order to enhance and strengthen the "interaction network" among the research units, we plan different levels of integration and collaboration.

1. A first basic level of integration will occur with little efforts because of geographical proximity. The two units in Rome already share a long history of scientific collaborations, joint seminars and international visitors. Similarly, although to a somewhat lesser extent, for the units in Padua and Milan. As a first step to greatly ameliorate this situation, we shall video-record all the seminars/lectures that will occur within the project and to collect them in the project web site. That will require a rather low level equipment, part of which is already available in the four departments. Integration and collaboration will also be boosted by sending team members of different units to international workshops dedicated to the main topics of the project (e.g. Oberwolfach 2016 "Large Scale Stochastic Dynamics").

2. As a second level of integration we shall organise, at the very beginning of the project, a series of keynote lectures across the units on the detailed state of the art of the main targets of the project. These lectures will be delivered by the leading scientists for each topic and the majority of the team members will attend them. In the second half of each year we plan a two day workshop across the units every year, where each sub-group will illustrate intermediate results and discuss future developments.

3. A third level of integration consists in a series of invitations of leading figures related to the main targets of the project to deliver mini-courses on advanced topics. We will organise them in a way to maximise the attendance by the team members and by graduate students and postdocs. The geographical location will rotate among Rome, Padua and Milan. Among the names we have in mind we mention R. Cerf (population dynamics and percolation), C. Garban (noise sensitivity), A. Smith (mixing times for constrained models), F.L.Toninelli (dimers and random surfaces), D. Chafai (random matrices and graphs), I. Corwin (KPZ qquation) and F. Delarue (stochastic games).

4. Finally, towards the end of the third year, we plan to organise an international event with a format in between a workshop and a summer school (i.e. a mixture of seminars and mini-courses).

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4 – Possibile application potentialities and scientific and/or technological and/or social and/or economic impact of the project

Scientific impact and possible applications

Our proposal is a ground breaking project with the best possible selection of researchers in the field, in agreement with the first pillar of Horizon 2020 "Excellent Science". The expected results, together with the new mathematical technologies and methods that will be developed to prove them, will produce a major advance in probability theory and its applications to mathematical statistical physics, with important cross fertilisations among them. As it is well known the above scientific area is one of the most lively and internationally active parts of mathematics, with several important recognitions and fruitful (and sometimes unexpected) ramifications into other branches of mathematics like PDE, geometry, algebra and theoretical computer science.
As indicated in the proposal, we are confident that our project will significantly impact other areas outside mathematics. We have in mind in particular:

Physics of glasses. Glasses are easily designed with desired mechanical or optical properties on an industrial scale, and they are widely present in our daily life. Yet, a deep microscopic understanding of the glassy state of matter remains a challenge for condensed matter physicists. The research of the PI et al. in kinetically constrained models had already a clear impact on the research developed within the physics community. For example wrong assumptions on time scale separation and quasi-one dimensional behavior for certain models, suggested by Monte Carlo simulations, have been vastly corrected and the rigorous analysis featured in a top physics journal (Europhysics Letters).

Theoretical computer science. Both the PI and P. Caputo have a long history of collaborations with keynote figures in theoretical computer science (A. Sinclair, P. Tetali and E. Vigoda), on the main topic of randomised algorithms for sampling and counting complex structures, with three contributions in the two most prestigious and competitive forums in the field (FOCS and STOC) besides journal papers. Moreover the PI was invited to temporarily join the "Theory Group at Microsoft Research" in '13 and the unit of the PI co-organized together with S. Leonardi, a leading computer scientist at Sapienza, the first two editions ('14 and '15) of a very successful workshop entitled "Kolmogorov meets Turing", on common topics in probability, networks theory and computer science, with outstanding speakers like L. Trevisan (Berkeley).

Theory of Networks. The main targets of research line B, as in the best tradition of random matrix and random graphs theory, may help develop important tools for the analysis of large real networks such as those forming the backbone of our society (transportation, traffic, communication and energy networks).

Biology. Synchronization phenomena in complex networks are ubiquitous in networks of living organisms, such as neurons in the brain and in the spinal cord, groups of animals as fireflies and human networks. The mathematical understanding of the origin of this behavior could help, for instance, to control the emergence of periodicity in neuronal systems, where the periodicity may be associated to pathologies.

Economics. Systems of interacting particles have recently emerged as a useful tool in modeling economic systems in which many agents act on a market. This allows one to account for interactions quite effectively, helping to control contagion-like phenomena, such as systemic risk.

Social impact

In a more restricted context, but with a high social impact, we expect an important benefit of the project on the scientific formation of young researchers. Graduate students and postdocs will be exposed to cutting-edge research at an international level, they will learn how to collaborate in a major scientific project and they will have the opportunity to get in touch and collaborate with different scientific environments and with some of the best international researchers of the area. Moreover, postdocs and graduate students will have the possibility to establish the necessary international connections to continue, later on, their professional formation abroad, a key issue for any modern country.
In a much wider context, the PI and the associated investigators will participate and promote events in which basic science and basic research is presented to a large social audience. We have in mind for example the monthly series of public lectures "The tea of Mathematics" in Roma Tre or the annual "Research Night", an event occurring throughout all the Italian universities and research institutions, in which scientists interact with the general public.

5 – Costs and fundings, for each research unit (automatically calculated)

nº	Associated or principal investigator	Total cost	Co-funding (item A.1)	MIUR funding (other items)
1.	MARTINELLI Fabio	227.734 €	60.000 €	167.734 €
2.	FAGGIONATO Alessandra	107.000 €	40.000 €	67.000 €
3.	CARAVENNA Francesco	154.800 €	25.000 €	129.800 €
4.	DAI PRA Paolo	131.000 €	55.000 €	76.000 €
	Total	**620.534 €**	**180.000 €**	**440.534 €**

B.2

1 – Scientific curriculum of PI (highlighting, for LS and PE fields, of bibliometric indicators related to publications and citations, and, for SH field, of the quality and impact of publications; awards and other honors; degree of success in Italian or international previous projects)

MARTINELLI Fabio

MARTINELLI Fabio

Personal Data

Born 01-03-1956 in Rome, Italy.

Education and Training
• Master Degree in physics cum laude, Rome ’79, advisor Prof. G. Jona–Lasinio.
• CNR-scholarship in mathematical physics (’80-’81).
• Postdoc in mathematical physics at the Ruhr-University (Germany), advisor Prof. S. Albeverio (’81-’83).

Academic Positions
• Full Professor in Mathematics, University of Roma Tre, '98-present
• Full Professor in Mathematics, University of L'Aquila, '94-'98
• Associate Professor in Mathematics, University of Roma 1 "La Sapienza", '87-'94
• Assistant Professor in Mathematics, University of Roma 1 "La Sapienza", '84-'87
• Assistant Professor in Mathematics, University of Trento '83-84

Appointments outside Academia
• Research Scientist, Theory Group, Microsoft Research Inc. '13

Visiting Positions
• Institute des Hautes Etudes Scientifiques
• Courant Institute
• Newton Institute
• Theory Group at Microsoft Research
• University of California at Irvine
• University of California at Berkeley
• UCLA
• University of Lyon
• University Paris VII

Awards
• Miller visiting professorship at UC Berkeley ('02)
• Prize “B. Finzi” for mathematical physics of the “Accademia Lombarda delle Scienze” ('00)
• Prize “E.Persico” of the Accademia Nazionale dei Lincei for three consecutive years (1975-79)

Grants
• ERC Marie–Curie fellowship (F.L. Toninelli, '14
• ERC Advanced Grant “Phase transitions in random evolutions of large scale structures” , 1.248.000 Euros, '09-'12
• PRIN “Research Projects of National Interest”, Italian Ministry of University, '00-'08
• ERC Marie–Curie fellowship (C. Roberto, '00)

Main Invited Talks and Courses
• Plenary talk at the XX Congress of the Italian Mathematical Society, '15.
• TAU-CECAM conference "Percolation and the Glass Transition", Tel Aviv '14
• Pacific Northwest Probability Seminar, '13
• Plenary talk at the "XII Latin American Congress of Probability and Mathematical Statistics", '12
• Plenary talk at the meeting of the “Societe' Mathematique Industrielle et Applique”, '07
• Plenary talk at the meeting “Theory of Computation & The Sciences” (Berkeley), '02
• Plenary talk (twice) at the “International Congress on Mathematical Physics”
• Invited course: Saint Flour “Probability Summer School” '97, Brazilian Summer School in Probability Theory '99, Summer School on Mathematical Physics Jerusalem '01, Summer School in Mathematical Statistical Mechanics, Prague '06

Research Organization
• Co-organizer of the workshop "Mathematics of kinetically constrained dynamics and metastability", Warwick '16
• Co-organizer of the workshop “ Percolation and particle systems”, Firenze '11

• Co-organizer of the meeting "Inhomogeneous random systems", IHP, Paris '11
• Co-organizer of a special semester on "Interacting particle systems, Statistical Mechanics and Probability Theory" at the Institute H. Poincaré '08
• Co-organizer of the workshop "Phase transitions, hard combinatorial optimisation problems and message passing algorithms", Banff '08
• Organizer of the special session "Probability Theory" for the International Congress of Mathematical Physics '06
• Co-organizer of a special trimester at the Mathematical Science Research Institute in Berkeley on "Markov chains in algorithms and statistical physics" '05
• Organizer of two workshops on "Statistical mechanics of interfaces" and "Probability Theory, Phase Transitions and Computational Complexity" in Cortona '00 and '97

Professional Counselling
• Scientific Committee for the Doeblin Prize 2015 in Probability Theory.
• Scientific Committee of the "Conference on Stochastic Processes and their Applications", Buenos Aires '14.
• International panel to appoint a chair in mathematics at the University of Goteborg '00 and at the University of Utrecht '12.
• International panel of the Deutsche Forschung Gemeinschaft for a four years research program in "Mathematical Biology" '11

Grant Reviewing
National Science Foundation (USA), National Science Foundation (Israel), National Science Foundation (Netherlands), ERC.

Editorial Activity
• Co-Chief editor together with M. Ledoux of "Probability Theory and Related Fields" (impact factor 1532), Sept '15- to present.
• Associated Editor of: Journal of Statistical Physics '94-97, Annales de l'Institut Henri Poincare' '97-'06, Journal of Potential Analysis '97-'06, Probability Theory and Related Fields '00-'08, ALEA '12-'15.

Journal Refereeing
Communications in Mathematical Physics, Annals of Probability, Probability Theory and Related Fields, Annales de l'Institut Henri Poincare', Journal of Statistical Physics, Random Structures and Algorithms, Inventiones Mathematicae, Journal of the American Mathematical Society.

Students
• P. Caputo (Associate Prof. , University of Roma Tre)
• A. Faggionato (Associate Prof., University of Roma 1 "La Sapienza")
• G. Posta (Associate Prof., University of Roma 1 "La Sapienza")
• A. Bianchi (Assistant Prof., University of Padova)

Research Interests
I have coauthored more than 100 research papers in leading internationalacademic journals such as Comm. Math. Phys, J. of Statistical Physics, Probability Theory and Related Fields, Ann. Inst. H. Poincaré, Ann. Appl. Prob., Ann. of Probability, European J. of Mathematics, Comm. Pure and Appl. Math.
My publication record comprises key contributions to mathematical physics and probability theory on different topics: probabilistic methods in quantum mechanics, random Schroedinger operators, random perturbations of dynamical systems, metastability phenomena, Poincaré and logarithmic Sobolev inequalities, phase transitions in statistical mechanics, quantum spin models, mixing times of randomized algorithms, interacting particle systems, Glauber dynamics. Some of the key results obtained in the above areas went definitely beyond the state of the art at that time and ref. [20] with 235 citations became a standard reference in probability theory and theoretical computer science as well.

Examples include:
• Detailed quantitative analysis of instabilities of tunneling phenomena in the semi-classical limit of quantum mechanics, a series of papers which prompted subsequent important contributions by B. Simon and Helffer-Sj ostrand;
• The first proof of Anderson localization in dimension greater than one with J. Frohlich, E. Scoppola and T. Spencer and the first (and only one until a contribution by J. Bourgain after many years) proof of Anderson localization with Bernoulli random potential;
• The proof of exponential relaxation towards the equilibrium Gibbs measure of attractive stochastic spin models in the whole uniqueness region;
• The first detailed analysis with sharp constants of the stochastic Ising model in the phase coexistence region;
• Completely new proof (after the work by H.T Yau) of the Poincar é and log-Sobolev inequalities for stochastic lattice gases;
• Quantitative sharp analysis of the energy gap of asymmetric quantum XXZ models via interacting particle systems representation and Poincar é inequalities for lattice gases;
• Analysis of the stochastic Ising model and other spin systems (independent sets and colorings) on trees inside a pure phase;
• The first mathematical breakthrough on the analysis of kinetically constrained spin models, a hot topic in the physics of glasses, where the only mathematical contribution by D. Aldous and P. Diaconis was confined to a one dimensional model and where our results corrected some of the conjectures made by the physicists (cf.

refs [2,9,10]).
• Quasi-polynomial mixing time of the Glauber dynamics for the Ising model at low temperature, a major step forward towards proving polynomial mixing time, an open conjecture since 1999.
• First sharp mixing time results on the evolution of monotone surfaces related to dimer tiling problems.
• First complete analysis of the equilibrium and dynamics of the Solid-on-Solid surface model at low temperature above a wall.

Bibliometric Data
From Google Scholar:
• Citations 3416 citations (1155 from 2010)
• h-index 29 (18 from 2010)
• i10-index 66 (36 from 2010)

2 - Scientific curriculum of associated investigators (highlighting, for LS and PE fields, of bibliometric indicators related to publications and citations, and, for SH field, of the quality and impact of publications; awards and other honors)

1. **FAGGIONATO Alessandra**

Personal Data
• Born 21-11-1974 in Udine, Italy
• Motherhood pause for 2 kids ('07,'11)

Education and Training
• Postdoc in probability at WIAS in Berlin, advisor Prof. A. Bovier ('03-'05)
• Postdoc in probability at the Technical University in Berlin, advisor Prof. A. Bovier ('02-'03)
• Ph.D. in mathematics cum laude, Scuola Normale Superiore, Pisa (Italy) '01, advisor Prof. F.Martinelli
• Master degree in mathematics cum laude, University of Pisa, '98, advisor Prof. R. Benedetti

Academic Positions
• Associate Professor in Mathematics, University of Rome "La Sapienza", '12-present
• Assistant Professor in Mathematics, University of Rome "La Sapienza",'05-'12

Awards
• National Habilitation for Full Professor in Mathematical Analysis, Probability and Statistics '13
• Fellowship of excellence "F. Severi", INDAM, '05
• Member of the Italian team at the International Mathematical Olympiad '93

Grants
• Short visit grant of the European Science Foundation '15
• "Progetto d'Ateneo" (project of University La Sapienza) '10-'15
• PRIN ''Research Projects of National Interest'', Italian Ministry of University, '09-'12 (Local PI)

Main Invited Talks and Courses
• Conference "Random walks in random environment", EURANDOM, Eindhoven '15
• TAU-CECAM conference "Percolation and the Glass Transition", Tel Aviv '14
• Conference ''Piecewise deterministic Markov processes'', Centre Lebesgue, Rennes '13
• Ph.D. course ''Hierarchical coalescence processes and East model'' CIRM, Marseille '13
• Conference ''Interacting Particle Systems and Related Topics'', Florence '12
• Conference ''Inhomogeneous Random Systems'', Paris '11
• Conference ''Large scale stochastic dynamics'', MFO, Oberwolfach (Germany) '10
• Invited speaker at special session, conference ''Stochastic processes and Applications'', Berlin '09
• Other invited talks at the Technical University of Berlin, Technical University of Munich, EURANDOM, Paris VII, University d'Aix-Marseille, CIRM-Marseille, University of Bielefeld, ESI in Wien, University of Warwick, University of Pisa, University of Bologna,...

Journal Refereeing
Annals of Applied Probability, Annales de l'Institut Henri Poincaré, ALEA, Communications in Mathematical Physics, Electronic Journal of Probability, Journal of Applied Probability, Journal of Statistical Mechanics: Theory and Experiment, Potential Theory, Stochastic Processes and their Applications, Journal of Statistical Physics, Markov Processes and Related Fields, Probability Theory and Related Fields

Students
• V. Silvestri (Ph.D. student in mathematics, Cambridge)
• M. Ribezzi Crivellari (postdoc in biophysics, Barcelona)

Research Interests
I have coauthor almost 40 research papers published in international journals, often top level journals, as Ann. of Probability, Prob. Theory and Related Fields, Comm. in Math. Phys., Ann. Inst. H. Poincaré, Ann. Appl. Prob., Stoch. Processes and Appl., Electron. J. Probab., J. of Statistical Physics, J. of Stat. Mechanics: Theory and Experiment, Europhysics Letters.

My research interests include: hydrodynamic limit of interacting particle systems, random walks in random environment, piecewise deterministic Markov processes, large deviations, subdiffusive processes with aging, coalescence processes, out-of-equilibrium statistical physics, kinetically constrained models.

Some of my key results include:
• first proof of the hydrodynamic limit for a lattice gas with site disorder (which was a 10-years open problem) [Ref. [20] of publication list]
• first spectral analysis of random walks with aging [16,19]
• first mathematical analysis of variable range hopping in amorphous solids and proof of Mott law for the asymptotics of conductivity at low temperature [15,18]
• first investigation of piecewise deterministic Markov processes from a non-equilibrium statistical physics viewpoint [13]
• first derivation of hydrodynamic limit for subdiffusive disordered interacting particle systems [12]
• introduction of a new family of coalescence processes (called "hierarchical coalescence processes") and derivation of associated limit theorems allowing the first mathematical explanation of the universal limit behavior in several physical models of coarsening [9]
• first proof of the aging behavior for a kinetically constrained model [8]
• disproof of the physical conjecture of time scale separation at equilibrium length scales of East model [4]
• disproof of the physical conjecture of dimension-independence of the East model [3]

Bibliometric Data
From Google Scholar:
• Citations 433 (342 from 2010)
• h-index 13 (12 from 2010)
• i10-index 19 (17 from 2010)

2. CARAVENNA Francesco
Personal Data
Born 15 March 1979 in Treviglio (BG), Italy.

Education and Training
• Master Degree in Physics cum laude, University of Pisa '02
• "Diploma di Licenza" in Physics cum laude, Scuola Normale Superiore of Pisa '03
• Ph.D. in Mathematics, University of Milano-Bicocca and University of Paris 7 '05 (advisors Prof. Giambattista Giacomin and Alberto Gandolfi)
• Postdoc in Mathematics, University of Zurich, advisor Prof. Erwin Bolthausen '05-'06

Academic Positions
• Associate Professor in Mathematics, University of Milano-Bicocca, '10-present
• Assistant Professor in Mathematics, University of Padova, '06-'10

Visiting Positions
• Visiting professor at the Institute of Mathematics, University of Leiden, ERC Advanced Grant VARIS 267356, PI Frank den Hollander, '12-'14 (5 months total)
• Laboratoire de Probabilités et Modèles Aléatoires, Universities of Paris 6 and Paris 7, invited by G. Giacomin and L. Zambotti, '09 (2 months)
• Technical Univerisity of Berlin, invited by J.-D. Deuschel, '07 (1 month)
• Shorter periods at the Department of Mathematics, National University of Singapore, '12-'15

Awards
• National Habilitation for Full Professor in Mathematical Analysis, Probability and Statistics, '13
• Winner of the "Fubini Prize" '11, awarded to a young mathematician working in Italy in the field of random processes

Grants
• PI of the Grant 'Probabilistic models for the statistical mechanics of polymers, interacting particle systems and applications', University of Padova '08 (34,000 Euros)

Invited Talks and Courses
• Levico Terme '15 (Berlin-Potsdam Summer School, course)
• Siena '15 (XX Congress of the Italian Mathematical Society, short invited talk)
• Buenos Aires '14 (SPA conference, session talk)
• Milano '14 (15th Italian Meeting on Hyperbolic Equations, plenary talk)
• Búzios – Rio de Janeiro '10 (Clay Mathematics Institute Summer School and Brazilian School of Probability, mini-course in collaboration with F. den Hollander and N. Pétrélis)
• Bari '07 (XVIII Congress of the Italian Mathematical Union, short invited talk)
• Other invited talks and courses at Oberwolfach '15, Singapore '15, Nantes '14, Abu Dhabi '14, Sapporo '13, Leipzig '13, Eindhoven '13, Singapore '12, Toronto '11, Berlin '10, Nantes '10, Warwick '08, CIRM - Marseille '08, Nice '07, Oberwolfach '06, Pisa '06

Organization
• Co-organizer of the Winter School "Recent Breakthroughs in Singular Stochastic PDEs" (Milano-Bicocca, Feb

'15)
• Co-organizer of the "XII Workshop on Quantitative Finance" (Padova, Jan '11)

Journal Refereeing
Probability Theory and Related Fields, Annals of Probability, Communications in Mathematical Physics, Stochastic Process and Their Applications, Annales de l'Institut Henri Poincaré, Electronic Journal of Probability, Statistics and Probability Letters, Markov Processes and Related Fields, Potential Analysis

Ph.D. Students
• Niccolò Torri (currently Postdoc at Univ. Nantes), thesis defended in September '15 [joint supervision with F.L. Toninelli]
• Jacopo Corbetta (currently Postdoc at ENPC Marne La Vallée), thesis defended in March '15

Research Interests
I have coauthored more than 20 papers, published on top journals such as J. Eur. Math. Soch., Probab. Theory Related Fields, Ann. Probab., Ann. Appl. Probab., Comm. Math. Phys., Ann. Inst. H. Poincare,́ Stoch. Process. Appl., Electron. J. Probab., Electron. Commun. Probab., J. Stat. Phys., Adv. in Appl. Probab.
My research focuses on probability theory and its applications. My main research topics are:
1. Probabilistic models in statistical mechanics, in particular random polymers
2. Asymptotic properties of real random walks
3. Probabilistic models for financial series
Some of my key results include:
• First derivation of a local limit theorem under the conditioning to stay positive, for general random walks in the domain of attraction of the Gaussian law (reference [20] of the publication list);
• Use of hypothesis testing with explicit error bounds, based on concentration inequalities, to give overwhelming numerical evidence disproving physical conjectures on the critical line of the copolymer model [17];
• Complete characterization of the phase diagram, in terms of sharp path properties, for weakly inhomogeneous polymer models [16] and for (1+1)-dim. Laplacian fields (membrane models) [11,15], based on Markov renewal theory;
• Introduction of a unified framework, based on polynomial chaos expansion techniques, to study the continuum and weak disorder scaling limits of random systems that are "disorder relevant" [1], and its application to construct the full scaling limit of disordered pinning models [2].

Bibliometric Data
From Google Scholar:
• Citations 388 (294 from 2010)
• H-index 12 (10 from 2010)
• i10-index 15 (11 from 2010)

3. DAI PRA Paolo

Personal Data
• Born 1 November 1962 in Venezia, Italy. Citizenship: Italian

Education and Training
• Master Degree in Mathematics cum laude, University of Padova (1986)
• CNR scholarship at LADSEB Padova, advisor M. Pavon (1987-1988)
• Ph.D. in Mathematics, Rutgers University, advisor Prof. J.L. Lebowitz (1992)

Academic Positions:
• Full Professor of Mathematics, University of Padova (2000-present)
• Associate Professor of Mathematics, Milan Polytechnical Institute (1998-2000)
• Assistant Professor of Mathematics, University of Padova (1992-1998)

Visiting Positions
• Université de Poitiers
• UST Lille
• Rutgers University

Grants
• "Progetto d'Ateneo" (project of Università di Padova), 2015-16, 20742 Euros
• PRIN “Research Projects of National Interest”, Italian Ministry of University, 2003-09, 115,000 Euros total

Main Invited Talks and Courses
• Invited speaker at the meeting “Inhomogeneous random systems”, Paris 2014
• Invited speaker at the workshop “Probabilistic Cellular Automata”, Eindhoven 2013
• Invited speaker at the SIAM Annual Meeting, Minneapolis 2012
• Invited speaker at the workshop “Discrete harmonic analysis”, Cambridge 2011

• Invited lecturer of a mini course at the Spring School "Stochastic Models of Complex Processes", Potsdam 2007

Editorial activity
Member of the editorial board of:
• Mathematics of Control, Signal and Systems (2003-2014)
• ISRN Probability and Statistics (2012-)
• La Matematica nella Società e nella Cultura (Journal of the Unione Matematica Italiana (2007-2012)

Journal Refereeing
Annals of Probability, Annals of Applied Probability, Probability Theory and Related Fields, Annales de l'Institut Henri Poincare', Journal of Statistical Physics, Stochastic Processes and their Applications.

Ph.D. Students
• Pierre-Yves Louis (Assistant Prof., University of Poitiers)
• Ida Minelli (Assistant Professor, University of L'Aquila)
• Marco Tolotti (Assistant Prof., University of Venezia)

Research Interests
I have coauthored more than 60 papers on international journal, as Ann. of Probability, Prob. Theory and Related Fields, Comm. Pure Appl. Math., J. Funct. Analysis, SIAM J. Control Optimiz., Ann. Inst. H. Poincaré, Stoch. Processes and Appl., Electron. J. Probab., J. of Statistical Physics.

My research focuses on probability theory and its applications. My main research topics are:
• Complex systems in Biological and social sciences.
• Geometric and scaling properties of stochastic processes.
• Convergence to equilibrium and functional inequalities for interacting particle systems.

Some of my key results include:
• A large deviation principle for disordered mean-field models
• A duality theorem connecting stochastic control problems and dynamic games
• First proof of the diffusive scaling of the spectral gap in zero-range processes
• A partial extension to jump process of the Bakry-Emery theory for diffusions
• Introduction of a new family of dissipative mean field dynamics, and proof of their collective periodic behavior in some special cases.

Bibliometric Data
From Google Scholar:
• Citations 753 (389 from 2010)
• h-index 15 (10 from 2010)
• i10-index 22 (10 from 2010)

3 – Principal scientific publications of PI

1. Lubetzky Eyal, Martinelli Fabio, Sly Allan, Toninelli Fabio Lucio, Caputo Pietro (in stampa). Scaling limit and cube-root fluctuations in SOS surfaces above a wall. JOURNAL OF THE EUROPEAN MATHEMATICAL SOCIETY, ISSN: 1435-9855 - **Articolo in rivista**
2. Chleboun P, Faggionato A, Martinelli F (in stampa). Relaxation to equilibrium of generalized East processes on Z^d: renormalization group analysis and energy-entropy competition.. ANNALS OF PROBABILITY, ISSN: 0091-1798 - **Articolo in rivista**
3. S. Ganguly, E. Lubetzky, Martinelli F (in stampa). Cutoff for the East process. COMMUNICATIONS IN MATHEMATICAL PHYSICS, vol. 335, p. 1287-1322, ISSN: 0010-3616, doi: 10.1007/s00220-015-2316-x - **Articolo in rivista**
4. CANCRINI NICOLETTA, MARTINELLI FABIO, ROBERTO CYRIL, TONINELLI CRISTINA (2015). Mixing time of a kinetically constrained spin model on trees:
power law scaling at criticality. PROBABILITY THEORY AND RELATED FIELDS, vol. 161, p. 247-266, ISSN: 0178-8051, doi: 10.1007/s00440-014-0548-x - **Articolo in rivista**
5. Caputo P, Toninelli F.L., Martinelli F (2015). Multi-level pinning problems for random walks and self-avoiding lattice paths. ELECTRONIC JOURNAL OF PROBABILITY, vol. 20, p. 1-29, ISSN: 1083-6489, doi: 10.1214/EJP.v20-3849 - **Articolo in rivista**
6. Caputo Pietro, Martinelli Fabio, Sinclair Alistair, Stauffer Alexandre (2015). Random lattice triangulations: Structure and algorithms. THE ANNALS OF APPLIED PROBABILITY, vol. 25, p. 1650-1685, ISSN: 1050-5164, doi: 10.1214/14-AAP1033 - **Articolo in rivista**

7. Caputo Pietro, Martinelli Fabio, Toninelli Fabio Lucio (2015). On the probability of staying above a wall for the (2 + 1)-dimensional SOS model at low temperature. PROBABILITY THEORY AND RELATED FIELDS, vol. 163, p. 803-831, ISSN: 0178-8051, doi: 10.1007/s00440-015-0658-0 - **Articolo in rivista**
8. Caputo P, Lubetzky E, Martinelli F, Sly A, Toninelli FL (2014). Dynamics of 2+1 dimensional SOS surfaces above a wall: slow mixing induced by entropic repulsion. ANNALS OF PROBABILITY, vol. 42, p. 1516-1589, ISSN: 0091-1798, doi: 10.1214/13-AOP836 - **Articolo in rivista**
9. Chleboun P, Faggionato A, Martinelli F (2014). TIME SCALE SEPARATION AND DYNAMIC HETEROGENEITY IN THE LOW
TEMPERATURE EAST MODEL. COMMUNICATIONS IN MATHEMATICAL PHYSICS, vol. 328, p. 955-993, ISSN: 0010-3616, doi: 10.1007/s00220-014-1985-1 - **Articolo in rivista**
10. P. Chleboun, A. Faggionato, Martinelli F (2014). The influence of dimension on the relaxation process of East-like models: Rigorous results. EUROPHYSICS LETTERS, vol. 107, ISSN: 0295-5075, doi: 10.1209/0295-5075/107/36002 - **Articolo in rivista**
11. E. Lubetzky, Martinelli F, Sly A, Toninelli F.L. (2013). Quasi-polynomial mixing of the 2D stochastic Ising model with "plus" boundary up to criticality. JOURNAL OF THE EUROPEAN MATHEMATICAL SOCIETY, vol. 15, p. 339-386, ISSN: 1435-9855, doi: 10.4171/JEMS/363 - **Articolo in rivista**
12. Martinelli F, Toninelli C (2013). Kinetically constrained spin models on trees. THE ANNALS OF APPLIED PROBABILITY, vol. 23, p. 1967-1987, ISSN: 1050-5164, doi: 10.1214/12-AAP891 - **Articolo in rivista**
13. Caputo P, Lacoin H, Martinelli F, Simenhaus F, Toninelli F.L. (2012). Polymer dynamics in the depinned phase:
metastability with logarithmic barriers.. PROBABILITY THEORY AND RELATED FIELDS, ISSN: 0178-8051, doi: 10.1007/s00440-011-0355-6 - **Articolo in rivista**
14. Caputo P, Martinelli F, Toninelli FL (2012). Mixing Times of Monotone Surfaces and SOS Interfaces: A Mean Curvature Approach. COMMUNICATIONS IN MATHEMATICAL PHYSICS, vol. 311, p. 157-189, ISSN: 0010-3616, doi: 10.1007/s00220-012-1425-z - **Articolo in rivista**
15. Faggionato A, Martinelli F, Roberto C, Toninelli C (2012). Aging through hierarchical coalescence processes in the east model. COMMUNICATIONS IN MATHEMATICAL PHYSICS, vol. 309, p. 459-495, ISSN: 0010-3616, doi: 10.1007/s00220-011-1376-9 - **Articolo in rivista**
16. Faggionato A, Martinelli F, Roberto C, Toninelli C (2012). Universality in one dimensional hierarchical coalescence processes. ANNALS OF PROBABILITY, vol. 40, p. 1377-1435, ISSN: 0091-1798, doi: 10.1214/11-AOP654 - **Articolo in rivista**
17. Caputo P, Martinelli F, Simenhaus F, Toninelli FL (2011). "Zero" Temperature Stochastic 3D Ising Model and Dimer Covering Fluctuations: A First Step Towards Interface Mean Curvature Motion. COMMUNICATIONS ON PURE AND APPLIED MATHEMATICS, vol. 64, p. 778-831, ISSN: 0010-3640, doi: 10.1002/cpa.20359 - **Articolo in rivista**
18. N. CANCRINI, C. ROBERTO, MARTINELLI F, C. TONINELLI (2008). Kinetically constrained spin models. PROBABILITY THEORY AND RELATED FIELDS, ISSN: 0178-8051 - **Articolo in rivista**
19. Caputo Pietro, Martinelli Fabio, Sinclair Alistair, Stauffer Alexandre (2013). Random lattice triangulations. In: ACM STOC 2013. ISBN: 9781450320290, doi: 10.1145/2488608.2488685 - **Contributo in Atti di convegno**
20. MARTINELLI F (2000). Lectures on Glauber dynamics for discrete spin models. In: J. BERTOIN, F. MARTINELLI, Y. PERES. Lectures on Probability Theory and Statistics. vol. 1717, p. 96-181, BERLIN:Springer, ISBN: 3-540-66593-5 - **Contributo in volume (Capitolo o Saggio)**

4 - Principal scientific publications of associated investigators

1. **FAGGIONATO Alessandra**

1. L. Bertini Malgarini, A. Faggionato, D. Gabrielli (2015). Large deviations of the empirical flow for continuous time Markov chains. ANNALES HENRI POINCARE', vol. 51, p. 867-900, ISSN: 1424-0637 - **Articolo in rivista**
2. Alessandra Faggionato, C. Roberto, C. Toninelli (2014). Universality for one-dimensional hierarchical coalescence processes with double and triple merges. THE ANNALS OF APPLIED PROBABILITY, vol. 24, p. 476-525, ISSN: 1050-5164, doi: 10.1214/12-aap917 - **Articolo in rivista**
3. P. Chleboun, Alessandra Faggionato, F. Martinelli (2014). The influence of dimension on the relaxation process of East-like models: Rigorous results. EUROPHYSICS LETTERS, vol. 107, p. 36002-36002-p6, ISSN: 0295-5075, doi: 10.1209/0295-5075/107/36002 - **Articolo in rivista**
4. P. Chleboun, Alessandra Faggionato, F. Martinelli (2014). Time Scale Separation and Dynamic Heterogeneity in the Low Temperature East Model. COMMUNICATIONS IN MATHEMATICAL PHYSICS, vol. 328, p. 955-993, ISSN: 0010-3616, doi: 10.1007/s00220-014-1985-1 - **Articolo in rivista**
5. Lorenzo Bertini Malgarini, Alessandra Faggionato, Davide Gabrielli (2013). Large deviation principles for nongradient weakly asymmetric stochastic lattice gases. THE ANNALS OF APPLIED PROBABILITY, vol. 23, p. 1-65, ISSN: 1050-5164, doi: 10.1214/11-aap805 - **Articolo in rivista**
6. P. Caputo, Alessandra Faggionato, T. Prescott (2013). Invariance principle for Mott variable range

hopping and other walks on point processes. ANNALES DE L'INSTITUT HENRI POINCARE-PROBABILITES ET STATISTIQUES, vol. 49, p. 654-697, ISSN: 0246-0203, doi: 10.1214/12-aihp490 - **Articolo in rivista**

7. Alessandra Faggionato, Davide Gabrielli (2012). A representation formula for large deviations rate functionals of invariant measures on the one dimensional torus. ANNALES DE L'INSTITUT HENRI POINCARE-PROBABILITES ET STATISTIQUES, vol. 48, p. 212-234, ISSN: 0246-0203, doi: 10.1214/10-aihp412 - **Articolo in rivista**
8. Alessandra Faggionato, F. Martinelli, C. Roberto, C. Toninelli (2012). Aging Through Hierarchical Coalescence in the East Model. COMMUNICATIONS IN MATHEMATICAL PHYSICS, vol. 309, p. 459-495, ISSN: 0010-3616, doi: 10.1007/s00220-011-1376-9 - **Articolo in rivista**
9. Alessandra Faggionato, Fabio Martinelli, C. Roberto, Cristina Toninelli (2012). Universality in one-Dimensional hierarchical coalescence processes. ANNALS OF PROBABILITY, vol. 40, p. 1377-1435, ISSN: 0091-1798, doi: 10.1214/11-aop654 - **Articolo in rivista**
10. Alessandra Faggionato, D. Di Pietro (2011). Gallavotti-Cohen-Type Symmetry Related to Cycle Decompositions for Markov Chains and Biochemical Applications. JOURNAL OF STATISTICAL PHYSICS, vol. 143, p. 11-32, ISSN: 0022-4715, doi: 10.1007/s10955-011-0161-7 - **Articolo in rivista**
11. A. FAGGIONATO (2009). The alternating marked point process of h-slopes of the drifted Brownian motion. STOCHASTIC PROCESSES AND THEIR APPLICATIONS, vol. 119, p. 1765-1791, ISSN: 0304-4149, doi: 10.1016/j.spa.2008.09.002 - **Articolo in rivista**
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15. Alessandra Faggionato, P. Mathieu (2008). Mott law as upper bound for a random walk in a random environment. COMMUNICATIONS IN MATHEMATICAL PHYSICS, vol. 281, p. 263-286, ISSN: 0010-3616, doi: 10.1007/s00220-008-0491-8 - **Articolo in rivista**
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20. A. FAGGIONATO, F. MARTINELLI (2003). Hydrodynamic limit of disordered lattice gas. PROBABILITY THEORY AND RELATED FIELDS, vol. 127, p. 535-608, ISSN: 0178-8051, doi: 10.1007/s00440-003-0305-z - **Articolo in rivista**

2. **CARAVENNA Francesco**

1. Caravenna F, Sun R, Zygouras N (in stampa). Polynomial chaos and scaling limits of disordered systems. JOURNAL OF THE EUROPEAN MATHEMATICAL SOCIETY, ISSN: 1435-9855 - **Articolo in rivista**
2. Caravenna F, Sun R, Zygouras N (in stampa). The continuum disordered pinning model. PROBABILITY THEORY AND RELATED FIELDS, ISSN: 0178-8051, doi: 10.1007/s00440-014-0606-4 - **Articolo in rivista**
3. Berger Q, Caravenna F, Poisat J, Sun R, Zygouras N (2014). The Critical Curves of the Random Pinning and Copolymer Models at Weak Coupling. COMMUNICATIONS IN MATHEMATICAL PHYSICS, vol. 326, p. 507-530, ISSN: 0010-3616, doi: 10.1007/s00220-013-1849-0 - **Articolo in rivista**
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6. Andreoli A, Caravenna F, Dai Pra P, Posta G (2012). Scaling and multiscaling in financial series: a simple model. ADVANCES IN APPLIED PROBABILITY, vol. 44, p. 1018-1051, ISSN: 0001-8678, doi: 10.1239/aap/1354716588 - **Articolo in rivista**
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8. Caravenna F, Giacomin G (2010). The weak coupling limit of disordered copolymer models. ANNALS OF PROBABILITY, vol. 38, p. 2322-2378, ISSN: 0091-1798, doi: 10.1214/10-AOP546 - **Articolo in rivista**
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10. Bolthausen E, Caravenna F, De Tiliere B (2009). The quenched critical point of a diluted disordered polymer model. STOCHASTIC PROCESSES AND THEIR APPLICATIONS, vol. 119, p. 1479-1504, ISSN: 0304-4149, doi: 10.1016/j.spa.2008.07.008 - **Articolo in rivista**
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14. CARAVENNA F, CHAUMONT L (2008). Invariance principles for random walks conditioned to stay positive. ANNALES DE L'INSTITUT HENRI POINCARE-PROBABILITES ET STATISTIQUES, vol. 44, p. 170-190, ISSN: 0246-0203, doi: 10.1214/07-AIHP119 - **Articolo in rivista**
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17. CARAVENNA F, GIACOMIN G, GUBINELLI M (2006). A numerical approach to copolymers at selective interfaces. JOURNAL OF STATISTICAL PHYSICS, vol. 122, p. 799-832, ISSN: 0022-4715 - **Articolo in rivista**
18. Caravenna F, Giacomin G, Zambotti L (2006). Sharp asymptotic behavior for wetting models in (1+1)-dimension. ELECTRONIC JOURNAL OF PROBABILITY, vol. 11, p. 345-362, ISSN: 1083-6489 - **Articolo in rivista**
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3. **DAI PRA Paolo**

1. Collet Francesca, Dai Pra Paolo, Formentin Marco (2015). Collective periodicity in mean-field models of cooperative behavior. NODEA-NONLINEAR DIFFERENTIAL EQUATIONS AND APPLICATIONS, vol. 22, p. 1461-1482, ISSN: 1021-9722, doi: 10.1007/s00030-015-0331-4 - **Articolo in rivista**
2. Dai Pra P, Pigato P. (2015). Multi-scaling of moments in stochastic volatility models. STOCHASTIC PROCESSES AND THEIR APPLICATIONS, vol. 125, p. 3725-3747, ISSN: 0304-4149, doi: 10.1016/j.spa.2015.04.007 - **Articolo in rivista**
3. Paolo Dai Pra, Benedetto Scoppola, Elisabetta Scoppola (2015). Fast Mixing for the Low Temperature 2D Ising Model Through Irreversible Parallel Dynamics. JOURNAL OF STATISTICAL PHYSICS, vol. 159, p. 1-20, ISSN: 0022-4715, doi: 10.1007/s10955-014-1180-y - **Articolo in rivista**
4. C. Borile, P. Dai Pra, M. Fischer, M. Formentin, A. Maritan (2014). Time to Absorption for a Heterogeneous Neutral Competition Model. JOURNAL OF STATISTICAL PHYSICS, vol. 156, p. 119-130, ISSN: 0022-4715, doi: 10.1007/s10955-014-0989-8 - **Articolo in rivista**
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6. Paolo Dai Pra, Gustavo Posta (2013). Entropy decay for interacting systems via the Bochner-Bakry-Émery approach. ELECTRONIC JOURNAL OF PROBABILITY, vol. 18, p. 1-40, ISSN: 1083-6489, doi: 10.1214/EJP.v18-2041 - **Articolo in rivista**
7. Paolo Dai Pra, Markus Fischer, Daniele Regoli (2013). A Curie-Weiss Model with Dissipation. JOURNAL OF STATISTICAL PHYSICS, vol. 152, p. 37-53, ISSN: 0022-4715, doi: 10.1007/s10955-013-0756-2 - **Articolo in rivista**
8. Paolo Dai Pra, Elena Sartori, Marco Tolotti (2013). Strategic Interaction in Trend-Driven Dynamics. JOURNAL OF STATISTICAL PHYSICS, vol. 152, p. 724-741, ISSN: 0022-4715, doi: 10.1007/s10955-013-0784-y - **Articolo in rivista**
9. ALESSANDRO ANDREOLI, FRANCESCO CARAVENNA, PAOLO DAI PRA, GUSTAVO POSTA (2012). Scaling and multiscaling in financial series: a simple model. ADVANCES IN APPLIED PROBABILITY, vol. 44, p. 1018-1051, ISSN: 0001-8678, doi: 10.1239/aap/1354716588 - **Articolo in rivista**

10. F. Collet, P. Dai Pra (2012). The role of disorder in the dynamics of critical fluctuations of mean field models. ELECTRONIC JOURNAL OF PROBABILITY, vol. 17, p. 1-40, ISSN: 1083-6489, doi: 10.1214/EJP.v17-1896 - **Articolo in rivista**
11. COLLET F, DAI PRA P., SARTORI E (2010). A Simple Mean Field Model for Social Interactions: Dynamics, Fluctuations, Criticality. JOURNAL OF STATISTICAL PHYSICS, vol. 139, p. 820-858, ISSN: 0022-4715, doi: 10.1007/s10955-010-9964-1 - **Articolo in rivista**
12. CAPUTO P, DAI PRA P., POSTA G (2009). Convex Entropy Decay via the Bochner-Bakry-Emery approach. ANNALES DE L'INSTITUT HENRI POINCARE-PROBABILITES ET STATISTIQUES, vol. 45, p. 734-753, ISSN: 0246-0203, doi: 10.1214/08-AIHP183 - **Articolo in rivista**
13. DAI PRA P, RUNGGALDIER W. J, SARTORI E., TOLOTTI M (2009). Large portfolio losses: A dynamic contagion model
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14. CATTIAUX P, DAI PRA P., ROELLY S (2008). A constructive approach to a class of ergodic HJB equations with nonsmooth cost. SIAM JOURNAL ON CONTROL AND OPTIMIZATION, vol. 47, p. 2598-2615, ISSN: 0363-0129, doi: 10.1137/070698634 - **Articolo in rivista**
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18. DAI PRA P., POSTA G. (2005). Logarithmic Sobolev inequality for zero range dynamics. ANNALS OF PROBABILITY, vol. 33, p. 2355-2401, ISSN: 0091-1798, doi: 10.1214/009117905000000332 - **Articolo in rivista**
19. ASSELAH A., DAI PRA P. (2004). Hitting times for special patterns in the symmetric exclusion process on Z^d. ANNALS OF PROBABILITY, vol. 32, p. 3301-3323, ISSN: 0091-1798, doi: 10.1214/009117904000000487 - **Articolo in rivista**
20. DAI PRA P., ROELLY SYLVIE, ZESSIN HANS (2002). A Gibbs variational principle in space-time for infinite-dimensional diffusions. PROBABILITY THEORY AND RELATED FIELDS, vol. 122, p. 289-315, ISSN: 0178-8051, doi: 10.1007/s004400100170 - **Articolo in rivista**

5 – Main staff involved, highlighting the time commitment expected

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List of the Research Units

Unit 1 - MARTINELLI Fabio

Personnel of the research unit

nº	Surname Name	Category	University/Research Institution	E-mail address	Months/person expected
1.	MARTINELLI Fabio	Professore Ordinario	Università degli Studi ROMA TRE	martin@mat.uniroma3.it (adesione completata il 13/01/2016)	4,0
2.	CAPUTO Pietro	Professore Associato confermato	Università degli Studi ROMA TRE	caputo@mat.uniroma3.it (adesione completata il 07/12/2015)	3,0
3.	SCOPPOLA Elisabetta	Professore Straordinario	Università degli Studi ROMA TRE	scoppola@mat.uniroma3.it (adesione completata il 07/12/2015)	2,0

Possible sub-unit

Surname	Name	Category	E-mail address	Months/person expected

Unit 2 - FAGGIONATO Alessandra

Personnel of the research unit

nº	Surname Name	Category	University/Research Institution	E-mail address	Months/person expected
1.	FAGGIONATO Alessandra	Professore Associato (L. 240/10)	Università degli Studi di ROMA "La Sapienza"	faggiona@mat.uniroma1.it (adesione completata il 21/12/2015)	4,0
2.	BERTINI MALGARINI Lorenzo	Professore Ordinario	Università degli Studi di ROMA "La Sapienza"	bertini@mat.uniroma1.it (adesione completata il 09/12/2015)	2,0
3.	MARIANI Mauro	Ricercatore non confermato	Università degli Studi di ROMA "La Sapienza"	mauro.mariani@uniroma1.it (adesione completata il 07/12/2015)	2,0
4.	CANCRINI Nicoletta	Professore Associato confermato	Università degli Studi de L'AQUILA	nicoletta.cancrini@univaq.it (adesione completata il 09/12/2015)	1,0

Unit 3 - CARAVENNA Francesco

Personnel of the research unit

nº	Surname Name	Category	University/Research Institution	E-mail address	Months/person expected
1.	CARAVENNA Francesco	Professore Associato confermato	Università degli Studi di MILANO-BICOCCA	francesco.caravenna@unimib.it (adesione completata il 11/01/2016)	4,0
2.	ZUCCA Fabio	Ricercatore confermato	Politecnico di MILANO	fabio.zucca@polimi.it (adesione completata il 07/12/2015)	1,0
3.	BERTACCHI Daniela	Professore Associato (L. 240/10)	Università degli Studi di MILANO-BICOCCA	daniela.bertacchi@unimib.it (adesione completata il 11/12/2015)	2,0

Unit 4 - DAI PRA Paolo

Personnel of the research unit

nº	Surname Name	Category	University/Research Institution	E-mail address	Months/person expected
1.	DAI PRA Paolo	Professore Ordinario	Università degli Studi di PADOVA	daipra@math.unipd.it (adesione completata il 12/01/2016)	4,0
2.	FISCHER Markus	Ricercatore confermato	Università degli Studi di PADOVA	fischer@math.unipd.it (adesione completata il 11/12/2015)	3,0
3.	CAMPANINO Massimo	Professore Ordinario	Università degli Studi di BOLOGNA	campanin@dm.unibo.it (adesione completata il 11/12/2015)	1,0
4.	BIANCHI Alessandra	Ricercatore non confermato	Università degli Studi di PADOVA	bianchi@math.unipd.it (adesione completata il 11/12/2015)	3,0

6 - Major new contracts for staff specifically to recruit

nº	Associated or principal investigator	Number of contracts RTD expected	Number of research grants expected	Number of PhD expected	Predictable overall time commitment (months)
1.	MARTINELLI Fabio	1	0	0	12
2.	FAGGIONATO Alessandra	0	0	0	0
3.	CARAVENNA Francesco	1	0	0	24
4.	DAI PRA Paolo	0	0	0	0
	Total	**2**	**0**	**0**	**36**

7 - Declaration Upload

- QUOTA PREMIALE MARTINELLI.pdf

"I dati contenuti nella domanda di finanziamento sono trattati esclusivamente per lo svolgimento delle funzioni istituzionali del MIUR. Incaricato del trattamento è il CINECA- Dipartimento Servizi per il MIUR. La consultazione è altresì riservata agli atenei e agli enti di ricerca (ciascuno per le parti di propria competenza), al MIUR - D.G. per il Coordinamento e lo Sviluppo della Ricerca - Ufficio V, al CNGR e ai CdS. Il MIUR potrà anche procedere alla diffusione dei principali dati economici e scientifici relativi ai progetti finanziati".

Date 13/01/2016 ore 21:07