



Consiglio di  
Amministrazione

Seduta del

17 NOV. 2015

..... O M I S S I S .....

**Sono presenti:** il **rettore**, prof. Eugenio Gaudio; il **prorettore**, prof. Renato Masiani; i consiglieri: prof.ssa Antonella Polimeni, prof. Maurizio Barbieri, prof. Bartolomeo Azzaro, dott. Francesco Colotta, prof. Michel Gras, sig. Domenico Di Simone, dott.ssa Angelina Chiaranza, sig. Luca Lucchetti, sig.ra Federica Di Pietro e il **direttore generale** Carlo Musto D'Amore, che assume le funzioni di segretario.

**Assiste per il Collegio dei Revisori dei Conti:** dott. Michele Scalisi.

..... O M I S S I S .....

DELIBERA  
361/15  
REL. INT  
8.2



Consiglio di  
Amministrazione

Seduta del

17 NOV. 2015

SAPIENZA UNIVERSITÀ DI ROMA  
Area per l'internazionalizzazione  
Il Direttore  
Dott.ssa Antonella Carrilera

SAPIENZA UNIVERSITÀ DI ROMA  
Area per l'internazionalizzazione  
Ufficio Internazionalizzazione Ricerca  
Il Capo Ufficio  
Anna Gambogi

Giuditta Carabella  
Anna Gambogi  
LW

## ACCORDO PER LA PARTECIPAZIONE AL GDRE (GRUPPO DI RICERCA EUROPEA) DENOMINATO ERS "EVOLUTION, REGULATION AND SIGNALLING"

Il Presidente sottopone all'esame del Consiglio di Amministrazione la seguente relazione, predisposta dall'Area per l'Internazionalizzazione e già approvata dal Senato Accademico con delibera n. 495 del 3 novembre 2015.

Il Consiglio del Dipartimento di Fisica, nella seduta del 17 giugno 2015, ha approvato la proposta avanzata dalla prof.ssa Irene Giardina di entrare a far parte del preesistente GDRE denominato ERS ("Evolution, regulation and signalling") come nuovo *partner* in fase di stipula di un *Agreement* per l'estensione della durata temporale dello stesso.

L'accordo è sottoscritto tra le seguenti unità:

- CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE
- ÉCOLE NORMALE SUPÉRIEURE PARIS
- UNIVERSITÉ PIERRE ET MARIE CURIE PARIS 6
- UNIVERSITÉ PARIS DIDEROT PARIS 7
- UNIVERSITY OF COPENHAGEN
- TESCHNISCHE UNIVERSITÄT MÜNCHEN
- STICHTING VOOR FUNDAMENTEEL ONDERZOEK DER MATERIE
- UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA"
- ABDUS SALAM INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
- UNIVERSITY OF EDINBURGH

L'obiettivo principale di ERS è quello di promuovere un'attività di ricerca congiunta tra gli enti firmatari l'accordo sulle tematiche scientifiche di competenza comune anche mediante l'organizzazione di conferenze, workshop e visite scientifiche.

L'accordo ha durata quadriennale e, per Sapienza, il Dipartimento direttamente coinvolto nelle attività di ERS è il richiedente Dipartimento di Fisica, con la designazione della prof.ssa Irene Giardina come responsabile scientifico per le attività.

Con lettera del 6 ottobre 2015, il direttore del Dipartimento di Fisica prof. Longo, il Responsabile Amministrativo Delegato dott.ssa Rubini e la professoressa Giardina in qualità di proponente, hanno altresì specificato che ogni onere finanziario derivante dalla partecipazione all'iniziativa graverà sui fondi di ricerca della prof.ssa Giardina.



Consiglio di  
Amministrazione

Seduta del

17 NOV. 2015

**SAPIENZA UNIVERSITÀ DI ROMA**  
Area per l'Internazionalizzazione  
Il Direttore  
Dott.ssa Antonella Cammisa

**SAPIENZA UNIVERSITÀ DI ROMA**  
Area per l'Internazionalizzazione  
Ufficio Internazionalizzazione Ricerca  
Il Capo Ufficio  
Anna Gambogi

**SAPIENZA UNIVERSITÀ DI ROMA**  
Area per l'Internazionalizzazione  
Settore Internazionalizzazione Ricerca  
Il Capo Settore  
Giuditta Carabella

Allegato parte integrante:

- memorandum for the extension of the European scientific coordination network (GDRE) ERS

Allegati in visione:

- verbale Consiglio Dipartimento di Fisica del 17 giugno 2015;
- lettera del Dipartimento di Fisica del 6 ottobre 2015;
- delibera del Senato Accademico n. 495 del 3 novembre 2015



17 NOV. 2015

..... OMISSIS .....

**DELIBERAZIONE N. 361/15**

**IL CONSIGLIO DI AMMINISTRAZIONE**

- **Letta la relazione istruttoria;**
- **Vista la proposta di accordo per la costituzione di un Gruppo di ricerca Internazionale denominato "ERS";**
- **Viste la delibera del Consiglio di Dipartimento di Fisica del 17 giugno 2015 e la lettera del 6 ottobre 2015;**
- **Vista la delibera del Senato Accademico n. 495, del 3 novembre 2015;**
- **Considerata la rilevanza delle istituzioni firmatarie dell'accordo;**
- **Presenti n. 12, votanti n. 10: con voto unanime espresso nelle forme di legge dal rettore e dai consiglieri: Polimeni, Barbieri, Azzaro, Colotta, Gras, Di Simone, Chiaranza, Lucchetti e Di Pietro**

**DELIBERA**

**di autorizzare il Rettore alla firma dell'accordo medesimo.**

**Letto e approvato seduta stante per la sola parte dispositiva.**

**IL SEGRETARIO**  
**Carlo Musto D'Amore**

**IL PRESIDENTE**  
**Eugenio Gaudio**

..... OMISSIS .....

**MEMORANDUM FOR THE EXTENSION OF THE  
EUROPEAN SCIENTIFIC COORDINATION NETWORK (GDRE)**

**“Evolution, Regulation and Signalling (ERS)”**

**CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE**, hereinafter referred to as **CNRS**, a public scientific and technological institution, with headquarters at 3, rue Michel Ange, 75794 Paris Cedex 16, France, represented by its **President, Mr. Alain FUCHS**,

acting in its own name and on behalf of:

- Laboratoire de physique statistique de l'ENS (LPS), UMR 8550, Director: Mr. Jorge Kurchan
- Laboratoire de physique théorique de l'ENS (LPTENS), UMR 8549, Director: Mr. Constantin Bachas

AND

**ÉCOLE NORMALE SUPÉRIEURE PARIS**, hereinafter referred to as **ENS**, a public institution for higher education and research, with headquarters at 45, rue d'Ulm, 75230 Paris Cedex 05, France, represented by its **Director, Mr. Marc MEZARD**,

acting in its own name and on behalf of:

- Laboratoire de physique statistique de l'ENS (LPS), UMR 8550, Director: Mr. Jorge Kurchan
- Laboratoire de physique théorique de l'ENS (LPTENS), UMR 8549, Director: Mr. Constantin Bachas

AND

**UNIVERSITÉ PIERRE ET MARIE CURIE PARIS 6**, hereinafter referred to as **UPMC**, a public scientific, cultural and professional institution, with headquarters at 4, place Jussieu, 75005 Paris Cedex 05, France, represented by its **President, Mr. Jean CHAMBAZ**,

acting in its own name and on behalf of:

- Laboratoire de physique statistique de l'ENS (LPS), UMR 8550, Director: Mr. Jorge Kurchan
- Laboratoire de physique théorique de l'ENS (LPTENS), UMR 8549, Director: Mr. Constantin

AND

**UNIVERSITÉ PARIS DIDEROT PARIS 7**, hereinafter referred to as **Université Paris 7**, a public scientific, cultural and professional institution, with headquarters at 5, rue Thomas Mann, 75013 Paris, France, represented by its **President, Mrs. Christine CLERICI**,

acting in its own name and on behalf of:

- Laboratoire de physique statistique de l'ENS (LPS), UMR 8550, Director: Mr. Jorge Kurchan

AND

**UNIVERSITY OF COPENHAGEN**, a public University, with headquarters at Nørregade 10 DK-1165 Copenhagen K 118, Denmark, represented by **Pro-rector, Mr. Thomas BJØRNHOLM** and **Rector, Mr. Ralf HEMMINGSEN**,

acting in its own name and on behalf of:

- Center of Models of Life, Niels Bohr Institute, Blegdamsvej 17, 2100 Copenhagen, Denmark, Head of Center: Mr. Kim Sneppen

AND

**TESCHNISCHE UNIVERSITÄT MÜNCHEN**, hereinafter referred to as **TUM**, a public University, with headquarters at James-Franck-Str. 1, 85748 Garching, Germany, represented by the **Dean of the Faculty of Physics, Mr. Johannes BARTH (to be confirmed)**,

acting in its own name and on behalf of:

- Physics-Department, Theory of Complex Bio-Systems Group, Head: Mr Ulrich Gerland

AND

**STICHTING VOOR FUNDAMENTEEL ONDERZOEK DER MATERIE** (Foundation for Fundamental Research on Matter), hereinafter referred to as **FOM**, an autonomous foundation for Fundamental Research on Matter responsible to the physics division of the national research council NWO, with headquarters at Van Vollenhovenlaan 659, 3527 JP Utrecht, the Netherlands, represented by the **Director of the Institute for atomic and molecular physics (AMOLF), Mr. Vinod SUBRAMANIAM**

acting in its own name and on behalf of:

- Institute for atomic and molecular physics (AMOLF), Amsterdam, Director: Mr. Vinod Subramaniam

AND

**UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA"**, hereinafter referred to as **Sapienza Universita di Roma**, a public University, with headquarters at Piazzale Aldo Moro 5, 00185 Roma, Italy, represented by its **Rector, Mr. Eugenio GAUDIO**,

acting in its own name and on behalf of:

- Dipartimento di Fisica, Head: Mr. Egidio Longo

AND

**ABDUS SALAM INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS**, hereinafter referred to as **ICTP**, an International Scientific Centre working under a tripartite agreement between the Italian Government, the International Atomic Energy Agency (IAEA) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) and administered by UNESCO under which it is considered as a UNESCO Category 1 institute, located at Strada Costiera, 11, I - 34151 Trieste, Italy, represented by its **Director, Mr. Fernando QUEVEDO**,

acting in its own name and on behalf of:

- Quantitative Life Sciences section of the ICTP

AND

**UNIVERSITY OF EDINBURGH**, a Registered Charity with headquarters at Old College, South Bridge, Edinburgh EH8 9YL, United Kingdom, represented by its **Head of Legal Division, Mrs. Nora KELLOCK**,

acting in its own name and on behalf of:

- School of Physics and Astronomy, Institute for Condensed Matter and Complex Systems, Head: Mr. Malcolm McMahon

**Hereinafter referred to individually as the “Party” or collectively as the “Parties”.**

## **CONSIDERING**

- The Memorandum establishing the European scientific coordination network “Evolution, Regulation and Signalling (ERS)”, signed on 19 December 2011 between CNRS, Institut Pasteur, Université Paris Sud, ENS Paris, UPMC, Université Paris 7, University of Copenhagen, Danish National Research Foundation, LMU, Royal Institute of Technology (KTH) and FOM.
- The replacement of some groups which have participated in the network during its first period (2011-2014) by other teams working on the new topics that emerged during the first period.

## **PREAMBLE**

With the following document we are renewing the support for a European wide scientific network centered around the biophysics of Evolution, Regulation and Signaling. This coordination network has functioned in a very successful way between 2011-2014, organizing a total of 11 conferences, workshops and summer schools. All meetings were very successful in terms of attendance and interest. Most importantly, the community feels the direct benefits from these regular interactions, which facilitate the exchange of ideas and people as shown by a survey at the recently organized Munich meeting. We are proposing to expand the range of the network to new topics, as they have become relevant to the research interests of the community, and to new countries by introducing a stronger representation of women in the scientific committee. Based on the experience of the last four years, we will work harder to create a platform for exchange for students and post-docs who will form the future basis of a solid European wide community.

In order to understand how physical principles are realized in biological organisms, it is instructive to study different systems and compare our understanding of how physical laws are implemented in different organisms and in different scales. In the last decade, such an approach of taking inspiration from different biological systems (such as vertebrate development, chemotaxis, fly development, olfaction, visual processing) has proven very fruitful in proposing potential design principles (noise minimization, information transmission, minimax strategies, evolvability) that govern how physical laws are realized in living organisms. The lessons learned from these theoretical ideas have enabled the participating laboratories to push the limits of experiments in concrete systems and often questioned our understanding of basic processes. This valuable interplay between physics and the biological sciences is what justifies the framework to exchange and discuss ideas made possible by the renewal of this network.

These exchanges of ideas and knowledge are both at the experimental level (development of new techniques, improvements in imaging and microscopy, analysis of experimental noise), as well as theoretical (interest in cellular stochasticity, signal processing, emergent behavior). Following this demand, this network unites the most important centers in Europe that work on the biophysics of Evolution, Regulation and Signaling, on a vast array of biological systems under one network, that facilitates the exchange of ideas and the search for new physical laws and behavior.

The list of laboratories signing the Memorandum for the renewal of the network has slightly changed, leaving participants being replaced by other teams working on the new topics that emerged during the first period of the network.

**It has been agreed as follows:**

### **Article 1 – Purpose**

The purpose of this Memorandum is the extension of the European scientific coordination network, (hereinafter referred to as the “Network”), a non-incorporated means of cooperation, named “**Evolution, Regulation and signalling (ERS)**” the purpose of which is to exchange information on the following scientific theme: *Physics of the evolution of regulatory and signalling mechanisms in biological systems*, hereinafter referred to as the Network Theme.

The scientific purpose of the Network within the framework of the Theme and the activities resulting from it are stated in Annex 1.

### **Article 2 – Composition**

The Network is composed of the laboratories/institutes/centers listed above.

The activities to be coordinated by the Network shall extend only to the scientific work inherent to the Network Theme of the laboratories/institutes/centers.

All personnel of the said laboratories or institutes contributing to the Network activities shall remain assigned to their home laboratory/institute/center and institution.

### **Article 3 – Resources**

Each Party shall undertake to make available to the members of the Network affiliated to said Party the means it deems necessary to promote their activities within the framework of the regulations of the individual Parties and in particular:

- a/ The exchange of information between Network members through the organization of conferences, seminars, colloquia, workshops, thematic schools or work meetings on said Theme.
- b/ Discussion of the setting up and running, if necessary, of joint research projects on said Theme at a later stage.
- c/ Cooperation in terms of information and scientific documentation in particular through the exchange of publications and scientific reviews on the Network Theme.
- d/ Facilitate contacts and exchanges of researchers participating in the Network on said Theme.

### **Article 4 – Organization**

A Coordinator, whose identity is given in Annex 2, shall be appointed jointly by the Parties for a four (4) year period.

The role of the Coordinator is to steer the Network activities and the Theme with the Scientific Committee, and to transmit the information submitted by the Parties to the Scientific Committee and Network members.

The Coordinator shall be assisted by a Scientific Committee. The Scientific Committee is composed of sitting representatives from member laboratories/institutes/centers, appointed by the Party (or Parties) to which the laboratory/institute/center is affiliated. The composition of the Scientific Committee selected is set forth in Annex 3.



The Scientific Committee shall meet at least once a year and as often as needed at the initiative of the Coordinator or of one third (1/3) of its members. As necessary and with the unanimous consent of the Scientific Committee members, these meetings may be held by videoconferencing. All minutes shall be distributed to the Parties.

Each Party shall transmit to the Coordinator the names of the scientists participating in the activities of the Network, for each member laboratory/institute/center affiliated to said Party. The Coordinator shall compile the list and transmit it to all the members of the Network. The Coordinator shall update the list whenever necessary.

For information purposes only, the list of the staff of the signatory Parties to the Memorandum and of external interested participants is attached to the present Memorandum.

The Coordinator shall draw up an annual scientific and financial report of the Network's activities which shall be submitted to the Parties.

### **Article 5 – Implementation of Network activities**

The conferences (after consultation with the Network laboratories/institutes/centers), seminars, colloquia, workshops, thematic schools or work meetings on the Network Theme are organized under the sole responsibility of the Party that takes the initiative to do so. Each Party shall fund the participation of each of its members in Network activities.

The laboratories/institutes/centers involved in this Network can fund their participation to their own activities in the Network using their respective grants.

Within the framework of the exchanges referred to in Section d of Article 3 above, the relationship between the institution to which the researcher belongs and the host institution shall be strictly bilateral and their terms and conditions are not governed by this Memorandum.

The Parties shall make mention of the financial resources that they intend to allocate to their participation in Network activities for information purposes in Annex 4.

If two or more Parties intend to carry out research work jointly within the framework of the Network Theme, they shall establish the terms and conditions of said cooperation in a separate agreement binding on the signatory Parties, particularly with regard to Intellectual Property, the ownership and the exploitation of results.

### **Article 6 – Duration**

This Memorandum is entered into for a period of four (4) years as of 1 January 2015 retroactively. Any Party may withdraw from this Memorandum by giving six (6) months advance notice by registered letter with acknowledgement of receipt addressed to the other Parties.

### **Article 7 – Confidentiality**

Each Party shall undertake to treat confidentially and not to reveal to third parties any information that comes to them within the framework of the coordination.

Information received by the Parties shall not be confidential information if:

- it was already publicly known at the time of its disclosure hereunder, or becomes thereafter publicly known otherwise than through the fault of a Party;

- it is demonstrably developed at any time by the Parties without any connection with the information received hereunder;
- it is rightfully obtained at any time by the Parties from a third party without restrictions in respect of disclosure or use;
- it is disclosed and/or communicated due to complying with national law, national regulation, a decision by a national authority, and/or national court order. If this is the case, the Party complying with such requirement shall, if legally possible, endeavour to notify the disclosing Party as quickly as possible.

#### **Article 8 – Disputes**

It is agreed that, in the event a problem arises from the interpretation or performance of this Memorandum, or if the Parties identify new problems not covered by this Memorandum, the Parties shall enter into amicable negotiations to resolve the problems. If it is necessary, the results of these negotiations could be the subject of amendments to this Memorandum.

If no amicable settlement is reached, the appellant shall request a settlement of the dispute before an arbitrary court, which shall rule in accordance with the rules of international law.

#### **Article 9 – Originals**

The present Memorandum has been drafted in ten originals.

Date..... Place.....

**For CNRS**

**Alain FUCHS**, President

Date..... Place.....

**For ENS**

**Marc MEZARD**, Director

Date..... Place.....

**For UPMC**

**Jean CHAMBAZ, President**

Date..... Place.....

**For Université Paris 7**

**Christine CLERICI, President**

Date..... Place.....

**For University of Copenhagen**

**Ralf HEMMINGSEN**, Rector

**Thomas BJØRNHOLM**, Pro-rector

Date..... Place.....

**For TUM**

**Johannes BARTH**, Dean of the Faculty  
of Physics



Date..... Place.....

**For FOM**

**Vinod SUBRAMANIAM, Director of AMOLF**

Date..... Place.....

**For Sapienza Università di Roma**

**Eugenio GAUDIO**, Rector

Date..... Place.....

**For ICTP**

**Fernando QUEVEDO**, Director

Date..... Place.....

**For University Edinburgh**

**Nora KELLOCK**, Head of Legal Division

## ANNEX 1

### DESCRIPTION OF THE COOPERATION

Physicists have been fascinated by phenomena in living systems for a long time, as evidenced by the very well known examples of Delbrueck or Crick. Conversely, biologists have identified important physical behaviors in the systems they were observing, such as Brownian motion first described by a botanist that later led to a revolution in physics. Over the last decade the interaction between these two fields has intensified, especially in problems linked to Evolution, Regulation and Signaling, the topics of the Network “ERS”. The reasons for this development come independently from the two fields. Physicists have become increasingly interested in non-equilibrium many body systems, that do not obey classical laws of equilibrium statistical mechanics, such as detailed balance. Living organisms consume energy and evolve providing inspiration for phenomena that can appear in this fascinating new regime. Biologists, on the other hand, especially since the great advances in molecular biology and genetics have spent a lot of effort characterizing the cellular elements. Despite Rutherford’s derogatory comment about stamp collecting, this was a necessary step that uncovered a richness of molecules and local interactions. However, over the past decade it has become clear that characterization alone is not enough and to understand how cells, or for that matter organisms function, we must be describe their interactions and emergent behavior at the level of a functional system.

This mutual interest has lead to an intensification of interactions between the two communities, with many conferences workshops, exchanges and even interdisciplinary departments, in the new interdisciplinary fields of systems or computational biology. The exchanges of ideas and knowledge are both at the experimental level (development of new techniques, improvements in imaging and microscopy, analysis of experimental noise), as well as theoretical (interest in cellular stochasticity, signal processing, emergent behavior). There have been a large number of international workshops in many areas of biophysics covered by this Network at well established physics venues, such as KITP, Aspen, ICTP and summer schools (Les Houches, Cargese, Boulder). *Following this demand, this Network unites the most important centers in Europe that work on the biophysics of Evolution, Regulation and Signaling, on a vast array of biological systems under one network, that facilitates the exchange of ideas and the search for new physical laws and behavior.*

It is worth noting that physicist working on biological systems often have a two-fold interest: understand the system at hand, but also discover new physical laws. Biological systems have to obey physical laws, from which they are not exempt. However there are additional difficulties with the implementation of these laws: living systems function out of equilibrium in naturally noisy environments. Additionally they constantly evolve, meaning rare events shape the outcome even at the population level. Therefore not only is it important to understand how biological systems function, but also living organisms stretch our understanding of non-equilibrium many body physics, providing the need for new tools and ways to think about these problems.

In order to understand how physical principles are realized in cells, it is instructive to study different systems and compare our understanding of how physical laws are implemented in different organisms and in different scales. In the last decade, such an approach of taking inspiration from different biological systems (such as vertebrate development, chemotaxis, fly development, olfaction, visual processing) has proven very fruitful in proposing potential design principles (noise minimization, information transmission, minimax strategies, evolvability) that govern how physical laws are realized in living organisms. The lessons learned from these theoretical ideas have pushed the limits of experiments in concrete systems and often questioned our understanding of basic processes. *This valuable interplay between physics and the biological sciences is what justifies the framework to exchange and discuss ideas made possible by the renewal of this Network.*

Below we give some examples of topics that are currently of interest to the groups participating in the Network. This list is not exhaustive, and should be supplemented by the further development of topics

that we have already started to work on in the last couple of years (described in the Examples of Scientific Progress section).

### **Examples of scientific progress**

A lot of the progress that has taken place in the field during the last couple of years is based on combining ideas between the three subfields of the network: regulation, signaling and evolution.

### **REGULATION**

Notions of evolutionary relatedness (phylogeny) and stochastic evolutionary models have been used to develop methods that can predict regulatory interactions. Members of the Network have proposed an algorithm that estimates genetic distance between possible regulators, assuming neutral evolution of non-regulatory sites, to identify transcription factor binding regions that are far away from the genes they regulate (cis-regulatory regions). Another big question of interest to a number of groups in the network has been the link between protein sequence and function. Although globally this problem remains unsolved and continues to be investigated, many groups have made significant progress by proposing inference procedures that use observed pair-wise correlations between amino acids to disentangle the direct interactions from ones that are mediated by other residues. Similar inverse techniques were also developed by members of the Network to describe non-independent nucleotides in transcription factor binding sites. Attempting to link structure to function at the network level was the focus of many inference studies in a wide variety of organisms from plants to yeast and mammals. Similar questions linked to the form of protein landscapes and their link to function have been asked experimentally. For example, optical tweezers were used to investigate the effect of chaperone trigger factor proteins on the folding of protein domains in *E. Coli* to their native state. These types of interactions are present in most newly synthesized proteins in *E. Coli*, leading to an additional post-translational form of regulation.

### **SIGNALING**

A lot of work has gone into understanding and identifying optimal strategies for transmitting biochemical signals in cells. A number of groups have looked at information transmission between and input and output concentrations and asked about the optimal molecular interacting regulatory network that encodes this function. As we understood more about the precision in signaling, many groups focused on the spatial distribution of receptors and enzymes that aids effective signal processing. The benefits and costs of clustering were discussed for enzymes and receptors and optimal spatial distributions compared with known examples. It was shown that minimal amounts of noise in signaling can be exploited by the cell to improve chemotactic performance in *E. Coli*. In another collaboration between network participants the observed property of adaptation to the background concentration during chemotaxis was linked to space-time chemoattractant fluctuations sensed by bacteria along their trajectories, again providing a link between noise and sensing. Additionally, experiments confirmed the relation between *E. Coli* swimming strategies and intensity-independent gradient responses of the signaling network indicating a robust strategy for spatial searches in diverse environments.

### **EVOLUTION**

The interest within the network in terms of evolution has covered both theoretical developments, as well as extensive data analysis and the experimental approaches mentioned in the previous sections. Member groups of the network developed a probabilistic framework that explains the expected patterns of genetic variation when weak or moderate selection acts on sites that evolve together. A lot of the work has centered on the evolution of bacteria and fungi. In an evolutionary genomics approach member groups proposed quantitative models to explain the scaling laws in the partitioning of genomes into evolutionary and functional gene families and compared them with large-scale data on protein domains. They also developed minimal stochastic models predicting the cross-species distribution of gene-family size as a consequence of horizontal gene transfer, duplication, loss dynamics, and compared it with data from ~1000 sequenced bacteria. Another active area of research was plant genetics, specifically mapping out the recombination landscape and determining rates of homologous recombination and strength of interference.

### **New themes that emerged during the first period of the network**

A number of new themes that we did not present in the 2010 application have emerged as new topics that interest the community. We discussed them broadly in the particular sections, but we mention them again here:

- collective animal and cellular behavior
- energy usage and dissipation
- resource allocation in cells (ribosomes, enzymes, receptors)
- how cell to cell diversity impacts evolution of populations
- diversity between organisms
- whole genome duplication events.

We note that a number of these topics were identified through discussions between particular network groups during common meetings. On the organizational side we also note an increase of women participants and scientific committee members, as well as younger but well established scientists joining our network.

The list of laboratories signing the Memorandum for the renewal of the network has slightly changed, leaving participants being replaced by other teams working on the new topics that emerged during the first period of the network.

### **Future activities to be supported by the Network**

Due to the success of the three types of meetings (Broad Network meetings, Specific subtopic meetings and Summer School and Student run meetings), it is planned to continue working in this framework. More emphasis will be given to student and post-doc integration events to create a vibrant European wide community.

**Broad Network interest meetings/international conferences** will play the essential role of bringing together the members of the Network and presenting the most recent results obtained by the various groups. We shall pay particular attention to the choice of the location, to favor informal discussions, interactions and the emergence of new ideas and collaborations. We shall continue to invite external scientists who have obtained results that look particularly relevant to the activities of the affiliated groups. In particular, biologists and scientists from other disciplines will be systematically invited to attend the meetings and other activities of the Network. Three days seems an optimal length for the meetings, which will be modulated as a function of the participants, the program and the agenda. Meetings of the scientific committee will take place during these general meetings. If the meetings are organized outside of France, the hosting node of the Network will contribute significantly to the budget, as has been the case until now.

**Specific subtopic workshops** will have the goal of gathering subgroups (and possibly external contributors) interested in a particular issue of interest to the network. The meeting will typically feature a one or two day overview, with a couple of more formal contributions, meant to introduce the subject, followed by informal interactions. This scheme will permit to stimulate discussions leaving time and space for exchange of ideas and common work among the participants.

### **Summer schools and student run meetings**

As mentioned above, the summer schools organized by the Network members have been phenomenal successes. We plan to continue with this activity, with sites like Cargèse, Les Houches, Lake Como or Bad Honnef being accessible to the Network. Students and post-docs of groups affiliated to the Network will have the possibility to attend the school with possible financial support. Partial support will also be considered for students attending other schools that are particularly relevant to the Network.

We will organize one 1-2 day general interest meeting a year where students and post-docs invite speakers. The main purpose of these meetings is that they remain more informal and the talks are more pedagogical than in the main Network meetings. The incredible success of the Paris Biophysics Community Day in 2013 shows a clear need for such an exchange.

**Support for the set-up of collaborative grants**

A major reason for the proposed European label to the Network is that it will permit groups to meet, get to know each other better and get to apply together for collaborative grants at the European level. This has been an important component in 2011-2014. As demonstrated by the last Munich meeting where we have been contacted by people who wanted to join the network, we have been very successful in this endeavour. However to keep what we have build we must continue to reinforce and further ground the European network in the research landscape. We shall work to favor the emergence of any collaborative actions (grant applications, meetings, student exchanges) and we shall consider the possibility of some support for their set-up, budget permitting.

**Information spreading and diffusion**

We will continue to use the email list to diffuse information announcing specific activities of the Network and post other relevant information, such as offers of Ph.D.'s, Post-Docs, workshops and conferences.

**Provisional Program for 2015-2016****2015**

July 2015 – Sensing, information and decision at the cellular level, Trieste, Italy  
August 2015 – Models of Life, Humlebaek, Denmark  
November 2015 – Paris Biophysics Community Day, Paris  
November 2015 – Darwin Seminar, Paris

**2016**

March 2016 - Evolution, Regulation and Signaling, Les Houches, France  
April 2016 – Protein Evolution, Cargese, France  
November 2016 – Paris Biophysics Community Day, Paris  
November 2016 – Darwin Seminar, Paris



**ANNEX 2**  
**COORDINATOR OF THE NETWORK AS OF JANUARY 1, 2015**

The signatory Parties to the Memorandum for the renewal of the European scientific coordination network entitled “**Evolution, Regulation and Signalling**” hereby appoint **Mrs. Aleksandra Walczak** (Laboratoire de physique théorique de l’ENS (LPTENS), UMR 8549), as Coordinator of the extended Network as of January 1, 2015 for a period of four (4) years.

**ANNEX 3**  
**SCIENTIFIC COMMITTEE OF THE NETWORK AS OF JANUARY 1, 2015**

- Aleksandra Walczak, Laboratoire de physique théorique de l'ENS – UMR 8549, Paris (CNRS, ENS, UPMC)  
awalczak@lpt.ens.fr

- Vincent Hakim, Laboratoire de physique statistique de l'ENS – UMR 8550, Paris (CNRS, ENS, UPMC, Université Paris 7)  
vincent.hakim@lps.ens.fr

- Mogens Høgh Jensen, Center of Models of Life, Niels Bohr Institute, Copenhagen (University of Copenhagen, DNRF)  
mhjensen@nbi.dk

- Ulrich Gerland, Physics Department, Theory of Complex Bio-Systems Group, Munich (TUM)  
gerland@tum.de

- Pieter Rein ten Wolde, Instituut voor Atoom en Molecuulfysica, AMOLF (FOM)  
tenwolde@amolf.nl

- Irene Giardina, Dipartimento di Fisica, Università di Roma La Sapienza  
irene.giardina@roma1.infn.it

- Antonio Celani, International Center for Theoretical Physics, Trieste  
acelani@ictp.it

- Rosalind Allen, School of Physics and Astronomy Institute for Condensed Matter and Complex Systems, University of Edinburgh  
rosalind.allen@ed.ac.uk

**ANNEX 4**  
**NETWORK PROJECTED BUDGET FOR 2015**

| Country                        | Resources  | Amount (€)    |
|--------------------------------|--|---------------|
| <b>France</b>                  |  |               |
| a) CNRS                        | a) Resources from CNRS (Europe of Research and International Cooperation Office) | 15 000        |
|                                | <b>Sub-total for CNRS</b>  | <b>15 000</b> |
| b) UPMC                        | a) Laboratory budget – UMR 8549<br>– UMR 8550                                    |               |
|                                | b) Supplementary resources from UPMC   |               |
|                                | <b>Sub-total for UPMC</b>  |               |
| c) Université Paris 7          | a) Laboratory budget – UMR 8550  |               |
|                                | b) Supplementary resources from Université Paris 7                               |               |
|                                | <b>Sub-total for Université Paris 7</b>  |               |
| d) ENS                         | a) Laboratory budget – UMR 8549<br>– UMR 8550                                    |               |
|                                | b) Supplementary resources from ENS  | 5 000         |
|                                | <b>Sub-total for ENS</b>   | <b>5 000</b>  |
| <b>Denmark</b>                 |  |               |
| a) University of Copenhagen    | a) Center budget   | 3 000         |
|                                | b) Supplementary resources from University of Copenhagen                         |               |
|                                | <b>Sub-total for University of Copenhagen</b>                                    | <b>3 000</b>  |
| <b>Germany</b>                 |  |               |
| TUM                            | a) Center budget   | 6 000         |
|                                | b) Supplementary resources from LMU  |               |
|                                | <b>Sub-total for LMU</b>   | <b>6 000</b>  |
| <b>The Netherlands</b>         |  |               |
| FOM                            | a) Laboratory budget   | 6 000         |
|                                | b) Supplementary resources from FOM  |               |
|                                | <b>Sub-total for FOM</b>   | <b>6 000</b>  |
| <b>Italy</b>                   |  |               |
| a) Sapienza Università di Roma | a) Laboratory budget   | 3 000         |
|                                | b) Supplementary resources from Sapienza Università di Roma                      |               |
|                                | <b>Sub-total for Sapienza Università di Roma</b>                                 | <b>3 000</b>  |
| b) ICTP                        | Laboratory budget  | 5 000         |
|                                | <b>Sub-total for ICTP</b>  | <b>5 000</b>  |
| <b>United Kingdom</b>          |  |               |
| Edinburgh University           | a) Laboratory budget   | 2 000         |
|                                | b) Supplementary resources from Edinburgh University                             |               |
|                                | <b>Sub-total for Edinburgh University</b>  | <b>2 000</b>  |
|                                | <b>TOTAL</b>   | <b>45 000</b> |

**PARTICIPATING STAFF OF THE SIGNATORY PARTIES TO THE MEMORANDUM FOR THE  
EXTENSION OF THE EUROPEAN SCIENTIFIC NETWORK (GDRE)**

**“Evolution, Regulation and Signalling (ERS)”**

Members of Laboratoire de physique théorique de l'ENS – UMR 8549, Paris, France (CNRS, ENS, UPMC)

Name: Aleksandra Walczak

Title: Chargée de recherche CNRS

Members of Laboratoire de physique statistique de l'ENS (LPS), UMR 8550, Paris, France  
(CNRS/ENS/UPMC/Université Paris 7)

Name: Vincent Hakim

Title: Directeur de recherche CNRS

Members of Physics Department, Theory of Complex Bio-Systems Group, München, Germany (TUM)

Name: Ulrich Gerland

Title: Professor

Members of Center of Models of Life, Niels Bohr Institute, Denmark (University of Copenhagen / DNRF)

Name: Mogens Høgh Jensen

Title: Professor

Members of Instituut voor Atoom en Molecuulfysica, AMOLF, Amsterdam, The Netherlands (FOM)

Name: Pieter Rein ten Wolde

Title: Professor

Members of School of Physics and Astronomy Institute for Condensed Matter and Complex Systems,  
Edinburgh, United Kingdom (University of Edinburgh)

Name: Rosalind Allen

Title: Reader

Members of Dipartimento di Fisica, Rome (Sapienza Università di Roma)

Name: Irene Giardina

Title: Associate Professor

E. Marinari

Title: Full Professor

I. Giardina

Title: Associate Professor

Members of ICTP, Trieste

Name : Antonio Celani

Title: Research Scientist

M. Marsili

Title: Research Scientist

Members of School of Physics and Astronomy Institute for Condensed Matter and Complex Systems,  
Edinburgh, United Kingdom (University of Edinburgh)

Name: Rosalind Allen

Title: Reader

#### EXTERNAL INTERESTED PARTICIPANTS

in France

Laboratoire de physique de l'ENS de Lyon, UMR 5672, ENS Lyon

A. Arneodo

A. Pumir

Unité physico-chimie Curie (P.C.C), UMR 168, Institut Curie

M. Dahan

H. Isambert

P. Sens

Laboratoire de Chimie, Biologie, Innovation, UMR 8231, ESPCI Paris

Clement Nizak

IGBMC, Strasbourg

G. Charvin, Dept. Biologie Cellulaire du Développement

Institut interdisciplinaire de neurosciences (IINS), UMR 5297, Bordeaux

V. Studer

Institut de recherche interdisciplinaire, USR 3078, Lille

M. Lefranc

Dynamique des systèmes d'adhérence et différenciation, ERL 5284, Université Joseph Fourier, Grenoble

B. Fourcade, Institut A. Bonniot

Laboratoire Interdisciplinaire de Physique (LIPhy), UMR 5588, Grenoble

O. Rivoire

Bahram Houchmandzadeh

I. Mihalcescu

Université Montpellier 2, Laboratoire Charles Coulomb, UMR 5221,

V. Lorman,

Université Paris Diderot, Laboratoire MSC

L. Auvray

Laboratoire de physique théorique de la matière condensée (LPTMC), UMR 7600, Paris

J.M. Victor

R. Voituriez

Laboratoire Jean Perrin, UMR 8237, Paris

D. Chatenay

Biologie Computationnelle et Quantitative (CQB), UMR 7238, Paris

M. Cosentino Lagomarsino

in Austria

Institute of Science and Technology Austria  
G. Tkacik

in the United Kingdom

Institute for Cancer Research and Treatment  
A. Gamba, Group Systems Biology

In Sweden

Uppsala University  
S. Tanase-Nicola, BioMedical Center

in Switzerland

Biozentrum, University of Basel, Basel.  
E.van Nimwegen, Computational and Systems Biology

University of Zurich  
A. Wagner, Dept. Biochemistry

in Germany

EMBL, Heidelberg  
L. Hufnagel, Dept. Cell Biology and Biophysics,

German Cancer Research Center  
T. Höfer, Group Modeling of Biological Systems

Max Delbrueck Institut, Berlin  
B. Obermayer

Max Planck Institute for Developmental Biology, Tübingen  
R. Neher

Max Planck Institute of Colloids and Interfaces, Potsdam  
S. Klumpp

University of Köln  
M. Lässig, Statistical Physics and Quantitative Biology

Ludwig Maximilian University, Munich  
Thomas Ligon, Statistical and Biological Physics

in Poland

Polish Academy of Sciences  
A. Ochab-Marcinek, Institute of Physical Chemistry  
T. Lipniacki, Institute of Fundamental Technology Problems