CIMPA RESEARCH SCHOOL PROPOSAL

Please read carefully the roadmap.

Deadlines:
***pre-proposal** June 15 (fields with*), **complete proposal** October 1st.*
Please respect these dates. Exceptional cases may be considered.

*A similar project has been submitted to CIMPA last year or the previous one.

NO

*We have completely read, we have understood and we will apply the points of the roadmap. **Non-compliance may result in the withdrawal of CIMPA**.

YES

*Title of the Research School (neither too general nor too long and without acronyms)

Tilings and related topics

The project is rather mixed (made of fundamental, applied and/or interactions)

***Only** the two digits of the 2010 Mathematics Subject Classification that mainly concern your project.

52

*Place and dates (**two** precise and **also** possible periods, the final choice will be made in February or March next year by CIMPA doing our best for retaining option A).

Lieu / place : Isfahan, Iran
Dates A : 19-30 january
Dates B : 24 august – 4 september

***Exactly** two administrative and scientific mathematician coordinators (one local and one working in France, Spain, Norway or Switzerland). They will be active, present during the Research School and responsible for

everything, in particular with respect to CIMPA.

Name: Thomas Fernique
Place of work : University Paris 13, France
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Name: Amir Hashemi
Place of work: Isfahan University of Technology
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*Short abstract of the scientific content.

This school is devoted to mathematical aspects of tilings in the various contexts where they appear, with an effort to achieve coherence of the program:

- discrete geometry (models of discrete surfaces)
- computability (local constraints on the way tiles can fit model transportation of information, similarly to the local rules of cellular automata)
- probability (convergence of stochastic processes on tilings, in particular random sampling, and typical properties of random tilings)
- combinatorics (counting the number of ways a region can be tiled)
- symbolic dynamics (coding trajectories of minimal non-periodic dynamical systems)
- effective algebraic geometry (use of Groebner basis to check tileability of a region or existence of a characterization by local patterns)
- ...

In addition to these “classical” themes, we also plane to include lectures related to the rich historical heritage of Isfahan (and more generally the islamic world), where tilings with quasicrystalline symmetries can often be found on architectural buildings. The Isfahan Mathematics House has already organized workshops on such thematics.

Gender balance is an important point for the entire evaluation of your project.

*Who will be the members of the Scientific Committee? All of them will need to participate in the Research School and give at least a lecture. Normally not more than five persons and from at least three different countries. Indicate their role and their email.

- Béatrice De Tillière, assistant professor, beatrice.de_tiliere@upmc.fr (France)
- Thomas Fernique, junior researcher (CNRS), fernique@lipn.fr (France)
- Chaim Goodmann-Strauss, professor, strauss@uark.edu (USA)
- Amir Hashemi, assistant professor, amir.hashemi@cc.iut.ac.ir (Iran)
- Ali Rejali, professor, a_rejali@cc.iut.ac.ir (Iran)
- Olivier Bodini, professor, bodini@lipn.fr (France)

Quels seront les membres du comité d'organisation local? Normalement pas plus que cinq, précisez le rôle de chacun d'eux et leur courriel.
Who are the members of the local organizing committee? Normally not more than five; indicate the role of each one and their email.

- Dr. Amir Hashemi (amir.hashemi@cc.iut.ac.ir): general organization
- Dr. Ramin Javadi (rjavadi@cc.iut.ac.ir): local accommodation
- Dr. Ms. Behnaz Omoomi (bomoomi@cc.iut.ac.ir): venue of non-local students
- Prof. Ali rejali (a_rejali@cc.iut.ac.ir): logistic at IMH

Describe in a few lines the local institution related to this project, provide its internet site and its main mathematical subjects. Describe the plan for the website for the Research School and/or give a temporary site.

There are two local institutions related to this project: the Isfahan Mathematics House (IMH, website: http://www.mathhouse.org) and the Isfahan University of Technology (IUT, website: http://www.iut.ac.ir/en/).

The IMH has been created in 1997, within the framework of an agreement signed between Isfahan Municipality and Ministry of Science, Research and Technology. Prof. Dr. Ali Rejali, as a Chairman of the Scientific Committee of the First Iranian Mathematics Education, played a crucial role in this creation. It was the first Mathematics Houses, and other have since been opened through the country. Mathematics Houses play a great role in the mathematic formation of teachers, as well as in the training of students for mathematical competitions (e.g., International Olympiad of Mathematics). The IMH works in close cooperation with universities (in particular the IUT) and secondary school. It has a great experience in organizing workshop or school (including thoses in connection with arts or architecture).

Opened in 1977, the IUT is one of the most prestigious engineering universities in Iran. There are currently around 10000 students, including 2500 post-graduates, enroled in 12 departments. The department of mathematical sciences has a broad-spectrum which notably include discrete mathematics and combinatorics.

*Give the motivation for this Research School proposal and the activities planned around it.

On the one hand, the theory of aperiodic tilings, born in the academic world in the 1960's and flourishing since the discovering of quasicrystals in 1982, turned out to have connections with the century-old tilings appearing in the islamic architecture. These connections have only recently been revealed in the academic world – e.g. in the resounding papers by Peter Lu and Paul Steinhardt, published in 2007 in Science, which exposed connections between the shrine of Darb-e Imam in Isfahan and the Penrose tilings (such connections have earlier been drew by our lecturer Emil Mackovicky, but remained more confidential).

One the other hand, most of french participants in this project are mathematicians or theoretical computer scientists involved in a mathematical research project which focuses on the structure and growth of aperiodic tilings. We are funded until 2017 and already applied for the organization of a thematic trimester in 2016 at the Institute Poincaré (Paris) on these thematics (mixing conference and school).

We thus thought that it would be challenging to also organize a more original event which would use historical tilings as an impulse to promote scientific interest towards tiling theory. As such, Isfahan appeared to be one of the better location for several reasons:

- The city is particularly rich in worldwide renowned historical tilings.
- The country has good infrastructures and is at the crossroads of Middle-east and Asia: this could offer a good opportunity for many students from the whole country as well as from neighbouring countries.
- A good contact was already established between Amir Hashemi and Olivier Bodini, while they both were in university Paris 6. This allowed to extend this contact to the IMH, which seems to us to be an ideal framework for such a school (as a bridge between several universities and a rich experience of such events).
- The number of good and motivated students seems to be high (one can for example mention the major successes achieved by Iran in the International Olympiads of Mathematics – where IMH and other Mathematics Houses play a prominent role). Such students could then be interested to explore this topic further by participating to the above mentioned thematic trimester in Paris.

Describe the related scientific work and training already carried out locally. What impact is expected? How many young - see the Road Map - should participate (locally, from your country, and from neighbouring countries)?

At this time, there is few related scientific work and training already carried out. The IMH however already asked for some scientific papers that could be advised to students willing to prepare the school (recall that many scholar and students spend time to IMH in order to learn more mathematics).

Oliver Bodini, Amir Hashemi and Thomas Fernique applied in mid-june 2013 for a Partenariat Hubert Curien (PHC Gundishapur), that is a two-years iranian-european funding to support emerging collaborations between both countries (in particular travel support). The project aims to study effective algebraic geometry for tilings, and is thus partly connected with this project of a CIMPA school. Two 10-days visit in Iran are planned, and shall also allow to discuss, in addition, the preparation of the CIMPA school.

The expected impact is to enhance the thematics of the school in Isfahan and to initiate new collaborations between Iran and Europe (especially France, from where most of the lecturers are), for example along the lines of Amir Hashemi, who came in Paris 6 to did his Ph. Thesis and then returned to Iran with this experience. We also hope to make a (modest) contribution to the scientific relations between Iran and its neighbours, through the venue of foreign students.

We expect around 40 young non-local to participate to this school, mostly from Iran (which is a big country with several universities in other cities), but also from what is sometimes called “the greater Iran” (that are neighbouring countries with strong cultural links: Tadjikistan, Afghanistan, Turkmenistan, Ouzbekistan, Azerbaidjan, Armenia, eastern Turkey and Irak, western Pakistan).

Describe briefly the infrastructure of the place where the Research School will take place and how you get there and ensure safety for participants. Will at least 25 accommodation places be available for young mathematicians from neighboring developing countries?

The IMH is a modern building located near the historical center of Isfahan. Schools combining lectures and tutorials are regularly held there, so that the conditions are ideal: a large lecture room with the required material and classroom for tutorials.

The IUT is designed and planned directly based on models of MIT and University of Illinois Urbana-Champaign. It is located on a moder campus, north-east of Isfahan historical center and has a guest house which shall very affordably accommodate the non-locals.

IUT and IMH are however almost 30km away. Therefore, we are looking for a possible accommodation that would be nearer to IMH (if impossible or much more expensive, we will organize shuttle between IMH and IUM).

Lunches and evening meals shall be served in a canteen close to IMH.

Isfahan is a safe city, for foreigners as for local, at least if basic infringement are avoided (we will brief non-locals before their venue).

Courses, lecturers and abstracts (written by the lecturers) of 10 lines each. Members of the Scientific Committee must participate.

Long courses (6h each, including tutorials) :

- Symbolic dynamics (Nicolas Bédaride/Mathieu Sablik)
- Random Tilings (Béatrice De Tillière/Cédric Boutillier)
- Substitutive tilings (Edmund Harriss/Chaim Goodmann-Strauss)
- Flip dynamics (Eric Rémila/Olivier Bodini/Damien Regnault)
- Self-assembly (Florent Becker/Eric Rémila/Chaim Goodmann-Strauss)
- Cellular Automata (Guillaume Theyssier/Mathieu Sablik/Damien Regnault)

Shorter courses (from 1h to 4h):

- Order and symmetry of tilings (Thomas Fernique)
- Effective algebraic geometry and tilings (Amir Hashemi/Olivier Bodini)
- Analytic combinatorics and tilings (Frédérique Bassino/Olivier Bodini)
- Islamization and escherization of tilings (Craig Kaplan)
- Tilings in contemporary architecture (Jean-Marc Castera/Jay Bonner)
- Tilings in historical architecture (Emil Makovicky/Jan P. Hogendijk)
- Tilings in physics (Mohammad Taghi Tavassoli)
- Tilings and mathematical teaching (Akbar Zamani/Meghdad Ghari/Ali Rejavi)

Abstracts will be given in the full proposal (october).

Provide a tentative schedule (**at most six hours each day**, normally Wednesday afternoon is free).

Monday:
AM: Introducing mathematics houses (A. Rejavi)
AM: Introducing the CIMPA (?)
PM: Tilings in physics (M. T. Tavassoli)
PM: Tilings and mathematical teaching (A. Zamani/M. Ghari)

Thursday:
AM: Order and symmetries (Th. Fernique)
PM: Islamization and escherization of tilings (C. Kaplan)

Wednesday:
AM: Tilings in historical architecture (E. Makovicky/J. P. Hogendijk)
PM: Tilings in contemporary architecture (J.-M. Castera/J. Bonner)

Tuesday:
AM: Effective algebraic geometry and tilings (A. Hashemi/O. Bodini)
PM: Analytic combinatorics and tilings (F. Bassino/O. Bodini)

Friday:
Excursion

Saturday:
Substitutive tilings (E. Harriss/Ch. Goodmann-Strauss)

Sunday:
Symbolic dynamics (N. Bédaride/M. Sablik)

Monday:
Cellular Automata (G. Theyssier/M. Sablik/D. Regnault)

Thursday:
Self-assembly (F. Becker/E. Rémila/Ch. Goodmann-Strauss)

Wednesday:
Random Tilings (B. De Tillière/C. Boutillier)

Tuesday:
Flip dynamics (E. Rémila/O. Bodini/D. Regnault)

Friday:
Excursion

Please insert **two** tables: one with the provisional budget, the other with anticipated funding (confirmed, required or provisional). Read the *roadmap* concerning the possible use of CIMPA funding.

Previsional budget (in euros)

- travel of 20 non-local lecturers : 12x600e (France) + 4*1600 (USA) +2*600 (NL) = 14800
- travel of 40 non-local students : 40x150=6000

- accommodation of 60 non-locals (12 nights & evening meals) : 60x16x12=10800
- lunches : 100x5x11=5500
- Excursions : 1000

Total : **38100** euros

Anticipated funding:

- French grant Quasicool (ANR) : 7000 euro (confirmed)
- CIMPA : 12000 (requested)
- French grant Magnum (ANR) : 600 (requested)
- CNRS (formation permanente) : 3000 (provisional)
- Univ. Paris 13, Paris 6, Savoie, Marseille, Evry, Orleans : 6x1000=6000 (provisional)
- ICTP : 3000 (provisional)

Total : **31600** euros.

We plane to search fo the 6500 remaining euros in several directions. In particular, we hope to find independent funding for travels of lectures on arts/architecture (Jay Bonner, Jean-Marc Castera, Emil Mackovicky, Jan Hogendijk, 3400 euros). We also would like to find some support in Iran : Isfahan University of Technology, Institute for Advanced Studies in Basic Sciences (IASBS), Center for International Research and Collaboration (ISMO), Office of Scholarships of the Iranian Ministry of Science and Technology...). The experience of the IMH and IUT in organizing conferences should be helpful. We also will ask Rashid Zaare-Nahandi, a colleague of Amir Hashemi, who has organized a CIMPA School in Zanjan in 2005.

SUMMARY POINTS to be filled by yourself:

What percentage of women?

a) In the Scientific Committee
b) In the Local organisation committee
c) which will give a course ?

a) 1/5 b) 1/5 c) 1/11

How much are you applying to CIMPA (2/3 at least will be for young mathematicians) and what percentage this represents of the anticipated financing?

12000 euros, 32% of the anticipated financing

How many young people from the region (not local ones) might be involved?

40

What is the average time per day of scientific activities and during how many days?

6h, 10 days (+1 free day)

You will be notified of the Scientific Committee's advice and the Steering Council decision by the end of January or beginning of February of next year. It may be possible that the Scientific Committee will request more details or changes at the beginning of December.

In all cases keep the lecturers informed. It's up to you to confirm their participation and to ask them to try to take care of their ticket with their own funding. This will allow CIMPA to allocate more funding to young people from neighbouring countries.

*Please confirm: we have completely read, we have understood and we will apply the points of the roadmap. This is crucial and will avoid misunderstandings.

November 2012