



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

Department for the evaluation of
research units

AERES report on unit:

Laboratoire de Physique Théorique

LPT

Under the supervision of
the following institutions
and research bodies:

Université Paris-Sud

Centre National de la Recherche Scientifique - CNRS



November 2013



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et de l'enseignement supérieur

Department for the evaluation of
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*On behalf of AERES, pursuant to the Decree
of 3 november 2006¹,*

- Mr. Didier HOUSSIN, president
- Mr. Pierre GLAUDES, head of the
evaluation of research units department

On behalf of the expert committee,

- Mr. Thierry DAUXOIS, chair of the
committee

¹ The AERES President "signs [...], the evaluation reports, [...] countersigned for each department by the director concerned" (Article 9, paragraph 3 of the Decree n° 2006-1334 of 3 November 2006, as amended).



Evaluation report

This report is the result of the evaluation by the experts committee, the composition of which is specified below.

The assessment contained herein are the expression of independent and collegial deliberation of the committee.

Unit name: Laboratoire de Physique Théorique

Unit acronym: LPT

Label requested: UMR

Present no.: UMR 8627

Name of Director
(2013-2014): Mr Hendrik-Jan HILHORST

Name of Project Leader
(2015-2019): Mr Sébastien DESCOTES-GENON

Expert committee members

Chair: Mr Thierry DAUXOIS, CNRS & ENS de Lyon

Experts: Ms Ana ACHUCARRO, Leiden University, Netherlands

Mr Aldo DEANDREA Lyon 1 University (representative of CNU)

Ms Belen GAVELA, Universidad Autónoma de Madrid, Spain

Mr Krzysztof GAWEDZKI, CNRS & ENS de Lyon

Mr Francesco ZAMPONI, CNRS & ENS de Paris (representative of CoNRS)

Scientific delegate representing the AERES:

Mr Marc KNECHT



Representative(s) of the unit's supervising institutions and bodies:

Mr Etienne AUGE, Université Paris-Sud

Mr Jean-Jacques GUILLEMINOT, CNRS

Mr Elias KHAN (Université Paris-Sud, Director of Doctoral School ED517)

Ms Sylvie RETAILLEAU, Université Paris-Sud

Mr Bart van TIGGELEN, CNRS



1 • Introduction

History and geographical location of the unit

The laboratoire de Physique Théorique (LPT) is an interdisciplinary, medium size research unit. It was created 51 years ago with three research directions: statistical physics, mathematical physics and high-energy physics. An activity around cosmology and gravitation has later been created.

The laboratory is located in the building 210 in the Valley part of the Orsay Campus. It is supported by Paris-Sud University (for offices, funding, and several professor, lecturer and technical staff positions) and by CNRS (for funding, a majority of the research positions, most of the technical staff).

Management team

The laboratory is directed by Mr Hendrik-Jan HILHORST (Université Paris-Sud) since 2005, the deputy director being Mr Philippe BOUCAUD (CNRS).

AERES nomenclature

ST2

Unit workforce

Unit workforce	Number as at 30/06/2013	Number as at 01/01/2015
N1: Permanent professors and similar positions	10	10
N2: Permanent researchers from Institutions and similar positions	13	13
N3: Other permanent staff (without research duties)	7	6
N4: Other professors (Emeritus Professor, on-contract Professor, etc.)		
N5: Other researchers from Institutions (Emeritus Research Director, Postdoctoral students, visitors, etc.)	16	7
N6: Other contractual staff (without research duties)	1	
TOTAL N1 to N6	47	36



Unit workforce	Number as at 30/06/2013	Number as at 01/01/2015
Doctoral students	16	
Theses defended	28	
Postdoctoral students having spent at least 12 months in the unit	24	
Number of Research Supervisor Qualifications (HDR) taken	7	
Qualified research supervisors (with an HDR) or similar positions	21	19

2 • Assessment of the unit

Strengths and opportunities related to the context

The laboratory has an excellent track record for developing theoretical physics in several research areas: high-energy physics, cosmology and gravitation, mathematical physics and statistical physics. The scientific production is excellent, and several members enjoy a remarkable recognition at the international level. The laboratory has a unique role at the interface between theory and experimental data (on flavor, LHC, neutrino, Planck, dark matter and also traffic). Its multidisciplinary nature is also a key characteristic that should continue and be fostered especially between groups. It has also shown its ability to develop several new research directions. The laboratory has excellent collaborations, within the campus, at the national and also international levels. It is funded at a very good level (directly from partner institutions and through many competitive national and European research grants) and benefits from a constant flux of graduate students.

Weaknesses and threats related to the context

Because of an impressive retirements rate in the last 10 to 15 years, associated to spin offs of talented previous members for various reasons, the number of researchers has decreased by 30 % since 2005 notwithstanding the arrival of several recruitments in the last period. Several groups have now attained subcritical conditions to develop collaborations simultaneously within and between teams. The added value of a multidisciplinary laboratory is in danger. Moreover, despite their high quality and reputation, the very low success rate in ANR competition of some groups generates difficulties in securing their future developments.

Another threat resides in the difficulty to control the dynamics of a medium size laboratory within a perpetually moving landscape especially because of the development of the surrounding huge structure of Paris-Saclay University. Moreover, the critical juncture for P210 labex is not a simple matter due to the presumable difficulties for funding the P2T project. The position of the small groups in statistical and mathematical physics in a project mainly devoted towards high-energy physics has to be carefully prepared, to avoid dilution. The next years are decisive for the future.



Recommendations

The committee recommends taking advantage of the potential for more collaboration between and inside groups: profiting from its multidisciplinary nature, the laboratory should strengthen its coherence, to improve the role of a theoretical physics laboratory. It is also important to compensate the loss of several members and anticipate coming retirements by attracting new talented physicists in several of the broad topics already covered by the activity of the laboratory. It is also recommended to attract more graduate students and to develop a proactive attitude to the gender issue aiming at a more balanced composition, in particular for the younger sector of the group: future hirings of permanent scientists and non-permanent ones (PhDs and postdocs).

A larger implication of the members of the laboratory at the level of the university, in the different committees in charge of the management of the university would be highly valuable. The management cannot rely only on the involvement of a very few members around the direction. A better recognition of people taking up collective charges should be encouraged in order to guarantee the laboratory a correct level of participation in the local and national committees. The management of the Paris-Sud University could be instrumental in this respect by facilitating the exchange between teaching duties of “enseignants-chercheurs” with CNRS researchers, the rotation of teaching subjects among the different “enseignants-chercheurs” and by facilitating the delegations of professors and associate professors to CNRS.



3 • Detailed assessments

Assessment of scientific quality and outputs

The activities of LPT cover a remarkably broad scientific scope, ranging from high-energy physics and cosmology to mathematical and statistical physics. In all the fields covered, the different teams of the laboratory have made important contributions during the last five years. The scientific production is excellent: there is a long-standing and recognized expertise in high-energy physics with good connections with experimentalists, at CERN, in the neutrino and Dark Matter experimental community, within the Planck collaboration but also on the campus. Recent developments of other research themes are also excellent. One might emphasize for example random tensors, transport problems, and the analogy between black hole radiation and hydrodynamics. These subjects generated a large number of high impact publications, which result from the development of highly innovative research in theoretical physics.

Assessment of the unit's academic reputation and appeal

The unit has a high international visibility. Laboratory members have also reached a relatively high success in competitive national or European bilateral calls. The number and quality of conferences organized by the different members are excellent. This very high reputation and international visibility of the laboratory members might allow them to attract slightly more postdocs and graduate students.

In the last five years, the laboratory has been able to attract several young researchers on junior CNRS or university positions. A number of researchers, with a strong scientific profile and leadership potential, have left the laboratory for various reasons. It recognizes of course the high quality of the research developed in the laboratory. However, as it is not limited to the present period and although no single cause can be identified, it is also a weakness if the flux is strong and not compensated by arrivals through recruitments or mutations.

Assessment of the unit's interaction with the social, economic and cultural environment

The activity of the laboratory to disseminate knowledge and popularise science is really excellent, especially for a theoretical physics laboratory. One can in particular emphasize the scientific blog “Resonances” focused on particle physics and related areas of science such as astrophysics or cosmology, together with several actions related to popular science, books, journals and conferences and outreach events.

Really remarkable are also the activity to improve the pedagogical accessibility of science in high school for disabled pupils, and the installation of a centre for mathematics in Senegal, which provides to selected African graduates a high-level education in mathematical sciences and financial support, enabling them to pursue careers in research, industry and government.

Assessment of the unit's organisation and life

The general organisation pattern is typical for such a medium size research lab, with a laboratory council and scientific council that represents the different research teams and is consulted by the director on scientific policy issues or on practical aspects of the laboratory life. The laboratory life seems to be of very good quality, with an excellent atmosphere between scientists, administrative and technical staff, students and post-docs.

The laboratory benefits from an excellent support from the staff. Their efficiency and competence have been emphasized not only within the activities strictly related to the laboratory but also through several commitments at the national level.

It appears that three teams over four are relatively small (typically four permanent researchers). They do have neither a well identified internal life, nor many collaboration programs. The scientific policy seems to be defined really at the personal level. The latter is generally excellent but an additional collective dynamics could be welcome. Therefore the committee suggests that the definition of a scientific policy at a more coarse grained level would be profitable to the entire laboratory.



In the same way, the general seminar for students/postdocs appears to be excellent to mix scientific interests for the youngest part of the laboratory, a refreshment of the existing common seminar in a general colloquium could be efficient to foster the scientific coherence and multidisciplinary of the laboratory.

Assessment of the unit's involvement in training through research

The implication of the laboratory members in graduate training is very good. The number of PhD students (about one student for two researchers on average) is reasonable for a theoretical physics laboratory, and guarantees a good quality of the training. Most former graduate students of LPT find postdoctoral positions in very good groups at the international level. The origin of the students is diverse, and illustrates the appeal of the scientific themes of the laboratory. The LPT students look very well integrated, well tutored and have been active in initiating interactions within the laboratory through the Sinje seminar.

Another positive aspect is the implication of some researchers in the organization of graduate studies at various levels or through their involvement of the Master, European networks (exchange between students). The potential to tutor more PhD students, to carry their research is clear; solutions to get additional fellowships have to be found. Some difficulty seems to reside in the rules imposing a researcher to selectively choose to recruit PhD students from only one local doctoral school in the Paris area. This makes no sense for a laboratory in which “multidisciplinary” is a keyword.

Assessment of the strategy and the five-year plan

The new direction seems most keen to be very active and gave us an excellent impression. It deserves support, resources. The committee has also appreciated the quality of the numerous scientific projects presented by the different teams, which are discussed in the team-by-team assessment below. Although most of projects are more or less in close continuity, they seem ready to adapt to unexpected directions for example if experiments evolve rapidly.

The lab space does not appear to be an issue. However, a possible moving to a neighbouring building after renovation has been mentioned; the uncertainty of this project not only for its financial funding but also for its scientific goals has to be clarified.

The permanently moving and sometimes turbulent landscape in the surroundings has led many members to adopt a “wait and see” attitude with respect to possible developments of the laboratory, while the direction (present and future) is trying to look for opportunities. The committee would like to encourage all researchers to take advantage of the many exciting opportunities that are offered by the new structures within the different labex the laboratory is associated to, the different connections with neighbouring laboratories, ... in particular, attracting new members (by recruitment or mutations) in the laboratory could be a way of strengthening the laboratory in the long term leading a theoretical initiative in contact with experiments, possibly in the center of the P2T. The requirements of excellence and originality with respect to the broad and high-level scientific environment are of course challenging, but consistent with the track record of the laboratory.

Overall, the committee believes the LPT has a very strong potential to continue developing research in theoretical physics. If the laboratory acts in a collective way along the lines that have been proposed by the present and future direction, there is no doubt that it will remain a leading scientific center in this field.



4 • Team-by-team analysis

Team 1 : Particle Physics

Name of team leader: Mr Ulrich ELLWANGER

Workforce

Team workforce	Number as at 30/06/2013	Number as at 01/01/2015
N1: Permanent professors and similar positions	4	4
N2: Permanent EPST or EPIC researchers and similar positions	7	7
N3: Other permanent staff (without research duties)		
N4: Other professors (PREM, ECC, etc.)		
N5: Other EPST or EPIC researchers (DREM, Postdoctoral students, visitors, etc.)	10	4
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	21	15

Team workforce	Number as at 30/06/2013	Number as at 01/01/2015
Doctoral students	8	
Theses defended	15	
Postdoctoral students having spent at least 12 months in the unit	18	
Number of Research Supervisor Qualifications (HDR) taken	2	
Qualified research supervisors (with an HDR) or similar positions	8	8



• Detailed assessments

Assessment of scientific quality and outputs

The particle physics team has a wide and very high quality scientific output in the most reputed international scientific journals. The team is the largest in the laboratory, embracing a wide number of subjects, which are often connected, giving rise to different collaborations. Among the main subjects, one can mention Higgs Physics, QCD (both perturbative and non-perturbative, in particular lattice), Flavour physics of quarks and leptons, Neutrino physics and Dark Matter physics. Activity in these fields is closely related to issues Beyond the Standard Model of Particle Physics, such as the explanation of the electroweak hierarchy problem, the origin of masses including that of neutrinos and dark matter, Dark Matter, Supersymmetry, Leptogenesis, Neutrinos, ... There is also a quite close relation to data from various experiments in all these fields (LHC, TeVatron, low energy precision experiments, B-physics and neutrino experiments, dark matter experiments both for direct and indirect detection, CMB data from Planck, low energy precision experiments, B-physics, neutrinos, etc.) as the group is mainly active in phenomenology and model building in all these fields. Collaboration and discussion with the experimental groups is also a strong and unique characteristic of the group allowing a rapid reactivity to experimental results.

The Higgs discovery in 2012 has boosted the activity in most of these fields, either directly (for Higgs physics) or indirectly (bounds, models, precision calculations) for the other fields. The team has explored new aspects of these subjects, which in some cases are now leading results at the international level (Higgs properties analysis, NMSSM, B-physics limits and fits, alpha strong calculations lattice results, unitarity/universality limits in the neutrino sector). It is to be stressed that this is a leading and almost unique laboratory in the Paris area doing in depth phenomenology of particle physics in close contact with actual data, with results of worldwide relevance.

Assessment of the team's academic reputation and appeal

The team has one ERC advanced grant, is node of a large EU ITN (to which several other subnodes in France are attached via CNRS), and has one junior member of IUF, which is a strong external indicator of its academic reputation. One can also mention many participations to EU programs, ANR programs, and the team members are involved in international bilateral programs present in the laboratory, including co-directions of PhD thesis. A large number of workshops and conferences were held over the last five years at LPT or outside, most at the international level thanks to the direct implication of the team members.

Assessment of the team's interaction with the social, economic and cultural environment

Being a theory laboratory, interaction is mainly through divulgation to the general public of the results in the field. Level is very good and most recent actions were triggered by the Higgs boson results, but not only. A considerable number of outreach events have taken place and others are planned (e.g. a full afternoon on Neutrinos is scheduled at Palais de la Découverte next July). On the other side, a fruitful connection to the economic world was mainly linked with the development of massive parallel computing for lattice QCD. The activity in improving pedagogical accessibility to disabled pupils at high school level is a remarkable action. The blog Resonances by one of the team members is also a landmark on the internet for discussion of particle physics results in a way which is accessible to a larger audience.

Assessment of the team's organization and life

The particle theory team has a coherent repartition of the forces in the different projects, with large possibilities of cross-project interaction. A journal club organized by team members weekly has attracted young researchers and postdoc and PhD students (even from outside the laboratory: Ecole Polytechnique, APC, units at the Saclay plateau) around the discussion of recent articles and also "historical" ones, with often discussions drifting to collaborations and new research papers. The atmosphere is quite good both among the staff members and the students.



Assessment of the team's involvement in training through research

Very good involvement of the team through doctoral student training and also at Master level, with key positions held by team members. Good involvement in international exchange programs for the students. We encourage the team to maintain this level of involvement and to increase it.

Assessment of the strategy and the five-year plan

The team gives a realistic plan based on present and future data results that will be available in the five-year period (LHC, JLab, Neutrino physics, precision flavour experiments, Dark matter experiments, LHCb etc.). Strategy in beyond the standard model physics (neutrino, supersymmetry, extra-dimensions) is strongly related to the interplay of all these fields and also to flavour bounds and precision QCD calculations. Reactivity to new data is also a key point, which they have shown to master. Quite naturally the strategy of the team is to reinforce the interactions among the different related subjects both internally in the team and with external collaborators. Also increased collaboration with the other teams at LPT, especially Cosmology and Gravitation group would be an interesting point. The team has shown a good ability to obtain fundings and grants at the national and international level and should keep doing so.

Conclusion

▪ **Strengths and opportunities:**

This is a flagship theory team in the interplay with the experiments. Excellent initiative in taking active part in the P2T pole, and in attempting to have a leading and accreting role in the theory activities; this will also reinforce visibility both locally in the university and in the Paris area. LPT faces important changes ahead and it seems well positioned to meet them.

▪ **Weaknesses and threats:**

There is a lack of young people to assure continuity in all the activities. The incertitude in the “Plateau” project and its evolution may be a threat.

▪ **Recommendations:**

As a world-level centre in phenomenology of particle physics, care should be given to foster renovation and high-level hirings. The Higgs and BSM activity is stabilized at a satisfactory level with recent hirings. The neutrino aspects of the flavour sector, and their interplay with the quark flavour activities and with the cosmological activities, should be encouraged as research topic to expand, and as interesting hiring ground as well as those related with lattice QCD (an activity in which the group is also internationally very reputed) which risks losing part of the know-how in the short term.



Team 2 : Cosmology and gravitation

Name of team leader: Mr Christos CHARMOUSSIS

Workforce

Team workforce	Number as at 30/06/2013	Number as at 01/01/2015
N1: Permanent professors and similar positions	2	2
N2: Permanent EPST or EPIC researchers and similar positions	2	2
N3: Other permanent staff (without research duties)		
N4: Other professors (PREM, ECC, etc.)		
N5: Other EPST or EPIC researchers (DREM, Postdoctoral students, visitors, etc.)	2	1
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	6	5

Team workforce	Number as at 30/06/2013	Number as at 01/01/2015
Doctoral students	4	
Theses defended	6	
Postdoctoral students having spent at least 12 months in the unit	3	
Number of Research Supervisor Qualifications (HDR) taken	1	
Qualified research supervisors (with an HDR) or similar positions	2	2



• Detailed assessments

Assessment of scientific quality and outputs

The scientific quality of the “cosmology and gravitation” team is very high. This is the most recent LPT team, created around the year 2000, and gradually expanded to cover a variety of topics and expertise within the field of gravitation and cosmology. These include black holes (classical and quantum properties), late time acceleration, modified gravity, cosmic inflation, primordial perturbations and cosmic microwave background (CMB) data analysis, among others. The group combines theory and observations of the CMB and, within the LabEx network, is collaborating with experimental groups in the area to study the analogue of Hawking radiation and cosmological pair creation in condensed matter systems under the project QEAGE.

Assessment of the team's academic reputation and appeal

The reputation of the “cosmology and gravitation” team is very high. Some members of this group play a key role in the Planck collaboration, which gives the group very high international visibility and scientific impact (Planck is a satellite mission of the European Space Agency ESA that is measuring the fluctuations in the cosmic microwave background radiation). The group’s work on modifications of gravity and models of dark energy is solid and very well recognized internationally. Finally, some group members have pioneered the study of condensed matter analogues of gravitational phenomena such as Hawking radiation, for over a decade, and are world leaders in this area.

The group maintains strong international collaborations, in particular within Europe but also in the US, and group members have many nationalities.

Assessment of the team's interaction with the social, economic and cultural environment

Their interaction with social and cultural environment seems adequate. The group has organized a number of very nice conferences, has been involved in some outreach activities and has written scientific reviews at both the professional and layman level.

Assessment of the team's organization and life

In general, the organization and the life of the team are very good. The relations among all members of the group (staff, postdocs and PhD students) appear to be excellent, and there seem to be many interactions within the group. The group also has frequent interactions with other groups in the greater Paris area with common research interests. The same apply to the relations with the rest of the teams in the laboratory, although it would be desirable for this group to have an increased daily presence and scientific interaction with the other LPT groups, which should at the same time have a needed centripetal scientific impact inside the team itself.

Assessment of the team's involvement in training through research

This group has a very good record of getting funding for PhDs and postdocs in the previous five years. Their involvement in training of PhD students and postdoctoral fellows is above the average at LPT, and they are keen to continue this level of training through research.

Assessment of the strategy and the five-year plan

The group presents a five-year plan that is, on the whole, closely related to their current activities but it also includes branching into new areas of possible collaboration with the particles group in the area of reheating and dark matter and with the mathematical physics group in the area of quantum gravity.



Conclusion

▪ **Strengths and opportunities:**

This group has high scientific impact with much flexibility and diversity of research projects and collaborations, but maintaining coherence. It contributes strongly to the training of early-stage researchers. It is particularly well placed to establish new collaborations with some of the other groups in the LPT, as well as with experimental groups in the valley-plateau area. This makes it a very important element in maintaining multidisciplinary within LPT and in P2IO labex. Contact with experimental data is also a clear strength. The group has benefited in recent years of bright and productive young hirings, and there are no retirements in sight; in this sense the group is strong and in no critical need of expansion.

▪ **Weaknesses and threats:**

The group is potentially vulnerable to becoming subcritical in the future, for instance by losing some of its members to larger, nearby groups in the Paris area. Recent changes in the organization of doctoral schools in physics and in the funding of ANR projects in the area of astronomy and cosmology are also threatening the group's ability to maintain a strong influx of MSc and PhD students.

▪ **Recommendations:**

This group has high international impact and visibility, it could be a key element in maintaining and strengthening the multidisciplinary character of the LPT, and in opening new research directions within the P2IO labex. It deserves the full support of the laboratory and the University in order to maintain the current level of activity in research and training. The group is encouraged to increase their daily presence in scientific interactions within the whole team and with the other teams in the laboratory, which may have a centripetal effect in its activities.



Team 3 : Mathematical Physics

Name of team leader: Mr Vincent RIVASSEAU

Workforce

Team workforce	Number as at 30/06/2013	Number as at 01/01/2015
N1: Permanent professors and similar positions	2	2
N2: Permanent EPST or EPIC researchers and similar positions	1	1
N3: Other permanent staff (without research duties)		
N4: Other professors (PREM, ECC, etc.)		
N5: Other EPST or EPIC researchers (DREM, Postdoctoral students, visitors, etc.)	3	2
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	6	5

Team workforce	Number as at 30/06/2013	Number as at 01/01/2015
Doctoral students	2	
Theses defended	4	
Postdoctoral students having spent at least 12 months in the unit	1	
Number of Research Supervisor Qualifications (HDR) taken	1	
Qualified research supervisors (with an HDR) or similar positions	5	4



• Detailed assessments

Assessment of scientific quality and outputs

The mathematical physics group at LPT has been traditionally specialized in algebraic and analytic aspects of theoretical physics. The group, which contains actually three permanent members (a full professor PR, an associate scientist CR and an associate professor MCF), and two emeriti, has maintained in the last years a high level of activity in these directions. Its recent research has been concentrated on quantum gravity theories, including the new “tensor track” approach developed to a large extent by members or collaborators of the group, on the quantum field theory on non-commutative spaces (including gauge theories) and their renormalization, on metric and differentiable aspects of non-commutative geometry, on non semi-simple quantum groups and quantum affine algebras and, last but not least, on the scattering theory for long-range non-linear evolution equations. The results obtained by the group were published in international journals, including leading ones, and in conference proceedings. Their visibility ranges from good to excellent for the works on tensor field theories, which attracted a lot of attention in the mathematical physics and quantum gravity communities, or on non-commutative geometry, a theme with a long history in LPT.

Assessment of the team's academic reputation and appeal

The more senior members of the group have a long record of scientific excellence in mathematical physics, in particular in the study of mathematical aspects of statistical physics, quantum field theory and non-commutative geometry as well as in nonlinear PDEs of mathematical physics. A recruitment of an MCF has strengthened the group activity in the direction close to the preoccupations of its members. The group was involved in two ANR projects. It has also profited from a Marie Curie grant and a specific exploratory program PEPS-CNRS funding. The members of the group organized four international conferences and workshops in LPT and participated in organizations of such events in other centers. They maintained multiple international collaborations, participated in international advisory boards, and directed international scientific journals (Ann. H. Poincaré, J. Noncomm. Geom., J. Geom. Meth. Mod. Phys.) or were members of the editorial boards.

Assessment of the team's interaction with the social, economic and cultural environment

The leader of the group has been actively involved in promoting science and building research and higher education structures in Africa, in particular in the creation and development of the African Institute for Mathematical Sciences in Senegal. He is one of the founders and organizers of “Séminaire Poincaré” that plays an inestimable role in the dissemination of knowledge on frontline subjects of research in physics.

Assessment of the team's organisation and life

The group runs an irregular “mathematics seminar” at LPT and occasionally contributes to the activity of the “Sinje” seminar on the spot. Much of its activity is concentrated on collaborations with members of other laboratories of the Paris region or from abroad. It seem that the possibilities of stronger integration within the group (whose members often work on related subjects) and with other groups in LPT have not yet been fully used.

Assessment of the team's involvement in training through research

The group had one postdoctoral fellow in last years and was involved in direction of three defended PhD's whose recipients continue scientific careers. The postdoctoral fellow and some of the PhD's supervised in the recent past by the members of the group have already obtained permanent positions in scientific institutions. Presently, there are three PhD students in the group who interact strongly also with regular visitors from other Paris area laboratories.



Assessment of the strategy and the five-year plan

The five-year project of the group is somewhat sketchy, which is understandable in the theoretical domain where the most interesting progress comes often from unexpected results. The group plans to continue investigations of the tensor track approach to quantum gravity and to this aim it has developed a good network of collaborations. This seems a potentially very promising research direction. The possibilities of future interactions with cosmology and statistical physics are briefly evoked in this project. The plan predicts also to continue the research and the related collaborations in two other active directions represented in the group: the non-commutative geometry with the study of associated quantum field theories and quantum groups of infinite type.

Conclusion

In spite of its small size, the mathematical physics group at LPT maintains a high level of activity, with development of new and promising directions and an opening toward mathematical combinatorics, with well developed national and international collaborations, and with good involvement in training of young researchers and in teaching.

▪ **Strengths and opportunities:**

Mathematical Physics has a long tradition at LPT. Originality of the interdisciplinary research conducted in recent years by the mathematical physics group, its high productivity and visibility, as well as a net of national and international collaborations, are undeniable the strong assets of the team, as is its placement in a pluri-disciplinary university laboratory, a source of inspiration for theoretical research and of contacts with students.

▪ **Weaknesses and threats:**

The small size of the group, that has considerably shrank due to retirements in spite of the hiring of a MCF, as well as some internal tensions not unrelated to slow pace of CNRS promotions, pose question about the future development of the team in the changing local environment. In comparison to other, usually more numerous, mathematical-physics teams in France, the activity of the group is more focused on conceptual research (namely the search of a proper framework for description of quantum gravitational effects) than on analysis of models of experimentally accessible physical reality. The concentration of activity on more speculative (at least from physics point of view) directions is not devoid of risks that could be attenuated by development of interfaces with other teams in the laboratory, in particular with the general relativity and cosmology and statistical physics groups. Such interfaces could provide a good base for the development strategy of the mathematical physics team that is presently not very transparent.

▪ **Recommendations:**

More effort should be made to strengthen the collaborations within the group and with the other teams of LPT and to diversify further the activity of the team, especially in view of the predictable discontinuation of certain directions of research. The group should work out, together with the rest of the laboratory, a sustainable strategy for its future development.



Team 4 : Statistical Physics

Name of team leader: Mr Hendrik-Jan HILHORST / Mrs Françoise CORNU

Workforce

Team workforce	Number as at 30/06/2013	Number as at 01/01/2015
N1: Permanent professors and similar positions	2	2
N2: Permanent EPST or EPIC researchers and similar positions	3	3
N3: Other permanent staff (without research duties)		
N4: Other professors (PREM, ECC, etc.)		
N5: Other EPST or EPIC researchers (DREM, Postdoctoral students, visitors, etc.)	1	
N6: Other contractual staff (without research duties)		
TOTAL N1 to N6	6	5

Team workforce	Number as at 30/06/2013	Number as at 01/01/2015
Doctoral students	2	
Theses defended	3	
Postdoctoral students having spent at least 12 months in the unit	2	
Number of Research Supervisor Qualifications (HDR) taken	3	
Qualified research supervisors (with an HDR) or similar positions	6	5



• Detailed assessments

Assessment of scientific quality and outputs

The statistical physics group at LPT is composed of five permanent members and pursues a variety of research directions in theoretical statistical mechanics, ranging from studies of equilibrium systems through the renormalization group technique, to studies of non-equilibrium systems through exact solutions, and numerical analysis (using new original algorithms) of models of the states of matter (liquids, crystalline and multi-layered systems, plasmas) and phase transitions. The group also develops several interdisciplinary applications, to road traffic, pedestrian traffic, and cellular traffic in biology. Some of the pursued directions were initiated by the group during the report period (for example the studies of collective dynamics in pedestrian flows), some were extensions of existing activities.

The group has published 98 articles, mostly in reputed international journals, including one PRL, two PNAS, one Physics Reports, one PLOS Computational Biology, and a research highlight in Nature Physics. Those were fruits of numerous collaborations within the group as well as on national and international levels.

Assessment of the team's academic reputation and appeal

The group members are well known specialists in their respective fields. They coordinated two ANRs (PEDIGREE and Walkmat) and two “Partenariats Hubert Curien”, and have obtained two grants from “Triangle de la Physique”. They have organized three international conferences and workshops at LPT and maintained a network of national and international collaborations. One member of the group is a corresponding member of the Royal Netherlands Academy of Sciences.

The group is active and has a well established academic reputation, as well as a very good national and international visibility. Unfortunately, all of its members are “senior” (DR or PR), and the only junior (CR/MdC) member of the group that was recruited during the report period left it shortly after recruitment. Moreover, several very well-known scientists that were members of the group left for various reasons in the last decade.

Therefore, even if the scientific quality of the group is very high, it is important to develop strategies to improve its appeal, in order to attract junior members in the future. Strengthening the group by attracting permanent personnel from other labs (e.g. already recruited CNRS staff, or professors in other universities), in order to compensate the outgoing flow that happened in the past, could also be important.

Assessment of the team's interaction with the social, economic and cultural environment

The members of the statistical physics team participated in outreach activities by giving interviews popularizing the results on the traffic flows obtained by the team. They also developed a collaboration with Laboratoire Central des Ponts et Chaussées to test lane changing rules in commercial softwares for traffic simulations.

Assessment of the team's organisation and life

The group runs an informal “tea group” in LPT, and co-organizes a monthly seminar series together with the statistical physics groups of the neighboring LPTMS and IPhT. The group has profited from Labex funding to organize seminars of interest to LPT, LPTMS and IPhT, and to invite shared visitors together with IPhT. The PhD students of the group participate to several activities organized by the PhD students at LPT.

Despite its very diverse interests, the group maintains its coherence and frequent exchanges of ideas happen between the group members. The atmosphere in the group seems very good both from the scientific and the management point of views. Increasing the presence of young members, in particular of PhD students and post-docs, could contribute to maintain the dynamism of the group.



Assessment of the team's involvement in training through research

One postdoctoral fellow and five PhD students were involved in the research of the group during the report period, and at least one has already defended his thesis and works now in the European Patent Office. Some of these PhD students follow a joint international program between LPT and another country (Germany, Colombia), which provides an important contribution to the international connections and visibility of the group. A member of the group is responsible for a Graduate School at the University. The group actively participates in the internship program.

It should be noted that the group has no planned postdoctoral position openings for the next years. Finding support from the lab and from other institutions (CNRS, ANR) to keep at least one postdoctoral position in the group for the next years is very important. It should also be noted that the distribution of effort in training is very unevenly distributed between the senior members of the group. It would be very beneficial for the group if all of its members were involved in training PhD or Master students.

Assessment of the strategy and the five-year plan

The future strategy of the group is based on its achievements up to date. Its project includes further continuation of research on fundamental questions and applications, with the numerical studies of phase diagrams and transitions, and further work on response theory in non-equilibrium physics and on pedestrian flows.

The group is also planning to expand its activities in the direction of biophysics. This seems a good choice, given the large number of resources that are invested in this direction in the Orsay region. Many neighboring labs have theoretical and experimental teams working on similar topics, which provide many opportunities for the group to bring its expertise in non-equilibrium processes to interdisciplinary collaborations.

Conclusion

The statistical physics group at LPT sustains an active research in selected fields of statistical physics at an excellent level. It is an active and productive group, with a very good publication record, working on a range of different topics, with good interactions between the members and the other groups of the lab. It is an active participant of wider activities in the subject stretching over the southern Ile-de-France area.

▪ **Strengths and opportunities:**

It is very important for the preservation of the group to be able to recruit at least one new young member during the next five years. The opening of a “Maître de Conference” position in the Orsay University in 2014 seems an excellent opportunity.

The involvement of the group, together with the rest of LPT, in the present reconstruction of the local scientific landscape in the Orsay-Saclay area may provide a real opportunity to extend the contacts and collaborations with the other statistical physics teams on the campus, or more generally, in the region, as well as with experimentalists and other isolated theoreticians in the framework of the new Paris-Saclay University, and possibly attract some already permanent scientist (e.g. CNRS or MdC) to the group.

▪ **Weaknesses and threats:**

The main threat to the group activity is the seniority distribution in the group. In fact, out of five permanent members, one will retire in a few years, and one is PRAG and therefore has an excessive teaching load and might leave to obtain a better position elsewhere. The absence of junior (CR and MdC) scientists in the group is therefore quite worrying for the future.

Also, the number of young non-permanent members of the group (especially PhD and Master students) is not very high and increasing it could be very useful to bring new energies to the group.



- **Recommendations:**

It could be useful to strengthen the identity of the group to improve its visibility and increase attractiveness. It could be also useful to strengthen the ties with neighboring labs (e.g. the neighboring LPS, LPTMS or the biophysics team at IMNC) and other teams in LPT. The planned increase of the group's activity in biophysics seems very promising in this direction.

To increase the group's activity in training, it is recommended that all the members of the group participate to training PhD and Master students.

The recruitment of a new member in 2014 seems crucial for the future of the group. The candidate should be carefully chosen to bring new energies to the group, in particular concerning training of young students, bringing funding through ANR and other grants, and developing the research directions that are already present in the group.



5 • Conduct of the visit

Visit dates

Start: Thursday, 28 november, 2013, at 9h00 am.

End: Friday, 29 november, 2013, at 4h30 pm.

Visit site

Institution: LPT

Address: Bâtiment 210, Université Paris-Sud 91405 Orsay Cedex

Program of visit

Thursday 28/11/2013

9h30-9h45	Preparatory committee meeting
9h45 -9h50	Introduction by the committee President (Mr Thierry DAUXOIS)
9h50 -10h30	Presentation by the laboratory Director (Mr Henk HILHORST)
10h30-10h40	Presentation by a representative of P2IO labex (Mr Faiçal AZAIEZ, director of IPNO)
10h40-11h05	Particle Physics: the Standard Model (Mr Sébastien DESCOTES-GENON)
11h35-12h00	Particle Physics: Beyond the Standard Model (Mr Ulrich ELLWANGER)
12h00-12h25	Cosmology (Mr Christos CHARMOUSIS)
14h00-14h25	Statistical Physics (Mr Henk HILHORST)
14h25-14h50	Mathematical physics (Mr Vincent RIVASSEAU)
14h50-15h50	Meeting of the committee with Particle Physics & Mathematical physics groups.
16h20-17h20	Meeting of the committee with Cosmology & Statistical physics groups.
17h20-17h35	Committee meeting with the Director of the Doctoral School ED 517 (Mr Elias KHAN)
17h35-18h00	Committee meeting with the thesis students and postdocs
18h00-19h00	Debriefing of the committee



Friday 28/11/2013

- | | |
|--------------|-------------------------------------------------------------------------------------|
| 9h00-9h20 | Committee meeting with the administrative staff (IT) |
| 9h20-9h40 | Public presentation by the future Director (Mr Sébastien DESCOTES-GENON) |
| 9h40-10h20 | Committee meeting with the Laboratory Council |
| 10h50-11h00 | Committee meeting with the present laboratory director (Mr Henk HILHORST) |
| 11h00-11h30 | Committee meeting with the future laboratory director (Mr Sébastien DESCOTES-GENON) |
| 11h30-12h30 | Committee meeting with the University and CNRS administration |
| 12h30 -16h30 | Closed committee session. |



6 • Supervising bodies' general comments

Le Président de l'Université Paris-Sud

à

Monsieur Pierre GLAUDES
Directeur de la section des unités de recherche
AERES
20, rue Vivienne
75002 Paris

Orsay, le 25 février 2014

N/Réf. : 30/14/JB/LM/AL

Objet : Rapport d'évaluation d'unité de recherche
N° S2PUR150007503

Monsieur le Directeur,

Vous m'avez transmis le 5 février dernier, le rapport d'évaluation de l'unité de recherche LABORATOIRE DE PHYSIQUE THEORIQUE – LPT- n° S2PUR150007503 et je vous en remercie.

L'université prend bonne note de l'appréciation et des suggestions faites par le Comité.

Les points à améliorer seront discutés avec le directeur d'unité dans un esprit constructif pour l'avenir de la recherche à l'université.

Vous trouverez en annexe les éléments de réponse de Monsieur Sébastien DESCOTES GENON, Directeur de l'unité de recherche.

Je vous prie d'agréer, Monsieur le Directeur, l'expression de ma sincère considération.


UNIVERSITÉ
PARIS
SUD
Jacques BITFOUN
Président
PRÉSIDENT
Bâtiment 300
91405 ORSAY cedex



17 February 2014

Object : AERES Report - LPT (UMR8627) - Observations

LPT thanks the AERES committee for its careful and positive assessment of its activities.

LPT agrees fully with the AERES committee that it needs to strengthen multidisciplinary and rejuvenate teams by hiring young researchers in the coming years. In addition, LPT stresses that its long-term strategy hinges on the creation of a new "Pole de Physique Théorique" within the future Paris-Saclay campus.

For LPT to reach these goals, a strong support of its supervising bodies (CNRS and Université Paris-Sud) appears essential, as illustrated in several instances of this report.

With my best regards,

S. Descotes-Genon

Director of LPT

Laboratoire de Physique Théorique d'Orsay

Unité Mixte de Recherche CNRS/Univ. Paris-Sud



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