Research evaluation

EVALUATION REPORT OF THE UNIT

LPTM - Laboratoire de physique théorique et modélisation

UNDER THE SUPERVISION OF THE FOLLOWING ESTABLISHMENTS AND ORGANISMS:

Cergy Paris Université - CY
Centre national de la recherche scientifique - CNRS

EVALUATION CAMPAIGN 2024-2025
GROUP E

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High Council for evaluation of research and hihter education

In the name of the expert committee :

Barend Van Tiggelen, chairman of the committee

For the Hcéres :

Stéphane Le Bouler, acting président

In accordance with articles R. 114-15 and R. 114-10 of the Research Code, the evaluation reports drawn up by the expert committees are signed by the chairmen of these committees and countersigned by the president of Hcéres.

To make the document easier to read, the names used in this report to designate functions, professions or responsibilities (expert, researcher, teacher-researcher, professor, lecturer, engineer, technician, director, doctoral student, etc.) are used in a generic sense and have a neutral value.

This report is the result of the unit's evaluation by the expert committee, the composition of which is specified below. The appreciations it contains are the expression of the independent and collegial deliberation of this committee. The numbers in this report are the certified exact data extracted from the deposited files by the supervising body on behalf of the unit.

MEMBERS OF THE EXPERT COMMITTEE

Chairperson:	Mr Barend Van Tiggelen, Centre national de la recherche scientifique, Grenoble
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Ms. Nadège Lubin-Germain - Cergy Paris Université

Mr. Bertrand Georgeot - Centre national de la recherche scientifique

CHARACTERISATION OF THE UNIT

- Name: Laboratoire de physique théorique et modélisation
- Acronym: LPTM
- Label and number: UMR 8089
- Composition of the executive team: Mr Jean Avan (Chairman)

SCIENTIFIC PANELS OF THE UNIT

ST Sciences et technologies
ST2 Physique

THEMES OF THE UNIT

The LPTM is a research unit with activities in theoretical, numerical and mathematical physics, involving both high - and low - energy physics. Within these themes, a considerably large diversity of topics exists, grouped together into three main and slightly overlapping themes: Condensed Matter Systems and Quantum Phenomena (theme A), Integrability Dynamics and Stochasticity (recently merged themes BC), and Physics of Complex Systems (theme D).

Theme A further splits up into a rich variety of subthemes such as low-dimensional systems, cold atoms, quantum entanglement, graphene, application of hydrodynamics to out-of-equilibrium quantum thermodynamics, quantum Hall effect, skyrmions (vortex states of spin systems) and recent studies on quantum computing.

The merged BC theme is the historically and more mathematically orientated activity of LPTM with activities on the application of mathematical techniques to not only quantum and classical physical problems, but also to phenomena in biology, economics or computer science. Two different parts are still visible. A first part of the research activity of Theme BC fits within the field of mathematical physics. Results mainly concern classical or quantum integrable systems (on the continuum or lattice) and their applications, combinatorics of models of statistical mechanics (6-vertex model or XXZ spin chain), off-equilibrium transport properties (multispecies generalizations of Asymmetric Simple Exclusion Process), inverse problems applied to Compton scattering tomography. More mathematical aspects are also investigated related to the theory of quantum groups, for instance the elliptic analogues of quantum W-algebras. The second part deals with dynamical and stochastic aspects of several classical systems. A large corpus of work exists on detailed random walks both at a fundamental level and in connection with applications, in particular on population genetics, in collaboration with a Chaire at the Ecole Polytechnique. Activity exists on interfacial phenomena in hydrodynamics, with applications to water storage.

A significant fraction of the research of theme D focuses on Living and Active Matter physics, in which many results have been obtained. Approaches in this field combine research on theoretical aspects (concerning both statistical physics and hydrodynamics) and applications in different domains (transport in cellular media, in complex tissues, exploration properties of bacteria, collective behaviour in animal systems, …). Other results have been obtained for polymer membranes (finite-temperature second-order phase transition controlled by disorder, revealed by the non-perturbative renormalization group), computational neuroscience (development of mean field approaches for spiking neural networks in the presence of fluctuation sources) or mutualistic networks (entropic origin of nestedness in mutualistic systems).

HISTORIC AND GEOGRAPHICAL LOCATION OF THE UNIT

The unit was created by University Cergy Pontoise (CY) and CNRS in 1993 as "équipe d'accueil". It was labelled "Unité Mixte de Recherche" (UMR 8089) in 2002 with the same supervising authorities. The unit occupies two floors in the Building Saint Martin E on the St. Martin Campus. On January 1st 2020, CY Cergy Paris University was created by the fusion of the former University Cergy Pontoise and the "École Internationale des Sciences du Traitement de l'Information" (EISTI). Other institutions such as the "École Pratique de Service Social" (EPSS) and the "École Supérieure des Métiers du Sport et de l'Enseignement" (ILEPS) entered the CY Cergy Paris University as component Institution ("établissement composante"). The instance CY Alliance coordinates this new landscape with some ten other institutions. The creation of CY Cergy Paris University has led to the simultaneous creation of several Graduate Schools, among which CY Tech for science, engineering, economics and management, also recognized as "Grande École d'Ingénieurs" in France. This School is actually spread among three faculties at three campus sites (Cergy, Saint-Germain en Laye in the Paris suburbs), and Pau (in the southwest of France). The Institute for Science and Technology ("IST") in Cergy is the direct contact for LPTM at CY.

The initial orientation of LPTM was devoted to the many methods and applications of statistical and mathematical physics, but the unit continuously evolved towards new developments. The Campus St Martin is situated 35 km northwest of Paris-intramurals and can be reached by train, RER A and C in roughly one hour. As such the Campus fully integrates the scientific activity in the Paris area.

RESEARCH ENVIRONMENT OF THE UNIT

With the two supervising authorities CY and CNRS, LPTM interacts daily with different instances. At the local level, LPTM interacts in particular with the Institute "Sciences et Techniques" of CY Tech that plays the role of physics department. IST controls four research units shared with CNRS and other establishments on "sciences of modelling" (one in mathematics, LPTM, ETIS on signal processing and THEMA on economic modelling) and eight on "experimental sciences" (among which the LPMS devoted to materials and surface physics, which is thematically closest to the LPTM). It also interacts a lot with CY Advanced Studies that stimulates interdisciplinary and international collaborations.

At the regional level, the unit is a full scientific partner in many initiatives in Île-de-France. It benefits significantly from the Program "Investissements d'Avenir" (PIA-3) and in particular from the ISITE Paris-Seine of which CY is a major partner. It is a member of Labex MME-DII "Modèles Mathématiques et Économiques de la Dynamique, de l'Incertitude et des Interactions" (now baptized Federation for Sciences of Modelling) with seven other units in the northern Paris area. The unit is partner in DIM ("Domaine d'Intérêt Majeur Science et Ingénierie en Région Île-de-France") for quantum technologies, and is part of the "Paris Center for Quantum Technologies " network).

At the national level, the LPTM is piloted scientifically by CNRS Physics and section 02 (Theory and Modelling) of the National Committee for Research, although topics exist associated with section 04 and 05. The unit is administered by the DR5 in Meudon (with only one other physics unit in its perimeter: Glass Surface and Interfaces in Saint-Gobain). The LPTM participates actively in a number of CNRS Research Groups (GDR) such as the GDR "Branchement" on mathematical physics, the GDR ANAIS (multifractal analyses), the GDR TEQ (quantum technologies) and the GDR Howdi (low dimensional heterostructures). CY faculty members are followed by sections 28 and 29 of National University Council CNU.

At the international level, CY is a founding member of EUTOPIA, an alliance of ten "like-minded" universities across Europe which enables LPTM to have scientific collaborations with most of all Warwick and Ljubljana. Many other active international collaborations exist as evidenced by the publications listed in the Portfolio (Manchester, Geneva, Sao Paulo …).

LPTM is heavily involved in the teaching and supervising of Master and PhD students. Staff members including CNRS agents run the two-year Master's program in Theoretical Physics, entirely taught in English. About 20 Master students in this program started their PhD at LPTM and roughly half have non-EU citizenship. LPTM is affiliated to the Doctoral School ED405 on Economy, Management, Mathematics, Physics and Computer Science but not to the one of Physics of the Île de France (EDPIF).

UNIT WORKFORCE: in physical persons at 31/12/2023

Catégories de personnel	Effectifs
Professeurs et assimilés	6
Maitres de conférences et assimilés	7
Directeurs de recherche et assimilés	2
Chargés de recherche et assimilés	3
Personnels d'appui à la recherche	2
Sous-total personnels permanents en activité	**20**
Enseignants-chercheurs et chercheurs non permanents et assimilés	7
Personnels d'appui non permanents	0
Post-doctorants	5
Doctorants	21
Sous-total personnels non permanents en activité	**33**
Total personnels	**53**

DISTRIBUTION OF THE UNIT'S PERMANENTS BY EMPLOYER: in physical persons at 31/12/2023. Non-tutorship employers are grouped under the heading "others".

Nom de l'employeur	EC	C	PAR
CY	13	0	0
CNRS	0	5	2
Total personnels	13	5	2

GLOBAL ASSESSMENT

The scientific output of all themes present in LPTM is, both quantitatively and qualitatively, of high standard and internationally recognized. The committee has appreciated in particular the remarkable diversity of in-house competences and scientific topics. They range from applied mathematics to advanced numerical methods and collaborations with experimental teams, to contemporary topics such as quantum technologies, applications of complexity to social and economic networks, and medical applications. This scientific activity is remarkable in view of the relatively small size of the unit and the high workload of teaching and administrative duties of many staff members, at the CNRS, at CY and at CNU.

LPTM is a unit with one single team that has implemented an internal strategy based on a minimum amount of rules and protocols to cope with a maximum number of challenges. This "pragmatic opportunism", supported by a well-developed democracy among all members, has been successful for the unit and to the satisfaction of the entire staff. Many national and international collaborations exist and the LPTM is successful in grant applications, both in local (IST, Labex), national (ANR), and international calls (ERC, EUTOPIA).

The number of PhD students, supported by many different sources, has increased a lot during the last term and is currently (almost) limited by the number of available offices. More and more PhD students are locally recruited through the Master 2 in Theoretical Physics run by LPTM staff, with the gracious support of the Doctoral School ED405 at CY. LPTM members sometimes complain about their difficulty to recruit high-quality students and the unfair competition they face with intramural Parisian establishments, but so far, they have managed well.

The unit is strongly supported by the two authorities CNRS and CY (both financially and in human resources). However, the workload of teaching (with extra complications such as the increasingly fragmented time slots for lectures) and administration at CY is large, to the point that it starts interfering destructively with the well-being of the staff, their scientific activity, and possibly with the future attractiveness of the LPTM.

DETAILED EVALUATION OF THE UNIT

A - CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

Retirement: Le nombre relativement important de prochains départs en retraite devra être compensé par de nouveaux recrutements. La forte proportion d'enseignants-chercheurs au LPTM, ainsi que le grand nombre d'heures supplémentaires d'enseignement et d'administration qu'ils doivent assurer, constitue un frein aux activités de recherche du LPTM.

During the period 2018-2023, LPTM has been active and successful in hiring new young scientific members. Two CNRS associate researchers (CRCN), one CPJ CY Chair with CNRS support, two CY professors (one CY professorship opening supported by PIA3 resources, one Labex Chair), and one Tenure Track CY. Also, the retirement of the administration head (RA) has been replaced by the CNRS. During the same period four members retired but are still active as emeritus, or as associate members.

Workload: La multiplication des projets de formation et des appels d'offres pour des partenariats internationaux [...] pèse lourdement sur les enseignants-chercheurs déjà très sollicités.

This is still a major problem and the creation and structuration of CY Cergy University and its various instances has exposed the administration and management to more paperwork and to even more effort to get things done. The proximity of the students is an asset for research but the teaching workload has increased even more and has become an increasing threat for LPTM scientific activity.

Valorisation: La question des brevets ne se pose donc pas de manière cruciale pour lui. Mais le comité encourage les membres du LPTM à explorer toutes les possibilités qui pourraient se présenter à lui.

LPTM deposited one demand for patent at DR5-Meudon of the CNRS, which failed due to lack of manpower at the DR5. Future collaborations are announced with the upcoming CY Medical School and Industry.

PhD supervising: Le comité avait noté [...] que le taux d'encadrement du LPTM était inégalement réparti entre les thèmes et entre ses membres [...]. Le comité encourage l'unité à poursuivre ses activités d'encadrement de thèses.

LPTM has seen a large rise of PhD recruitment (eleven early 2018, against 23 early 2024), from which themes A and D have benefited mostly. The recent merger of themes B and C has also increased the recruitment of PhD in mathematics as well.

Multi-thématiques: Le comité encourage le LPTM à poursuivre ses réflexions sur les liens possibles entre les différents thèmes. Les activités interdisciplinaires sont un des points forts du LPTM, et le comité soutient les efforts visant à les concrétiser par des collaborations impliquant des spécialistes d'autres disciplines.

The diversity of topics in LPTM is still a strong point and has grown. Currently, many members participate in more than one theme. The LPTM strategy is to let the thematic evolution to be determined by proactive opportunism rather than by detailed planning. Theme D clearly has many opportunities while this is more difficult for mathematical activities. For that reason, a high priority is set on the recruitment of a CPJ CNRS Chair in themes BC.

Individual resources against collective welfare: Il faudra veiller à ce que cet apport de ressources individualisées ne porte pas atteinte aux très bonnes pratiques de gestion collective mises en œuvre au LPTM.

This problem is well known by all research units and supervising authorities in France and stems from the introduction of the Anglo-Saxon model for scientific funding in France. Many LPTM members are indeed successful in getting individual grants (ANR, ERC) but those who have been less lucky do not seem to suffer. Nevertheless, no systematic overhead on grants is taken to support those without individual funding. This is a compromise made in many other units in France.

B - EVALUATION AREAS

EVALUATION AREA 1: PROFILE, RESOURCES AND ORGANISATION OF THE UNIT

Assessment on the scientific objectives of the unit

The scientific objectives of LPTM are: 1) to be a major actor in theoretical physics, in the Paris area, in France, in Europe, and world-wide, 2) to conduct multimethodological research where all aspects in analytical, numerical, mathematical physics exist in-house and find their right place; 3) to stay on the cutting edge by moving to competitive, contemporary topics such as currently quantum engineering, neural networks and AI, 4) to continue to act as a one single team sharing this common objective. These challenges are highly ambitious in view of the presence of so many different themes - old and new. The high workload of many staff members in teaching and administrative duties poses an increasing problem to reach all these objectives.

Assessment on the unit's resources

The current scientific, permanent human resources consist of thirteen CY faculty members, six full time CNRS researchers, two Tenure Track Chairs and four still active emeritus members. This is quite equally spread over three main themes. Operational support consists of one IT engineer and one administrative manager from CNRS, handling approximately 50 members. The unit hosts more than 20 PhD and six postdocs. This picture summarizes the LPTM as a "small" research unit, though with sufficient critical mass. Despite its small size, LPTM has sufficient critical mass, typical for French theoretical physics labs.
The unit's financial resources include 25 k€ from CNRS and 41 k€ from CY annually, both increasing steadily during the evaluation period. CY's recurrent support, based on excellence indicators like top journal rankings, and PIA-3 funding, have been beneficial. External grants have increased significantly, from 500 k€ in 2018 to 1300 k€ in 2024, including a 1.5 M€ ERC award in 2023. CY manages contracts and takes a 20 % overhead on external grants, redistributing 5 % back to the unit.

Assessment on the functioning of the unit

The unit is supervised by a Director (CNRS senior Research Fellow) and a Deputy director (CY Professor). This is an efficient combination. An executive committee exists that also includes the two supporting staff members: the administrative manager (CNRS) and the computer engineer (CNRS). This team takes care of daily affairs. The LPTM consists of one single team displaying three main activities to the outside. Unit members are not assigned to themes and can sign up for different themes. The Laboratory Council comprises all permanent members and all non-permanent members with a seniority exceeding one year, including PhD and postdocs. It meets on a regular basis and decides on all rankings of priorities. This functioning seems adequate and is at the satisfaction of all. No collective "outside the wall" days are organized, but a good collective spirit exists, supported by internal workshops and seminars.

1/ The unit has set itself relevant scientific objectives.

Strengths and possibilities linked to the context

To realize their objectives, LPTM can count on the strong support of the two supervising authorities, with both financial means and good will to assign human resources of different kind.

Many PhD scholarships have come from the local Doctoral School but other possibilities for scholarships have been seized (Labex, ANR, Eutopia providing many PhD "en co-tutelle").

Both authorities have assigned Junior Chairs and have the good will to do so in the future.

The recent strong reorganization of the local scientific landscape at CY is a huge opportunity.

The strong implementation of many unit members in local teaching is a very strong element since it guarantees a proximity to potential future Master and PhD students.

The integration of the unit into the Paris research landscape, despite being highly competitive and somewhat distant, should be regarded, first of all, as strength with lots of opportunities.

Weaknesses and risks linked to the context

The objective is quite ambitious especially for a unit that is heavily involved in teaching and administrative duties. Only roughly half of the research time (thus already excluding regular teaching duties at CY) is devoted to performing and supervising research.

The strategy of "pragmatic opportunism" to realize high stakes is comprehensible, and maybe unavoidable but also constitutes a risk factor because future developments - positive or negative - tend to depend a lot on external factors and are not anticipated.

The large diversity of scientific topics, some of historical origin and with the continuous addition of contemporary topics- by far more than the number of permanent researchers, has the risk of diluting the visibility of the main scope of the unit to the outside world. Efforts to keep historical topics related to geometry at LPTM may turn out in vain and also lacks support and lobby from local partners, as seems to be the case with more applied mathematical subjects. The creation of important activities that largely overlap different themes (like non-equilibrium dynamics = theme ABC) makes the thematic borders look somewhat arbitrary and is arguably neither attractive nor transparent for new recruitments.

Two external risk factors exist. Firstly, the LPTM struggles with unsigned conventions for PhD programs run by university partners outside France, which complicates the integration of foreign students on the Campus. Secondly, the CY Junior Chair with CNRS support will be tenured to professor in 2025, unlike another CPJ that might decide to leave LPTM.

2/ The unit has resources that are suited to its activity profile and research environment and mobilises them.

Strengths and possibilities linked to the context

The unit has sufficient financial resources to realize its objectives. It has gracious access to PhD scholarships from the local CY Doctoral School, that comprises only four units so that one scholarship each year is guaranteed, and a second is likely. Yet, other PhD fundings have come from the LabeX (8), EUTOPIA, ANR and ERC. This has allowed to run a healthy research program. The unit has enough resources to support internships of Master students, which are partially supported by local support from the Science department IST.

Emeriti, Chairs and contractual teaching staff (ECC) excluded, among the nineteen scientific unit members currently present, only five do not have HDR (two CNRS associate researchers, three associate professors).

The technical and administrative support provided by two agents is highly satisfactory though especially the administrative support is fragile. The laboratory members apply to calls with satisfactory acceptance rate.

LPTM has access to local facilities for advanced (HPC) computing.

Weaknesses and risks linked to the context

The square metres provided by the CY premises are no longer sufficient in times with lots of visitors and students. The number of required desks has increased from roughly 30 to 50 during the last term but five desks have been lost due to reattributions by CY. Especially students suffer from this problem and some are even housed outside the perimeter of the LPTM and close to noisy classrooms.

Many senior members have or have had important but time-consuming administrative duties (Chair of CY Advanced Studies, Deputy Scientific Director at CNRS Physique, Chair of CY Scientific Council, Scientific Director of CY Alliance, Deputy Director of Department of Physics, members of CNU and CoNRS panels).

The intermittence of external funding is considered to be a threat by the LPTM, but this is not seen to be worse than anywhere else in France. The exact future of the local Labex MME-DII may be at stake after the recent reorganization. It has provided eight PhD scholarships to LPTM.

The LPTM is exposed to many support units of the CY, with whom the communication is not always efficient causing problems of different kind such as the impossibility to create computer accounts rapidly.

With only one administrative manager for 50 members, operational support appears inadequate, posing risks to efficiency.

With roughly half of the PhD students having non-EU citizenship, the presence of differentiated inscription fees for non-EU residents at CY is a real risk, especially because many other establishments in the Paris area have decided not to impose this raise.

Strengths

- **Steady growth of recurrent support**: The increasing contributions from CNRS and CY provide a reliable base of financial stability.
- **Significant external funding**: The unit has successfully secured substantial national and international grants, including a prestigious ERC award.
- **No premises charges**: The absence of charges for premises reduces financial pressure on the unit.

Weaknesses

- **Fluctuations in external funding**: While overall funding has grown, the variability between years poses challenges for long-term planning.
- **Overhead management**: The 20 % overhead taken by CY, with only 5 % redistributed, limits the resources directly available to the unit.

3/ The unit's practices comply with the rules and directives laid down by its supervisory bodies in terms of human resources management, safety, environment, ethical protocols and protection of data and scientific heritage.

Strengths and possibilities linked to the context

The unit is well aware of the many, often national, social and ethical challenges set out by the supervising authorities, and even the EU guidelines on "Human resources strategy for researchers" (HSR4R).

Data protection, gender parity, open science and low carbon footprint are the most relevant issues for LPTM. LPTM has identified persons in charge to follow the developments and to implement them in the unit. Especially in the Open Access of publications, the unit publishes regularly in Scipost – the open access diamond journal - and is timely since all publications are deposited in HAL and/or ArXiv.

Weaknesses and risks linked to the context

The persons that have been identified (one has just arrived) and assigned are still in training and few concrete actions have so far been undertaken, such as the creation of a charter that specifies the objectives and corresponding actions to lower carbon footprint.

The protection of scientific production is assured by an external CY officer, whose actions are not transparent. There is no sign of open codes, nor of a data management plan ("DMP'), nor of open courses.

As usual in theoretical physics, gender equality is well respected in the equality of opportunities but much less in the equality of numbers (< 20 %), and the LPTM is not the exception to the rule. The origin of this low number must be sought in the non-attractiveness of theoretical physics for women in their early stages of education, despite serious efforts by research units and research organizations to recruit more female scientists.

EVALUATION AREA 2: ATTRACTIVENESS

Assessment on the attractiveness of the unit

Attractiveness can be quantified by 1) the ability of the unit to attract the competent young scientists; 2) the number of recruited PhD students (15 defended their thesis successfully, 20 present during the interview) and postdocs (4) ; 3) the number of (foreign) visitors (roughly six per year); 4) the number of invitations to international conferences; and 5) the degree of innovation of the unit to evolve towards new topics. Given these indicators there is no doubt that the unit is highly attractive. The capacity to attract and to keep technical and administrative staff is less relevant for this small unit, but clearly it succeeded in keeping a healthy support where these staff have been given large responsibilities e.g. as part of the executive committee.

1/ The unit has an attractive scientific reputation and is part of the European research area.

2/ The unit is attractive because for the quality of its staff support policy.

3/ The unit is attractive through its success in competitive calls for projects.

4/ The unit is attractive for the quality of its major equipment and technical skills.

Strengths and possibilities linked to the context for the four references above

Many national or European collaborations exist with joint publications and unit members are active in the organization of scientific meetings.

Many members have been or are PI of grants (ANR, 1 ERC, EUTOPIA).

The number of PhD students has grown significantly during the last term.

A healthy recruitment of permanent researchers exists via different channels (CY, CNRS, including Chairs on both sides).

The age pyramid of the unit has a healthy structure with only four upcoming retirements in the next term. Retired scientists often wished to stay on board for two or more years.

All themes A, BC and D clearly reach out for new research topics, with novel or upcoming collaborations being initiated (such as the medical school).

The growing visibility of CY is a huge opportunity for the LPTM, especially as its single unit in fundamental physics. The large variety of competences present in the unit is an asset for students and visitors.

Weaknesses and risks linked to the context for the four references above

The problem of promoting technical staff (especially from Assistant Engineer (AI) to Ingénieur d'Etudes (IE) remains difficult.

EVALUATION AREA 3: SCIENTIFIC PRODUCTION

Assessment on the scientific production of the unit

The unit achieves a remarkable annual output of 53 publications, demonstrating consistent productivity and a notable peak in the pandemic year. The publication rate of 3.13 /y/ETPT is an excellent ratio compared to the national average. The repartition among the themes is in good equilibrium, also given the different habits of the different communities.

1/ The scientific production of the unit meets quality criteria.

2/ The unit's scientific production is proportionate to its research potential and properly shared out between its personnel.

3/ The scientific production of the unit complies with the principles of research integrity, ethics and open science. It complies with the directives applicable in this field.

Strengths and possibilities linked to the context for the three references above

Many publications are signed by LPTM members working on different themes, a clear sign that the desired strategy of having permeable theme borders is valid. The equilibrium between themes (counting B,C as one) is remarkable. Many publications are co-authored with scientists outside the LPTM, in the Paris area, in France or in other international units.

The publications occur in a large variety of excellent peer-reviewed journals mostly edited by learned societies (Phys. Rev, J.Phys, EPL, J. Magnetism & Magnetic Materials, Comm. Math. Phys.), some from ("meant to be") prestigious journals such as Nature, Nature Comm, Nature Physics, Scientific Reports, PNAS and Symmetry, and a few have appeared in Diamond Open Access journals such as Scipost. All visible publications have been extracted from HAL, showing that LPTM respects the directives of authorities. There is no sign of inactive researchers.

The scientific output of Theme A is characterized by a few real breakthroughs supported by press releases: In Theme A two world-wide highlights exist: 1) the liquid-to-gas phase transitions in antiferromagnetic materials, supported by experimental work and a huge international collaboration, 2) the nonlocality of a photon in a multi-arm interferometer, work done with theoreticians and experimentalists at the Raman Research Institute in Bangalore.

Among the highlights obtained in theme BC, let us mention the introduction of the boundary emptiness formation probabilities associated with certain overlaps in the XXZ spin chain, for which explicit closed formulas are obtained at the so-called combinatorial point. Let us also mention the long-standing question of the classical algebraic structure associated with the classically integrable complex sine-Gordon field theory in two dimensions. A classical R-matrix formulation is given in terms of two matrices satisfying a system of modified classical Yang-Baxter equations. New proposals are given in order to investigate the quantum integrability of the model, that is still an open problem.

The results are published in top journals of the field, with a clearly identified international impact. At the national level, strong connections with other units have been pursued during the period (for instance with LAPTh Annecy). Globally, the theme BC covers both fundamental research and interdisciplinary topics. Some research areas tackle traditional subjects; others are particularly innovative. Generally speaking, the theme's research areas occupy an important place in international research, and the theme's activities are convincing, both in terms of research and in the training of doctoral students.

The activities of theme D are of high standard, and are widely recognized at international level. Scientific output is abundant and published in excellent journals. There were 16 articles per year over the period, i.e. almost 3/year/ETPT, with several publications in high-impact journals (Nature Physics, Nature Materials, Nature Communications, PRL, PNAS, PRX…), a policy that is encouraged by the presidency of CY and has been rewarded by more recurrent funding.

The publications cover a wide range of topics. Numerous collaborations with researchers in the Paris area are a clear strength of the theme. The theme has attracted a large number of doctoral and post-doctoral students, training many young researchers in a contemporary, interdisciplinary field.

Weaknesses and risks linked to the context for the three references above

A few publications are published in expensive open access journals (Scientific Reports: 2300 €, Nature Comm: 5700 €). Although these works are done in international collaborations, the French authorities recommend avoiding spending APC on publications.

EVALUATION AREA 4: CONTRIBUTION OF RESEARCH ACTIVITIES TO SOCIETY

Assessment on the inclusion of the unit's research in society

LPTM is hardly active (5 % self-attributed in rapport) in the outreach of its research activities or of the promotion of theoretical and fundamental physics in general. Yet, it has a huge potential to make such contributions, and maybe even a responsibility in view of the growing visibility of the CY community, in which LPTM is the sole unit on fundamental physics. Actions on valorisation are rare for units on theoretical physics.

1/ The unit stands out for the quality and the amount of its interactions with the non-academic world.

2/ The unit develops products for the cultural, economic and social world.

3/ The unit shares its knowledge with the general public and takes part in debates in society.

Strengths and possibilities linked to the context for the three references above

A huge opportunity exists for LPTM to be more visible in public debates, and many laboratory members have the quality to do this.

Weaknesses and risks linked to the context for the three references above

The large workload of most permanent researchers undoubtedly explains the lack of outreach.

ANALYSIS OF THE UNIT'S TRAJECTORY

A new director, currently deputy director, is proposed by the unit to lead LPTM during the next term. The unit has no imminent risk of massive retirement in the next term (one CNRS agent and three CY faculty members plan to retire). It is also not threatened either by the retirement of any of the two supporting agents (AI and IE CNRS) but may have to make an effort for their promotion.

The reorganization of the scientific activity into three themes has been accomplished and the unit intends to stick to them, and make reinforcements wherever necessary, for instance in the former C activity on stochastic aspects. The unit intends to accomplish this by maintaining its strategy of pragmatic opportunism and "to use all opportunities offered by the environment", in particular to apply for coloured Junior Chairs. Many new scientific developments are under preparation such as the possible collaborations with different hospitals (Pontoise, Sorbonne...) on subjects like brain dynamics. With the creation of the CY medical school a theme on sociophysics might even emerge in Theme D. More activity is likely on quantum information and artificial intelligence, priority topics both the CY and the CNRS, and on social and ecological networks. The unit may have to cope with the extension of its premises at the CY campus St. Martin, although this seems unlikely to have a sustainable solution before the end of the current regional CPER contract in 2030. The unit is well aware of and enthusiastic about the new challenges but has a "wait and see" policy, because so many elements depend on unknown external developments.

Theme A

The ERC grant "Hydrodynamics and entropy production in low-dimensional quantum systems" will run until 2027. New projects are in preparation on superluminality in quantum field theory, new quantum phases of matter emerging from entanglement, topological matter out-of-equilibrium supported by partly existing collaborations with experimental teams, and the continuation of research on 2D quantum materials. Grant preparations are conducted to start projects on quantum information and quantum magnetocaloric materials, the latter with possible industrial involvement.

THEME BC

The planned research activities (with some overlaps with Theme A) may be divided into two parts. In continuity of previous works, one part aims to (i) further study algebraic and combinatorial aspects related to the dynamics of integrable models in statistical mechanics; (ii) further study the non-standard r-matrix structures and their q-analogs that arise in complex sine-Gordon or Peakon models; (iii) further study in imaging analysis, in particular Compton scattering tomography. A second part aims to consolidate, strengthen and even introduce new integrability-related subjects with a large spectrum that includes algebraic structures, technical methods such as the Bethe ansatz and bootstrap, field models (non-linear sigma, CFT, SUSY models) and applications to out-of-equilibrium properties and quantum transport...). New developments relying on the expertise at LPTM in image processing are planned in collaboration with other actors in CY (including the Pontoise hospital) in the framework of a new CY medical school.

Both parts have priority in Theme BC, a choice that is strategically consistent with the current expertise of the team but especially in view of the expected retirement of the DR CNRS working in this field within the next few years. To avoid a weakening of the integrability research activities in this perspective, the team is targeting a CPJ CNRS in 2025.

THEME D

The theme D has selected convincing directions for its future research, covering timely areas of great interest: (i) a project on non-ergodic features of the brain dynamics as well as aspects of complexity related to social and ecological networks will be explored; (ii) concerning active matter, the developments will again be divided into fundamental directions, such as microscopic and continuous modelling, topological defects and defect interactions in active systems, and applied directions among which the exploration capacity of bacteria, the functionality of collective patterns and the adaptive behaviour in biological systems. This part of the theme, which has benefited from several recent hiring including that of a brilliant and very active young CNRS researcher, should continue to play a leading role in the field in the coming years. (iii) regarding complex fluids, the study of topological transformations in mesophases, and the physics of foams will be important directions of research. (iv) as for the physics of polymerized membranes, an ambitious project of highly technical complexity, one aims at modelling two coupled flat crystalline membranes, using the Renormalization Group approach, in order to model and study the geometric properties of bilayer graphene. New developments are planned as part of CY's thematic priorities. The first one will focus on the cross-links between artificial intelligence and statistical physics, and the second one on extending the activities on biophysics and active matter within the CY's new Medical School. All topics proposed are of great interest and cover current fields in which Theme D has considerable expertise. Its future trajectory is therefore highly convincing.

RECOMMENDATIONS TO THE UNIT

Recommendations regarding the Evaluation Area 1: Profile, Resources and Organisation of the Unit

The committee recommends to get rid of the ABCD nomenclature for the general themes and to use attractive titles that no longer rely on historical structure.

A solution needs to be found for the collective administrative overload that has become a real threat to the daily functioning of the unit. Some CY faculty members benefit already from reduced teaching load (CPJ, PI ANR, etc.) but more collective effort seems to be necessary to liberate more time for research and supervise: CRCT, CNRS Délégation, Institut Universitaire de France.

The annual CSI (Comité de Suivi Individuel) for the PhD students comprises for the moment the director of the unit and another member of the LPTM. It would be much more instructive to make the CSI more independent and to look out for an external member of the unit, for instance a scientist from a neighbouring unit like AGM or even in the Paris area.

The communication lines with different services at CY do not operate well despite good will on both sides. It is important that the various spokesmen in the different services are well identified and become familiar with the LPTM so that intensive case-by-case error-correction becomes unnecessary. It is strongly recommended that the executive team organizes regular on-site 'Dialogue" meetings with the authorities in CY. This could also be an occasion to discuss threats to the good functioning of the unit such as the increasing lack of space, the growing fragmentation of lectures, the lack of updates in the CY databases, and the unsigned conventions for PhD students "en cotutelle".

It is important to nominate a spokesperson of PhD students and postdocs in the Laboratory Council. The intention of the future director to keep the General Meeting as "Laboratory Council" despite the fact that the total amount of human resources has exceeded 30, is supported by the committee, but is no reason not to appoint spokespeople. Indeed, a spokesperson for each of the three themes might simplify the discussion in the General Meeting of the unit without giving up the principle of having one single team.

The committee recommends to follow the events concerning the upcoming novel structure of CoNRS, with new keywords, and even a new section. The unit seems connected to several CoNRS sections. This may be an opportunity for a secondary affiliation.

Several important tasks are already in the pipeline but more effort is needed to come to concrete actions, such as a charter to reduce the carbon footprint, a detailed data management plan, and a charter to increase and preserve gender equality. One can be inspired by many existing initiatives in other units. At present, the first efforts are taken by the technical staff, but it might be essential to also include scientists.

Recommendations regarding the Evaluation Area 2: Attractiveness

Several permanent members have a significant administrative workload, that adds up to the already high teaching load. Both activities are, of course, important. Nevertheless, the unit should try collectively to avoid collective overload and ask more often for dispensations (Délégation CNRS, IUF, CRCT).

Recommendations regarding Evaluation Area 3: Scientific Production

The committee encourages the LPTM to keep this precious high scientific level and its impressive thematic diversity.

Recommendations regarding Evaluation Area 4: Contribution of Research Activities to Society

The committee recommends to make this more a priority and to solve the problem of administrative overload, e.g. by appointing a COM officer. Work on societal challenges such as carbon footprint could be communicated to the outside. The new projects with upcoming medical school and industry-related projects, such as the one on magnetocaloric materials, will also deserve outreach.

CONDUCT OF THE INTERVIEWS

DATES

Start: October 15th 2024 at 13 h 00

End: October 16th 2024 at 12 h 00

Interview conducted: online

INTERVIEW SCHEDULE

MARDI 15 OCTOBRE 2024

The presentations given by the Director and the 3 Themes were attended online by the entire unit.

13 h 00 - 13 h 15	Présentation du comité et du programme	
13 h 15 - 14 h 00	Présentation du directeur/directrice (& future direction) devant le comité, les tutelles et le personnel (bilan et trajectoire)	
14 h 00 - 14 h 30	Discussion et échange avec le comité	
14 h 30 - 14 h 45	Huis clos du comité et pause	
14 h 45 - 15 h 15	Présentations Thématique A : matière condensée et phénomènes quantiques (bilan et trajectoire)	
15 h 15 - 15 h 45	Discussion et échange avec le comité	
15'	Huis clos du comité et pause	
16 h 00 - 16 h 30	Présentations Thématique BC : Intégrabilité, dynamique, stochasticité (bilan et trajectoire)	
16 h 30 - 17 h 00	Discussion et échange avec le comité	
10'	Huis clos du comité et pause	
17 h 10 - 17 h 40	Présentations Thématique D : Physique des systèmes complexes (bilan et trajectoire)	
17 h 40 - 18 h 10	Discussion et échange avec le comité	

MERCREDI 16 OCTOBRE 2024

08 h 30 - 09 h 05	Échange comité – C/EC	
10 mn	Huis clos du comité et mise en place de la visio	
09 h 15 - 09 h 35	Échange comité - PAR (ITA/BIATSS/CDD/CDI)	
10 mn	Huis clos du comité et mise en place de la visio	
09 h 45 - 10 h 20	Échange comité – Doctorants et Postdocs	
10 mn	Huis clos du comité et mise en place de la visio	
10 h 30 - 11 h 00	Échange comité-tutelle	
15 min	Huis clos du comité et pause	
11 h 15 - 12 h 15	Échange à huis clos - Direction (& future direction)	
45'	Huis clos du comité ou pause	

PARTICULAR POINT TO BE MENTIONED

The committee regrets the evaluation on distance and believes that an evaluation on site would have been of higher quality.

GENERAL OBSERVATIONS OF THE SUPERVISORS

The institution responsible for submitting the application, which is also responsible for coordinating the response on behalf of all the research unit's supervisors, did not submit any general observations.

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