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## LPTENS - Laboratoire de physique théorique de l'ENS

Rapport Hcéres

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agence d'évaluation de la recherche  
et de l'enseignement supérieur

Section des Unités de recherche

Evaluation report

Research unit:

Laboratoire de Physique Théorique

(LPT ENS) – UMR 8549

Ecole Normale Supérieure (ENS)



March 2009



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Section des Unités de recherche

## Evaluation report

Research unit :

Laboratoire de Physique Théorique

(LPT ENS) – UMR 8549

Ecole Normale Supérieure (ENS)



Le Président  
de l'AERES

Jean-François Dhainaut

Section des unités  
de recherche

Le Directeur

Pierre Glorieux

march 2009



# Evaluation report )

## The research unit:

Name of the research unit : Laboratoire de Physique Théorique de l'ENS

Requested label : Unité Mixte de Recherche

N° in case of renewal : UMR 8549

Head of the research unit : Mr Bernard JULIA

## University or school:

Ecole Normale Supérieure (ENS)

## Other institutions and research organization:

Université Pierre et Marie Curie (Paris 6)

CNRS

## Date(s) of the visit:

January 26<sup>th</sup>, 2009

# Members of the visiting committee



## Chairman of the committee:

Mr Marc KNECHT, Université d'Aix-Marseille

## Other committee members:

Mrs Nathalie DERUELLE, Université Paris 7

Mr Abdelhak DJOUADI, Université Paris 11

Mr Satya MAJUMDAR, Université Paris 11

Mr Joseph POLCHINSKI, Université de Californie, Santa Barbara

Mr Boris SHRAIMAN, Université de Californie, Santa Barbara

## Representatives of national institutional evaluation committees (CNU, CoNRS, CSS INSERM, INRA, INRIA, IRD...):

Mr Jihad MOURAD, CNU

Mr Malte HENKEL, CoNRS

# Observers

## AERES scientific representative:

Mr Jean-Michel ROBBE

## University or school representative:

Mr Yves GULDNER, Ecole Normale Supérieure (ENS)

## Research organization representative(s):

Mr Christian CHARDONNET, CNRS/INP

Mr Patricio LEBŒUF, CNRS/INP

M. J-B. ZUBER, Université Pierre et Marie Curie (UPMC)

## 1 • Short presentation of the research unit

At the time of the visit, the Laboratoire de Physique Théorique of the Ecole Normale Supérieure (LPT ENS - UMR 8549) counted 44 members (15 full time researchers, 4 researchers with teaching duties at ENS or at UPMC, 1 administrative technician, 1 assistant-engineer, 6 emeritus or honorary members, 6 post-doctoral researchers, and 11 PhD students). One professor is senior member of the Institut Universitaire de France, 2 emeritus researchers are members of the French Academy of Sciences, and one researcher is a corresponding member. Of the 19 researchers on permanent positions, 13 are HDR, and 7 have acted as advisors for PhD students during the last four years, while 9 students trained in the laboratory have completed their PhD. The average preparation time for a PhD was of three years. All PhD students presently trained in the laboratory benefit from a fellowship. During this same period, two researchers were on leave of absence in a foreign institute, and one researcher has accepted a permanent position abroad. All researchers on permanent positions publish regularly in internationally recognized and peer-reviewed scientific journals, and satisfy the requirements to be considered as “publishing researchers”.

## 2 • Preparation and execution of the visit

The meeting of the committee took place on January 26, 2009, in the building of the Ecole Normale Supérieure where the laboratory is located. The director first gave a general presentation of the laboratory, of its activities and its perspectives for the future. Then, followed six short scientific presentations of the research themes, of the achievements during the four last years, and of the projects for the future. After that, the committee split into two sub-committees in order to meet separately the members of the two research teams. In the afternoon, the committee met the technical and administrative staff, and had three further meetings, first with the present director, second with the proposed future director, and third with the representatives of the research organisations in charge of the laboratory. Finally, the committee had a closed discussion.

Before the visit itself, the AERES had provided the members of the committee with several documents prepared under the supervision of the director of LPTENS: an activity report for the last four years, a scientific project for the next four years, and an assessment grid for the laboratory as a whole and for each of its two teams separately. These documents were very informative and useful for the preparation of the visit.

The committee appreciated the perfect organization of this visit, including the material part, and its members for the quality of the discussions, during the scientific presentations as well as during the other meetings.

## 3 • Overall appreciation of the activity of the research unit, of its links with local, national and international partners

The overall scientific level of the laboratory is quite outstanding, with a strong international impact. The laboratory has a world leading position in several of its research activities.

The laboratory exhibits excellent productivity that is well balanced between the two teams: more than 200 articles in international scientific journals, 16 communications in conference proceedings and 19 contributions to books during the last four years. The committee also notes the strong involvement of the members of the laboratory in the organization of international scientific workshops and conferences.



The research groups of the laboratory have developed strong long term contacts and collaborations with other institutes at the international level. The members of the laboratory are regularly invited to present their results at various places abroad. The international visibility of the laboratory is very strong. There are also good connections with other theoretical physics groups in the Ile-de-France area, and the laboratory participates actively to the events organized in the framework of the FRIF (Research Federation for Fundamental Interactions). Relationship with other French theoretical physics groups are however more scarce.

#### 4 • Specific appreciation team by team and/or project by project

The research activities of the laboratory are organized in two teams. The activities of Team 1 concern the study of fundamental interactions, particle physics, string theory and gravitation. The research in Team 2 is devoted to statistical mechanics and condensed matter theory.

##### Team 1: Particles, strings and gravitation :

The research carried out by the particle, strings and gravitation team at LPTENS over the period 2005-2008 is of excellent scientific quality with high international impact and visibility. This research activity covers several topics :

##### – Elementary particles, dark matter and gravitation :

Overall, the activity of this group is excellent. Building models of low-energy supersymmetry (LPTENS is the main place where the widely investigated minimal supersymmetric extension of the standard model was developed) and studying their phenomenology at high-energy colliders and in astroparticle physics experiments remains a very strong point of the laboratory. The search for "supersymmetry in the sky" has been a pivotal field of research of the laboratory and continues to be so, with even increasing speed-up, thanks to the many experiments under way. The interaction with astroparticle physicists is good and should be pursued. The connection of string theories with experiment is hopefully going to take a new turn with the starting of LHC. The lab is clearly ready to participate in the interpretation of the experimental results expected from the LHC, in particular if they point towards the observation of supersymmetric particles. The activity in General Relativity and its extensions is pursued with thoroughness and with a notable willingness to make contact with experiments. Regular external collaborations are also noteworthy.

##### – String theory, particles and cosmology :

The String, Particle, and Cosmology group at LPTENS has a long record of important contributions to the development of quantum field theory, the Standard Model, supersymmetry, supergravity and string theory. Its members continue to contribute actively in the fields of string compactification and cosmology, supergravity, and conformal field theory. There have also been a number of significant results in the active area of flux compactification, and in the properties of black hole microstates. There is a high level of collaboration and visibility both within France and worldwide, and the group continues to produce excellent students and post-doctoral fellows.

##### – Integrability, AdS/CFT duality, and random matrices :

Research in the field of Integrability, AdS/CFT Duality, and Random Matrices constitutes an area of particular strength. This topic has been a subject of major research activity in string theory in recent years. The ENS group (strengthened by a recent young hire) has played a leading role in this. Major results in the past four years include the development of the algebraic curve governing the solution of the classical non linear sigma model and the development of the Bethe Ansatz for the string dual to superconformal Chern-Simons theory. The group has just announced a solution for the full spectrum of operator dimensions in AdS<sub>5</sub> x S<sup>5</sup>, which has been a central goal in this field for many years, and should bring the subject to a new level.



During the last four years, the particle physics, strings and gravitation team has produced results of the highest quality at the international level.

Note de l'équipe	Qualité scientifique et production	Rayonnement et attractivité, intégration dans l'environnement	Stratégie, gouvernance et vie du laboratoire	Appréciation du projet
A+	A+	A+	A	A+

**Team 2: Statistical mechanics and applications :**

The research carried out by the statistical physics team at LPTENS over the period 2005-2008 is of excellent scientific quality with a strong international impact and visibility. This research activity covers several topics :

– **Random geometry :**

The members of the group working on random geometry have established very important links between the theory of SLE (Schramm-Loewner evolution) and conformal field theory in several two-dimensional systems at criticality. In addition, their recent application of SLE theory in two-dimensional turbulence has been a very important and interesting contribution, which provides a hitherto unknown and potentially profound connection between two-dimensional turbulence and conformal field theories.

– **Condensed matter and disordered systems :**

The members of the group of condensed matter and disordered systems are world leaders in the sophisticated functional renormalization group techniques. They have successfully applied this tool to several problems in disordered systems, most notably in the field driven interface depinning in disordered medium. Their recent work in developing a field theory for loop-erased random walks is of outstanding quality.

– **Interdisciplinary applications of the statistical physics of disordered systems :**

The group working on the applications of statistical mechanics in computer science and biology has made very important contributions to optimization problems (for example constraint satisfaction problems) using ideas and techniques developed in the context of spin glass theory. Its members have discovered new and interesting phase transitions in the constraint satisfaction problems. They have made important progress in the well known but difficult problem of random packing of spheres. More recently, they have studied "inverse " problems, where the goal is to estimate the coupling strengths from the knowledge of the available data on correlation functions, with important applications in biology.

In summary, the work of the LPTENS statistical physicists has been world-leading and highly innovative, important, instructional, influential and interactive.

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A+	A+	A+	A	A+



## 5 • Appreciation of resources and of the life of the research unit

The general atmosphere in the laboratory appears to be very good and convivial. There are many interactions among the different research groups and research teams, with several members being involved in more than one research topic. The organization of a weekly general seminar of the laboratory also contributes positively to the dialogue and interactions between the different research groups.

The administrative staff of the laboratory has suffered from a significant turnover during the last four years. The present situation, with only one person in charge of the administrative tasks, is clearly unsatisfactory. It is crucial that a person be hired soon to assist her. The computer system is maintained by an assistant-engineer whose assignment and tasks are shared with another laboratory of the ENS physics department.

The laboratory definitely suffers from an acute lack of office space. This not only constitutes a real hindrance to its future development, but already impinges on the possibilities to invite visitors or to host post docs and PhD students. Furthermore, even the organization of the existing space is far from optimal, with some offices (like the director's) being located at distant or isolated corners of the building.

## 6 • Recommendations and advice

### – Strong points :

LPT ENS has a strong tradition of innovation, scientific diversity and intellectual breadth. This tradition had in the past enabled many of LPTENS members to cross the boundaries making important contributions in other sub-disciplines. LPTENS remains committed to the maintenance of this scientific diversity in the present with its scientific breadth extending to mathematical physics, computer science and biophysics. The committee noted several areas of overlap and potential cross-fertilization between the high-energy and statistical physics sub-fields including integrable systems and conformal field theories, which provide intellectual cohesion.

The laboratory is strongly involved in the training programs of the ENS and of the university Paris 6, especially at the masters level. This provides a regular access to students with a high level of training.

### – Weak points :

The number of PhD students trained in the laboratory could certainly be improved upon. Only about half of the members endowed with a HDR effectively act as PhD advisors. The younger members should be encouraged to prepare their HDR as soon as possible and efforts should be made to secure an increase in the number of available pre-doctoral fellowships.

While LPTENS ranks include a number of post-doctoral researchers, it does not have the ability to offer multi-year post-doctoral appointments, which is necessary in order to compete (for post-doctoral candidates) with foreign academic institutions of a comparable stature (e.g. Harvard, Princeton). This difficulty appears to be in common with other physics labs at ENS.

While the amount of financial support provided by the research organizations in charge of the laboratory is appropriate, given the size and the kind of activity of the laboratory, several contracts financed by the EC have just come to an end or will be terminating soon. Renewal of these contracts in some form or the other is essential, in particular to maintain the presence of post-doctoral fellows at an acceptable level.

The age distribution of the scientific staff of the particle, strings and gravitation team is not ideal, being markedly skewed towards more senior scientists.



– **Recommendations :**

The committee strongly recommends that the laboratory continues to benefit from institutional support during the next quadrennial period. The association between the Ecole Normale Supérieure, the University Paris 6 and CNRS constitutes the appropriate framework in this respect.

The committee felt that broad coverage of sub-disciplines of theoretical physics was an important strength of LPTENS and that the leadership of the laboratory must continue its efforts to achieve and maintain this breadth. Introducing a too sharp distinction between the two teams or, even worse, a third team, does therefore not appear as a promising evolution. The committee agreed with the hiring priorities, including the recruitment this year of a professor in particle physics, which offers a very good opportunity to strengthen the link with collider phenomenology, and of a senior researcher in quantum condensed matter, in order to strengthen an activity which has suffered most from recent departures.

It was also felt that LPTENS should strive to preserve the scientific cohesion of its diverse research efforts by placing special value on intellectual breadth of its future members and by maintaining a harmonious balance between the different research topics. The future direction should be careful to avoid any bias, and to put the emphasis on the unity of the laboratory. In this respect, the director should seek the assistance of a bona fide “conseil de laboratoire”, with elected representatives of the different research fields and of the various categories of personnel. This would not only provide the appropriate environment to discuss strategical issues affecting the future evolution of the laboratory, but would also help the director to run the laboratory in a smooth way.

Recent and ongoing reorganization of hiring practices in research has created an important niche for post-doctoral fellowships for young scientists. Post-doctoral positions give young scientists time to develop their independent research agenda before they move on to more permanent jobs in academia or industry. Post-doctoral fellows also enliven scientific environment of the host laboratory and enhance its research productivity. The stature of LPTENS in the international scientific community would allow it to successfully compete for the best and the brightest post-doctoral candidates. However, in order to be internationally competitive, LPTENS must have an ability to offer 2 and preferably 3 year post-doctoral fellowships. This problem could be solved by establishing an institutionally funded or endowed line of LPT/ENS Post-doctoral Fellowships which would compete with the prestigious international fellowships, such as Pappalardo Fellowships at MIT or CTS (Center for Theoretical Science) Fellowships at Princeton.

The number of PhD students at LPTENS could be enhanced by making available more pre-doctoral fellowships, particular fellowships for foreign students. This would take better advantage of the availability of LPTENS researchers as PhD mentors, and help attract international scientific talents to France.

While solving the office space problem might certainly represent a long term endeavour, the committee recommends that all possibilities are explored in order to rapidly alleviate the situation. The reorganization of the offices within the existing building, while not offering a solution to the global space problem, would nevertheless constitute a first improvement for the laboratory's everyday life, and can be handled at the level of the physics department of the ENS.

Note de l'unité	Qualité scientifique et production	Rayonnement et attractivité, intégration dans l'environnement	Stratégie, gouvernance et vie du laboratoire	Appréciation du projet
A+	A+	A+	A	A+



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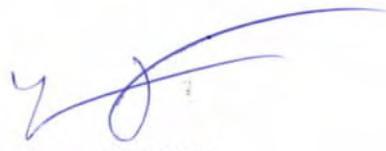
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Paris, le 30 avril 2009

**OBJET :** Rapport d'évaluation du Laboratoire de Physique Théorique  
UMR 8549

Je vous informe que nous n'avons pas d'observations à formuler concernant le rapport d'évaluation de l'UMR 8549 - Laboratoire de Physique Théorique de l'École normale supérieure.

Avec nos salutations les meilleures.



Yves GULDNER