NUI MAYNOOTH

Ollscoil na hÉireann Má Nuad

Quality Review of the Department of Mathematical Physics April 2009

Peer Review Report

Peer Review Group:

External reviewers: **Professor Sander Bais**
University of Amsterdam, The Netherlands
Professor Poul Damgaard
University of Copenhagen, Denmark

Internal reviewers: **Professor Ray O'Neill**
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Dr David Redmond
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National University of Ireland at Maynooth
Department of Mathematical Physics
Peer Review Report
April 2009

Background

The Peer Review Group was appointed by the President of the National University of Ireland, Maynooth, to report on the research and educational activities of the Department of Mathematical Physics over the period from 2003 to the present, and advise on the future plans and opportunities. The external members of the panel were Prof. F.A. Bais (University of Amsterdam) and Prof. P.H. Damgaard (University of Copenhagen/Niels Bohr Institute).

The external peer reviewers visited the Department from 6 to 9 April, 2009. On the first day they – after a welcome by the coordinators of the Quality Promotion Office – held meetings with the President of the University, the internal reviewers, and the Head of the Department. On the second day the external peer reviewers had one-on-one meetings with all individual staff members including the contracted teaching staff, then with 2 postdocs, 4 tutors, and a group of around 25 undergraduate students, after which a closing session with all staff of the Department was arranged. On the final day the external reviewers met with 6 Masters and PhD students, and again with the internal reviewers and had a final meeting with staff. The (preliminary) exit report was prepared and presented to the staff and officials involved in the afternoon.

Before the visit, the panel members received a copy of the self-assessment document prepared by the Department. During the visit they received the NUI protocol for quality assessment. After the visit they also received the report of the external review that took place in 1999.

Summary of the current situation

At present the Department of Mathematical Physics is rather small and with a clear and positive identity, independent of the adjacent Departments of pure Mathematics and Experimental Physics. The Department has a scientific staff that covers a substantial diversity in subjects such as nonlinear dynamics, topology in physics, lattice field theory, quantum information theory, and some condensed matter physics. The research effort of the staff is supplemented with postdocs and Master/PhD students. The Department offers a number of undergraduate programs that overlap substantially, i.e., many modules are shared between different programs. The department also provides service education with other departments, such as that of Electrical Engineering. From looking at the Quality Review of 1999, the panel concludes that the qualitative and quantitative level of performance both in research and teaching has improved significantly.

Assessment of research quality

After interviews with staff and a review of the publication record for the last five years the panel assesses the research quality and research leadership as follows.

- The current Head of Department has a very energetic and enthusiastic approach to scientific leadership. Decision-making is based on consensus in the Department, but the main initiative comes from the Head, who seizes opportunities wherever they come up. The research strategy is extremely ambitious and it is pursued vigorously.
- There has been a major renewal of permanent staff in recent years which has brought an internationally known group of young scientists to Maynooth.
- The panel is particularly impressed with the hiring policy of the Department. There has been a conscious decision to seek *scientific excellence* rather than specific research directions. This has led to a broadening of the Department, bringing in two new areas of research with very strong potential. With the Department now being well covered in several main areas of modern theoretical physics, it will probably be wise to seek to fill in remaining gaps in possible future hirings (see below). Although this will represent a break in the present hiring tradition, the panel nevertheless makes this recommendation.
- The two new research directions that have opened up due to recent hirings are: *lattice gauge theory* (one new staff member, a post-doc and a PhD-student) and *topological quantum computing* (two new staff members, post-docs and PhD-students). **For both of these new areas there are exciting research possibilities to explore with senior staff. This should be seriously pursued.** To give examples: gauge field topology is a hot current topic in lattice gauge theory, numerical simulations can complement analytical results, overlap with lattice spin models, fractional quantum Hall effect, phase transitions, etc.
- The push towards lattice gauge theory in the Department is well planned due to an existing and strong research group in Dublin. This is good for the PhD-students and post-docs, and is already leading to shared responsibilities between the group in Maynooth and the one in Dublin. *In this way the Department can reach "critical mass" in a subject without losing diversity*. The lattice gauge theory group in Maynooth should seek further alliances in Ireland and abroad, perhaps more broadly under the heading *computational physics*.
- Also the push towards topological quantum computing and related areas seems to be extremely well timed. The Department can explore the possibility of establishing a genuine center for quantum information theory and quantum computing in Ireland. There is potential for major funding in this subject at the European level (and perhaps also at the Irish level), and the panel notes with satisfaction that there are serious efforts in that direction.
- With the new staff hirings there are completely new possibilities for attracting PhD-students and post-docs. Efforts should go into exploring shared PhD-supervision with senior staff members in the Department or outside so that the supervision of students does not fall on the newly hired staff alone.

- The panel has observed that the research environment of the Department is *open* (the Department has a consistent “open doors” policy), and visitors to the Department (including undergraduate students) feel very comfortable there. The atmosphere is very pleasant.
- The level of research in the Department is high. This is reflected in the publication record and in the choices of journals. There seems to be an awareness of the prestige in publishing in places like, e.g., Physical Review Letters. In the future, an eye towards this particular aspect could lead even higher impact. *In general*: in the next self-assessment report some bibliometric analysis ought to be included so that more quantitative measures are more readily available to the reviewers.
- The panel suggests that the Department might exploit the potential of the Maynooth campus more. The beautiful and tranquil country-side location may not be well known to many, and is a substantial asset. An active visitor program should be pursued, both at the short-term level and at the full sabbatical level. A culture of regular seminars or colloquia should be introduced, perhaps sharing visitors (and the expenses) with institutions in Dublin.
- The panel notes with satisfaction that there seems to be consensus on the idea that a future hiring in the Department could be targeted towards modern aspects of condensed matter physics. Such an initiative would be a unique opportunity not just for Maynooth, but also on a broader national scale (where there appears to be a peculiar lack of this fundamental subject).

Assessment of educational and teaching quality

The reviewers were offered ample opportunity to talk with undergraduate and graduate students, their tutors and other staff involved in executing the teaching duties of the Department. The following conclusions were reached:

- The panel was impressed by the very positive response of the students about the contents of the study programs they were involved in. They expressed that they experienced the curriculum as well organized and coherent.
- Students were very positive about the level and quality of the teaching and the pleasant and stimulating atmosphere.
- Students found that the teaching staff was overall accessible. Because of an open-door policy it was possible to discuss problems and questions with them also outside the classroom.
- The students were unanimous in their judgments about the need for the problem sessions and the high quality of the tutors that do the teaching of those sessions.
- The panel found the information on the teaching performance in the self-assessment report somewhat limited on the quantitative side. It would have helped if there would have been more information concerning: the number of students in the various programs over the last 5 years, the drop-out rate, and possibly an exit interview with those people. Also an attempt at listing the professional directions taken by the students after obtaining their degrees would be a valuable source of information about the relative use and success of a given program.

- The panel had the opportunity to meet with representatives of one of the other Departments for which courses are delivered. It was clear that these teaching contributions were highly appreciated.
- The reviewers ranked the infrastructural facilities, such as lecture rooms and computational facilities, as very good according to modern standards.

In spite of the very positive overall response, the reviewers identified a number of issues where improvements in the educational program of the Department appeared to be possible.

- It was felt that there was very little opportunity for the students to improve and get experience with basic written and oral presentation skills. Especially since there is no formal thesis requirement for the undergraduates it is important to implement explicit components where these skills are developed, starting already in the first year of the curriculum. It would be even better to couple those components with small research projects. This will improve the quality of the graduates from the Department.
- The panel believes that the tutors would profit from a short, compulsory and rather intensive course to ensure that their teaching skills are at an appropriate level. A careful analysis with an expert (senior staff member, for example) of the tutor's teaching (perhaps taken on a video, if possible) may give them an enormous incentive to improve their teaching skills. The reviewers sensed enthusiasm about such possibilities with the tutors themselves.
- It was noted that the students had very little knowledge about the job opportunities they would have with their degree. It would be very useful to have more activities in which information about these matters is provided by the Department, possibly organizing special meetings with alumni who could share their experiences with the present student body. Information on the career paths of former students would also be helpful in this respect.
- Students were not aware of international opportunities such as the Erasmus program or participation in summer programs (like at CERN, for example).
- Students showed a keen interest to be involved in various outreach activities for potential new students and the general public. The Department could be more active to undertake such activities and could indeed give the students an important role in this.
- In order to fulfill the teaching obligations, a policy has been adopted to hire so-called contract lecturers who even teach courses that belong to the very core of the curriculum. This may be a provisional measure for staff members who are about to be appointed or on sabbatical leave. The panel nevertheless wishes to express the view that *as a matter of principle all important and basic courses should be taught by permanent and experienced staff*.
- The various teaching programs might profit from a restructuring. The aim of this would be to ensure that exciting subjects of (modern) physics, like relativity, non-linear dynamics and quantum physics would be prominently introduced earlier into the program. This may be at the expense of some of the classical subjects like mechanics and hydrodynamics. In this respect the division between optional en compulsory courses should also be re-evaluated.

- The panel encourages an open-minded exploration of possibilities to reduce the overlap between courses given in different programs and in other neighboring Departments. Reduction of some redundancy should be used to increase the overall diversity in courses offered, thereby strengthening the ties between research and education. In this perspective also opportunities offered by the presence of the nearby Hamilton Institute should be explored.

Future perspectives

The panel finds that the future perspectives for the Department are excellent, especially when the potential of the new staff hirings will come to full development. It can set apart the Department in the Irish scientific and educational landscape as a very attractive and vital place. *The University has all reasons to vigorously support this high-profile department in order that it may succeed in meeting its ambitious goals.*

Summary and recommendations

It is evident that the Department is doing very well and successfully provides a challenging environment for both students and young researchers under its energetic leadership. The panel met a very dedicated staff, committed to first class research and teaching. The panel is very positive about the recent hirings that substantially broaden the scope of the research and teaching potential. This enhances the national and international visibility of the Department in a number of active and important fields in Mathematical Physics. This should make the Department in Maynooth a very attractive option for studying Mathematical Physics in Ireland.

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Professor Sander Bais
External Reviewer

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Professor Poul Damgaard
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