A report on the development of theoretical sciences in Taiwan in relation with scientific collaborations with France

January 11, 2010

1 General remarks

1.1 Purpose and implementation of the mission

A French delegation consisting of four scientists working in theoretical sciences (two theoretical physicists and two mathematicians) visited Taiwan at the end of October 2009.

The purpose of this mission, organized by the "Institut Français de Taipei" (FIT), with the support of CNRS and of several scientific institutions in Taiwan, universities or national agencies (foremost among these being the National Science Council of Taiwan, NSC), was to prepare a report on the present situation of theoretical sciences in Taiwan inasmuch as new or existing collaborations with France in these fields could be initiated or enhanced.

The purpose was by no means to evaluate the scientific level of the research carried out in Taiwan in one or another field, but only to identify in which areas of mathematics and of theoretical physics French or Taiwanese governmental agencies or institutions could help scientists develop partnerships and joined programmes of research.

It should also be stressed that the delegation was supposed to focus its attention on "theoretical sciences", understood here as mathematics and theoretical physics. In particular, the mission did not investigate research activities in physics in general, although what is meant by "theoretical physics" may depend on the country. Notice that defining the border line between mathematics and theoretical physics may also lead to a debate (see the discussion in next section). Also, the views expressed in this report are certainly influenced by the selection of places the delegation visited and the people the members of the delegation spoke to. In any case, this should, by no means, be seen as stating that very good research does not exist in other places that the delegation had no time to visit.

The mission lasted approximately a week, and the members of the delegation were brought to a selection of research institutes in Taiwan, namely in Taipei: Academia Sinica and National Taiwan

University (NTU); in Jhongli: National Central University (NCU), in Tainan: National Cheng Kung University (NCKU); and in Hsinchu: the National Center for Theoretical Sciences (NCTS) and National Tsing Hua University (NTHU).

The delegation had discussions both with colleagues working in theoretical sciences met at the various institutions but also with many persons in charge of running the different institutions that were visited. All members of the French delegation also lectured in the various places. A detailed description of how the mission developed is given as an annex.

Members of the delegation :

- Jean-Pierre Bourguignon (CNRS and Institut des Hautes Études Scientifiques, Bures-sur-Yvette)
- Daniel Braun (Laboratoire de Physique Théorique, UPS, Toulouse)
- Robert Coquereaux (Centre de Physique Théorique, CNRS, Marseille)
- Gilles Lachaud (Institut de Mathématiques de Luminy, CNRS, Marseille)

The mission was coordinated through the "Service de coopération et d'action culturelle de l'Institut français de Taipei", in particular by Arnaud Lalo (Attaché de coopération scientifique et universitaire) and David Ma (Attaché de coopération scientifique et universitaire adjoint).

1.2 Some considerations about mathematics and theoretical physics

History of sciences has shown that theoretical physics and mathematics have always been developed alongside one another with multiple interactions and sollicitations, but the motivations leading to new developments, as well as the finality of these sciences, are usually different. Moreover, if all mathematicians would agree on what mathematics "is", not all physicists would agree on what "theoretical physics" is. Actually, the description of this activity often seems to vary from country to country, if not from institute to institute, and also to be time dependent. In order to dissipate possible misunderstandings a few words of introduction on this point seem necessary.

About thirty or forty years ago, theoretical physics was conceived as the study of the conceptual tools allowing one to give a description of fundamental physical interactions. This included, in particular, the study of laws governing the behavior of elementary particles and their interactions (electromagnetism, weak interactions, strong interactions), the study of gravitational forces, the development of general tools like mechanics itself, or statistical mechanics, the study of general techniques of quantization like quantum field theory, and, of course, mathematical physics.

Nowadays, theoretical physics departments around the world may incorporate scientists working not only on the above traditional topics, but also, for example, on theoretical solid state physics, theoretical physics of soft matter, mesoscopic physics, nanophysics, complex systems, quantum computing, and sometimes dynamical systems, integrable systems, or even computational physics.

At the same time, several fields of research that are (or were) considered in some places as integral part of theoretical physics have moved to mathematics departments, for instance theoretical mechanics is now often considered as part of symplectic geometry.

The ratachment of one or another field of research to a mathematical institute or to a physical institute are often different in France and in Taiwan. Moreover, some research activities that are done, in Taiwan, in a theoretical physics department, may be associated, in France, with more specialized departments. For instance theoretical solid state physics, that is often, in Taiwan, part of the theoretical physics department, may be studied, in France, in a department of condensed matter.

2 Mathematics and theoretical physics in Taiwan: general features

2.1 Mathematics

The level of mathematics in Taiwan is very high in algebra, number theory, geometry, and analysis, domains in which the island counts a number of mathematicians of international caliber.

From the point of view of the number of people involved, the delegation had the feeling that a majority of research groups and faculty members, in Taiwan, work either on fields related to analysis, like partial differential equations (PDE's), harmonic analysis, dynamical systems, statistics, applied mathematics (numerical analysis), or on fields related to number theory (automorphic forms, coding, etc) often in connection with algebraic geometry. Other fields of mathematics do not seem to attract so many people, even if, as already mentioned, there are individuals of very high level working in these other fields of research.

At this point one may notice that, in Taiwan, research activities related to the study of dynamical systems seem to be performed within mathematical departments whereas, in France, they would often take place in theoretical physics departments. To some extent, this is also true for mechanics (symplectic geometry), for functional analysis, and for those parts of representation theory that deal with quantum algebras (i.e. Hopf algebras, quantum groups, Hecke algebras, braid groups etc.)

In recent years Taiwan has successfully attracted back to the island some high level mathematicians trained in the US in some of the very best universities. It should also be pointed out that some collaborations with French institutes are already in place and functioning well.

Our general impression is that presently scientific research in Taiwan, particularly in theoretical sciences, is managed in a dynamical and efficient way, free from usual causes of inertia like administrative or apparatchik interferences, unlike what may sometimes happen in some Asian countries. From that point of view the fact that a national structure (NCTS) has been put in place with the purpose of reaching, for some activities, a critical mass and exposure to high level seminars for a larger group of people and works successfully should be stressed. NCTS also gives a good opportunity for very promising young mathematicians to present their research to a larger group.

2.2 Theoretical Physics

The level of theoretical physics in Taiwan is very high, and the researchers are very well connected with the international physics community. Almost all faculty members the delegation met received their Ph.D. in the US, often at the most prestigeous universities, and in many cases continue to have active exchanges with the US. Many other collaborations or links with Japan, China, South Korea, Australia, and some European countries (notably Germany and the UK) exist.

In terms of fields of research, the delegation observed a concentration on a relatively small number

of fields. In a nutshell, one can say that theoretical physics activities related to modern solid state physics, such as ill condensed matter, soft matter, mesoscopic physics, as well as material sciences are well developed, and attract a big number of researchers and students. The same is true for quantum information theory (QIT). QIT seems to be located predominantly in theoretical physics departments, and the research in this area is consequently rather close to physical systems, mostly solid state systems and quantum optical systems (there is some activity at NCKU related to properties of certain quantum states and their usefulness for different QIT applications, though). This is somewhat different from the situation in France, where in addition to the physics community, computer scientists and even mathematicians work on more formal aspects of QIT. Since the delegation did not visit any computer science departments in Taiwan, it cannot be excluded that such activities also take place there.

Apart from these fields, there are also, of course, several people of very good level working on fundamental interactions, either on the phenomenology of elementary particle physics (usually in connection with experiments to be performed at SLAC in the US, or at CERN in Switzerland), or on model building based on string theory, but the corresponding groups seem relatively small, when they exist at all.

As for more formal aspects of theoretical physics, in particular mathematical physics, they seem to be almost absent from physics departments. However, some of the research activities present, in France, in theoretical physics departments are associated, in Taiwan, with mathematical departments.

3 About the different research institutes and universities visited in Taiwan

3.1 Taipei: Academia Sinica and National Taiwan University (NTU)

In Taipei, the delegation has been received by colleagues of the Academia Sinica, and by different groups working at NTU.

http://www.math.sinica.edu.tw/www/default_e.jsp

http://www.math.ntu.edu.tw/webadm/php/english/

Mathematics

The Institute of Mathematics of Academia Sinica has about 30 members. The director is Tai-Ping Liu (who just retired from Stanford University), an expert in partial differential equations connected to fluid mechanics, and we have met Jih-Hsin Cheng.

The current research activities are summarized as follows:

- Combinatorics,
- Number theory and algebra, algebraic geometry,
- Applied mathematics and analysis,
- Geometry and mathematical physics,
- Probability and applications,
- Fluid mechanics and computational mathematics.

Chia-Fu Yu, associate research fellow, is a very active mathematician working in arithmetic geometry. He is visiting IHÉS for the present academic year, and is working in particular with Vincent Maillot (CNRS, Institut de Mathématiques de Jussieu).

The Department of Mathematics, National Taiwan University (NTU), has also around 30 faculty members and 40 Ph.D. students in mathematics. The current research activities covers roughly the following: Combinatorics, number theory and algebra, algebraic geometry, mathematical analysis, partial differential equations, differential geometry, probability and applications.
It appears that the research activities are gathered in the Taida Institute for Mathematical Sciences (TIMS). The office of the Mathematics Division, NCTS (North Branch) is presently located in Old Mathematics Building, NTU. The members are mainly to be found in the Department of Mathematics, NTU. The director is Gerard-Jennhwa Chang (graph theory), and the delegation met

Jing Yu (number theory) and Chang-Shou Lin (partial differential equations). The Department of Mathematics and the Institute of Mathematics of Academia Sinica will be located in the same new building in a few weeks. This will be the greatest concentration of mathematicians in Taiwan with many high level researchers.

Chang-Shou Lin, who held for a long time a professorship abroad, is an excellent expert in elliptic PDE's for their own sake but also in connection with differential geometry, has a great ambition for the department, and wants to take advantage of the new concentration to attract many more very high level mathematicians. The level of graduate students there is remarkable, and this can add to the attraction from the research point of view as some of them can be interested in preparing a Ph.D. in a sandwich programme.

Visiting members of NTU in December:
— Junkai Chen (algebraic geometry) is involved in a CNRS/NTU cooperation with Vincent Maillot.
— Antoine Ayache (probability, Laboratoire Paul Painlevé, Lille),
— Alain Perronet (algorithmic geometry, Laboratoire Jacques-Louis Lions, Paris),
— Bruno Kahn (arithmetic geometry, Institut de mathématiques de Jussieu, Paris).
Previous visiting members:
— Loïc Merel (arithmetic geometry, Institut de mathématiques de Jussieu, Paris 7).
— Jacques Tilouine (modular forms, Institut Galilée, Villetaneuse).

This shows that cooperation with France already exists: it would be worthwhile to increase it. Note that Jean-Pierre Serre (algebra and number theory, Académie des Sciences de Paris) was an invited lecturer for the inauguration meeting of the building in July 2009.

Theoretical physics

NTU is involved in two theory centers (NTU Center for Theoretical Sciences (CTS)), and NCTS North Branch. Whereas all members of the CTS (about 20+ people) are professors at the NTU, the NCTS North Branch includes other Universities in Northern Taiwan and Academia Sinica. The offices used by the NCTS North Branch on the NTU campus are located on the 13th floor of the condensed matter physics building, but are scheduled to move into a former dorm building in the center of the campus that is currently being refurbished for that purpose. There is substantial overlap in terms of the researchers and the missions of the two centers. Amongst the 7 members of the CTS Executive Committee, Professor Ching-Ray Chang is also the Director General, Department of International Cooperation of the NSC.

About 10 members of the CTS are distributed over particle physics, nuclear physics, string theory, and cosmology, whereas the rest is in condensed matter physics and AMOP (atomic, molecular and optical physics), including Quantum Information Theory (plus two researchers in physical chemistry). In condensed matter there is basically one permanent researcher per area (with typically a group of several students and post-docs around him or her), such as strongly correlated electrons, mesoscopic physics, spintronics, density functional theory etc.

At the Academia Sinica several members are actively engaged in international collaborations on high energy physics, mostly with Fermilab in the US, but also with ATLAS, at CERN, or work on

the analysis of other experiments (properties of the neutrino) taking place in Taiwan. In particle physics, we find also here researchers working on particle physics phenomenology like Professor Li Hsiang (QCD corrections, form factors, quarkonium spectroscopy, B-physics) with active collaborations, mostly with the US. There are of course other groups, for instance working on superconducting phenomena, like Professor Yip Sungkit, but those different activities seem to involve very small groups, often limited to a single person.

There are also people working on nanophysics, or on the physics of surfaces and interfaces, but the delegation did not meet them. Academia Sinica hosts a rather large center of nanoscience (in cooperation with National Tsing-Hua University, providing about 20 students/year) but their activities appear to be almost exclusively experimental.

We should mention also one physicist working on lattice QCD, because there are actually a few others in Hsinchu and Tainan; one may notice, at that point, that "lattice people" (who need large computer facilities) form a small but international community with strong international ties, for example with France, Germany, and the US; in a sense they do not need our help too much since they know each other very well and have already very active collaborations.

It should be stressed that members of the Academia Sinica who are not at the same time faculty members of some university cannot officially direct Ph.D. thesis; for this reason, the same people will usually have a faculty position at the National Taiwan University (NTU). For this reason also, the various members of the different teams are often post-doctoral students coming from countries like China, Korea, Japan, or India, working under the guidance of a local faculty member.

At NTU, the delegation was told that about $12 - 15$ faculty members work on different fields of theoretical physics (on the CTS web page, this number seems to be slightly higher), but this includes condensed matter theory and astrophysics. Actually, a majority work on condensed matter: at least 9 people at CTS, with only one, Professor Goan also doing quantum information theory. So, the number of faculty members of this department drops considerably if one restricts the activities to those that would be called "theoretical physics", in France. We are then left with essentially three activities: high energy physics, string theory, and quantum information theory.

In string theory, for instance, we find a very active group of post-docs and Ph.D. students, working under the supervision of Professor Pei-Ming Ho.

QIT is represented by two researchers at the Academia Sinica, specializing mostly on quantum communication protocols (Yao-Chen Hung and Chin-Kun Hu), and one very active professor at NTU (Hsi-Sheng Goan) who works on a broad variety of fields ranging from quantum measurement theory over one dimensional conductors to High-Tc-superconductors. He is a member of the Quantum Information Focus group of the NCTS, supervises a relatively large group of students and a post-doc, and is well connected with leading members of the Australian QIT community, as well as with the University of Southern California.

Remark

At NTU, the delegation had also a very interesting discussion with Professor Ching-Ray Chang, Director General, Department of International Cooperation of NSC (the National Science Council), but the question will be addresed again in the summary section.

3.2 Jhongli: Center for Mathematics and Theoretical Physics, National Central University (NCU)

http://www.phy.ncu.edu.tw/cmtp/english/index.html

In Jhongli, the delegation visited several experimental facilities (acceleration of particle beams using lasers, biophysical experiments etc.) In principle, there should be there, in the future, some common facilities for both mathematicians and theoretical physicists, but it seems that a critical size has not yet been reached. In mathematics there are indeed faculty members working on PDE's, functional analysis, numerical analysis, statistics, graph theory and hyperbolic geometry, on high energy physics phenomenology, general relativity or string theory but in each case the groups are relatively small, often restricted to a single person (with the exception of graph theory and high energy physics). In mathematics, this center has around 30 faculty members and 40 Ph.D. students. There are research groups in the main fields of mathematics as described above. Jean-Yves Briend (dynamical systems, LATP, Marseilles) visited this center in November.

3.3 Tainan: National Cheng Kung University (NCKU)

http://www.math.ncku.edu.tw/english/news.html

Mathematics

The Department of mathematics has around 25 faculty members and 10 Ph.D. students. The current research activities covers roughly the following:
— probability, biomathematics, PDE's, differential geometry, algebraic geometry, computational mathematics, representation theory, and number theory.
— King Fai Lai (p-adic modular forms) has been visiting professor in Paris 7. The university houses the south branch of NCTS.

Theoretical physics

In the National Cheng Kung University in Tainan, theoretical physics seems mostly concentrated around quantum information theory and computational physics, in the sense that those groups are well developed and play the role of coordinators for the "focus groups" of NCTS (more about it

later). Of course, there are also scientists working in other areas like gravity, string theory or high energy physics, but every such activity does not usually involve more than a single faculty member, so that, in order to meet their colleagues, these researchers have to travel to other places, and use resources provided by NTCS focus groups localized mostly in Taipei. We may also notice that in Tainan NCKU, like in most other places of Taiwan, mathematical physics seems to be absent.

There are at least four professors in the physics department at NCKU who are very active in QIT: Yueh-Nan Chen, Shih-Yuin Lin, Chopin Soo, and Wei-Min Zhang. Professor Chen heads the QIT focus group (together with Hsi-Sheng Goan at NTU) and works mostly on QIT in relation with mesoscopic physics and quantum optics. Professor Shih-Yuin Lin is very active in questions of entanglement dynamics in relativistic settings. Professor Soo has a background in cosmology and quantum gravity and works now on questions of quantum non-locality and entanglement. Prof. Zhang is a specialist in decoherence, in particular in mesoscopic solid state systems. The group has close links with several internationally renowned researchers, including Professor Brandes in Berlin, Professor Martinis at UCSB, Professor Milburn in Queensland, Professor Schön in Karlsruhe, Professor Bei-Lok Hu at the University of Maryland, and many more. Professor Hu is in fact a senior multi-year visitor with the group and has a fruitful collaboration with Shih-Yuin Lin. The group organizes a yearly winter school on QIT, for which they bring in several specialists from around the world, and which caters to the entire Taiwanese student body in QIT. The QIT focus group also organizes mini-workshop and seminars at NCKU, NTHU, and NTU.

Remark

The delegation had an interesting discussion with the Vice-President of NCKU, Professor Feng. His opinion was quite clear cut: if people working in France on such domains as quantum computing or soft matter physics (and maybe also mesoscopic or nano physics), whose development is considered a priority in Tainan, are willing to develop collaborations with their local homologues, money is not and will not be a problem, and they will receive a strong support on behalf of the university. To the contrary, fields like particle physics or mathematical physics should not hope for too much. The message was clear. Daniel Braun, a specialist of quantum computing who is a member of the delegation, has already forged links with his local colleagues and discussed the possibility of creating some kind of project along the lines sketched by Professor Feng. There is in particular discussion of co-organizing a Taiwanese-French winter school on QIT in 2011. The delegation did not have any specialist of soft matter, for the reason that the study of soft matter, or of ill-condensed matter, does not usually take place, in France, in theoretical physics laboratories, but members of the delegation will certainly transmit the message to their colleagues.

3.4 Hsinchu: National Center for Theoretical Sciences and National Tsing Hua University (NCTS/NTHU)

http://www.math.cts.nthu.edu.tw/main.php

The case of Hsinchu is special, in the sense that the delegation was hosted by the National Tsing Hua University (NTHU) but all the discussions, as well as a full day of scientific workshop, took

place on the premises of NCTS, the National Center for Theoretical Sciences, which is itself hosted by NTHU.

The role of NCTS seems to be so crucial in Taiwan that one has to devote a few lines to explain what the delegation understood about it. Note though that one delegation member, Jean-Pierre Bourguignon, was twice a member of the international evaluation committee of NCTS in 2002 and in 2008. This role is rather ubiquitous. In a sense, NCTS is a place (in Hsinchu), with conference rooms, offices, computer facilities, library, administrative staff, etc. As such, it may welcome international conferences and host foreign scientists for possibly extended periods of time. Similarly, at NCKU the NCTS runs a center which serves mostly as meeting place for visiting scientists.

NCTS is also an institution whose steering committee selects what are called "focus groups", that play somehow the role of the French "GDR", which are "CNRS laboratories without walls" and provide financial support allowing members of a given focus group, who are living, working and teaching in distant places, to meet regularly and work together. These focus groups also play an important role in the training of students and young researchers, as they organize centralized advanced classes and schools, with lectures that would be too specialized to attract sufficiently many students if they were organized locally, in the various universities.

For many faculty members of Taipei, NCTS seems to be "just a funding agency" where they can apply for small or medium size projects (for projects requiring more substantial financial support, they would directly apply to the NSC that itself funds the NCTS). Notice however that this last point of view, although rather common among NTU faculty members, is not compatible with the official mission of NCTS, presented and defended by its direction (the present director is a mathematician, Professor Wen-Ching Winnie Li, with whom the delegation had several conversations about the role of NCTS). The NCTS also directly employs a number of scientists. Six center scientists and one staff scientist of the NCTS work at the NCTS facility at Hsinchu. From the perspective of the NSC, NCTS was created as an experimental project that was supposed to test a way of giving more freedom to theorists, in particular to young researchers who would typically return to Taiwan after Ph.D. and/or post-doc in the US. The center scientists, considered outstanding in their field, are offered reduced teaching loads and are involved in running the NCTS programmes.

The workshop organized at NCTS was mixing mathematicians and theoretical physicists in the same conference room (a nice feature... since in the majority of other places that the delegation visited, both departments were geographically separated). In view of the variety of the talks presented both by members of the delegation and by several local colleagues, and from the questions asked by people attending the workshop – quite a large number of people, actually – it is clear that the organizers have succeeded in attracting many faculty members, postdoctoral students and Ph.D. students working in many branches of theoretical sciences.

The Director of NCTS is Professor Wen-Ching Winnie Li (number theory, automorphic forms). The former director, from 2004 to 2009, was Professor Jing Yu, from NTU. The headquarters of NCTS are located at NTHU, with additional offices in Taipei and Tainan. In 2009 the NCTS had a budget of about 3.10^6 US Dollars. Founded in 1997 and initially hosted at NTHU and NCTU, it went through several transformations, as new projects were added. Its steering committee consists of eight outstanding scientists. It contains a mathematics division (headed by Professor Wen-Ching

Winnie Li) and a theoretical physics division (headed by Professor Yu-Mo Chung). NCTS has several programmes to attract and promote promising or already established researchers, such as the "Visiting distinguished research chair professor", or the "S.S. Chern Fellow", reserved for an extremely outstanding domestic scientist.

Without trying to be exhaustive, the following focus groups in theoretical physics can be mentioned:

There is a computational material research focus groups with 33 faculty members (+23 Ph.D. students) all over Taiwan. This group works mostly on band structure calculations, 1st principle structure calculations, molecular dynamics, nanoscale materials, and surface phenomena. They are actively involved in developing new codes, and have experts for the calculation of excited states, and in Quantum Monte Carlo methods.

Another focus group in solid state physics works on mesoscopic and spin physics, and a third one on novel quantum phenomena in condensed matter. There is some overlap between both groups, as well as with the focus group on quantum information. The members of these groups have well developed contacts or collaborations with well known groups abroad, mostly in Japan, the US, and Germany.

In mathematics there are two regional sub-projects :

- North : Taipei (still for a few days in the old mathematical building, NTU), involving more than 100 mathematicians.
- South : Tainan (inside main NCKU campus), involving around 40 mathematicians.

Ten topical programmes in mathematics have been defined for 2008/2009:

- algebraic geometry (Jungkai Cheng, Chin-Lung Wang)
- discrete mathematics (Gerard J. Chang, Xuding Zhu)
- dynamical systems (Kuo-Chang Chen, Cheng-Hsiung Hsu, Chih-Wen Shih)
- geometric analysis and differential geometry (Shu-Cheng Chang, Jih-Hsin Cheng, Yng-Ing Lee, Chiung-Jue Sung, Dong-Ho Tsai)
- mathematical biology (Sze-Bi Hsu)
- number theory and algebra (Julie Tzu-Yueh Wang, Chia-Fu Yu, Jing Yu)
- partial differential equations (Chiun-Chuan Chen, Jong-Shenq Guo, Jenn-Nan Wang)
- probability and related topics (Yuen-Chung Sheu, Narn-Rueih Shieh)
- representation theory (Shun-Jen Cheng, Meng-Kiat Chuah, Ching-Hung Lam)
- scientific computation (Ming-Chih Lai, Wen-Wei Lin, Wei-Cheng Wang)

Bilateral thematic exploratory workshops

If one wants to step up the cooperation on an ad hoc basis, one should consider workshops of around twenty people on a precise thematic subject, according to the topical programmes of NCTS. It will be easy to define common research topics.

Research in pairs

The idea would to support a joint research programme between one French and one Taiwanese scholars (or very small research groups) during one year. An evaluation would be made at the end, leading to a renewal or to a closure of the programme. There are enough facilities in each country to support the meetings of the members of the programme (CIRM in France, NCTS offices in Taiwan or in Hsinchu). This will provide an opportunity for Taiwanese scientists to visit other French laboratories.

According to Da Hsua Feng, Vice-President of NCKU, such a programme has been set up between Taiwan and Israel in medicine for one year, and met a very good success.

3.5 National Taiwan Normal University (NTNU)

On the last day, D. Braun visited the physics department at NTNU. There is a group of about 15 researchers working in condensed matter and bio-physics. Three of them are theorists: Professor Ming-Che Chang works on topological insulators, and is also interested in QIT topics. Professor Chi-Ming Chen specializes in biologically motivated physics, such as membrane folding, polymer physics, and synchronization in neural networks. Professor Wen Chin Wu specializes in strongly correlated systems, quantum magnetism, and Bose-Einstein condensates. There are also faculty members working in other areas of theoretical physics, such as particle physics, but D. Braun did not meet any of them.

4 Conclusions

Theoretical physics

Collaborations between French and Taiwanese scientists can exist at various levels.

The first level is a kind of person to person collaboration, involving two mature scientists (usually not more) deciding to work together on a subject of common interest. Such a collaboration can only be initiated by the scientists themselves. Such collaborations, between French and Taiwanese researches actually do exists in several fields. The role of institutions like CNRS or FIT, and NCTS, is then to provide some facilities allowing those researchers to travel in order to finalize the work that they are doing together (usually by e-mail).

Another level of collaboration involves teams, usually rather small ones (do not forget that we are talking about theoretical sciences!) involving people who would benefit from discussion groups and workshops. As far as theoretical physics is concerned, and considering the existing potentialities of Taiwan, it seems that the most promising areas that could be supported are to be found in such domains as quantum information, theoretical nanophysics (mesoscopic physics), condensed matter physics (maybe also "ill-condensed matter" physics), even if the later type of activity is not usually carried out, in France, within centers of theoretical physics.

Given the strong support phrased by NCKU's Vice-President, as well as the already existing contacts, QIT might be currently the most promising area for creating concrete common projects, be it on the level of organizing a joint winter-school, or actual scientific collaboration. This might also be beneficial for the QIT community in Taiwan itself, as although there exist an NCTS focus group on QIT, collaborations in Taiwan seem to remain geographically localized in the area of Tainan. One could imagine that increased cooperation with scientists in France could also enhance the links within this community, in Taiwan.

The strong presence and level of mesoscopic physics in Taiwan as well as in France, combined with the fact that there are apparently no bilateral French-Taiwanese endeavors in this field, makes this another area that could profit a lot from mutual cooperation. Some of the mesoscopic physics community overlaps with the QIT community, but the scope of common interests and strengths in this field goes beyond QIT. Such cooperations always start from personal contacts, of course, and one might therefore hope that QIT could function as a nucleus from which cooperation might spread further into the wider mesoscopics community.

A last level of French-Taiwanese collaborations may involve activities that are not much developed in Taiwan, for historical reasons. Here we return to a discussion that the delegation had in Taipei with the Director General for International Relations of the NSC (Professor Ching-Ray Chang). For such activities, like for instance investigations made in various fields of mathematical physics, ranging from operator algebra to geometry (classical, i.e. Riemanian or symplectic, or quantum), as well as the study of quantum algebras in relations with integrable systems, mechanics, conformal quantum field theories, etc., activities that are mostly absent of the Taiwanese scientific landscape but are well represented in France, one could organize thematic conferences in Taiwan, for instance at NCTS, in Hsinchu, that could be of interest both for mathematicians and theoretical physicists,

faculty members or Ph.D. students. This last type of possibility relies of course, on positive decisions that could be taken at some high level, by those persons managing the scientific activities in Taiwan.

Mathematics

The natural partner for French-Taiwanese cooperation in mathematics (and, to some extents, theoretical physics) in Taiwan is NCTS: this center is a national institution, covering the whole island, promotes research at an excellence level, is well organized, and has strong resources at its disposal. On the French side, the operator should be the CNRS through its "INstitut des Sciences Mathématiques et de leurs Interactions" (INSMI), in cooperation with its "Direction des Affaires Internationales". For this discipline the programme ANR/NSC does not seem an appropriate tool as it a priori focuses on areas of priorities set by the government, and mathematics is not presently a priority on the French side.

Remark.

Pascal Chossat (Deputy director in charge of Foreign Affairs for the INSMI) is interested in the present initiative, started by FIT, and would like to be kept informed of any project that could follow, in order to involve INSMI directly.

Conferences

Conferences by JPB

23.10.2009, National Taiwan University (NTU), Taipei
Ricci curvature and measures
26.10.2009, National Center for Theoretical Sciences (NCTS), Hsinchu
Ricci curvature and measures
27.10.2009, National Tsing Hua University (NTHU), Hsinchu
The Ricci Curvature, as an Active Link between Mathematics and Theoretical Physics.

Conferences by DB

23.10.2009 National Cheng Kung University (NCKU) & NCTS (South) seminar, Tainan
Decoherence - foe or friend?
26.10.2009, National Center for Theoretical Sciences (NCTS), Hsinchu
Decoherence - foe or friend?
28.10.2009, National Taiwan Normal University (NTNU), Taipei
Decoherence - foe or friend?

Conferences by RC

21.10.2009, National Taiwan University (NTU) & NCTS (North), Taipei
Quantum subgroups of Lie groups and modular invariance in conformal field theory
23.10.2009 National Cheng Kung University (NCKU) & NCTS (South) seminar, Tainan
Quantum subgroups of Lie groups and modular invariance in conformal field theory
26.10.2009, National Center for Theoretical Sciences (NCTS), Hsinchu
Fusion graphs for Lie groups at level k.

Conferences by GL

21.10.2009 TIMS Seminar, National Taiwan University (NTU), Taipei
The order of a unimodular matrix modulo n
23.10.2009 National Cheng Kung University (NCKU) & NCTS (South) seminar, Tainan
The order of a unimodular matrix modulo n
26.10.2009, National Center for Theoretical Sciences (NCTS), Hsinchu
A question of Serre on Jacobian of genus 3.