Science Meeting – Scientific Report

Proposal Title*:* **Winter Braids IV**

Application Reference N°*:* **4889**

1)   **Summary (up to one page)**

Winter Braids is an international doctoral school on low dimensional topology, with a particular emphasis on braid groups, their generalisations and applications in other domains. The school is held each winter since 2010, and is hosted each year by a different french university. The fourth edition, Winter Braids IV, took place in Dijon from february 10th to 13th, 2014, while the previous editions were organised in Pau (December 2010), Caen (December 2011) and Grenoble (December 2012).
The school typically offers four to five mini-courses (three hours each) on classical or emerging topics of our research area, and gives in addition the opportunity to the young participants (students and posdocs) to present their own work through thirty minutes talks.
The mini-courses of this fourth edition were dedicated to mapping class groups, Khovanov homology, Lefschetz fibrations and interactions with mathematical physics. The organisers selected 21 short talks, covering a wide spectrum of topics in topology, in particular braid groups and generalisations, knot theory, Khovanov and Heegaard-Floer homology and quantum and classical invariants of 3-dimensional manifolds.
This was the most successful edition of Winter Braids, both in terms of the quality (and quantity) of student talks, and of the number and diversity of the participants (62 participants, including 50 PhD students or postdocs, coming from universities in 14 countries).
All informations on the school are available on the conference homepage, at http://winterbraids.math.cnrs.fr/.

2)   **Description of the scientific content of and discussions at the event (up to four pages)**

The four mini-courses covered a wide range of topics on low dimensional topology and interactions. Below is a short description for each of them.

. Luis Paris (Dijon) gave three lectures on the mapping class group for non orientable surfaces. A strong emphasis was put on the basics of mapping class group (including proofs of some key results in the orientable case), and on pointing out the basic new features and objects that arise in the non orientable settings. The structure of the mapping class group of non orientable surfaces of low genus has been fully described.

. David Cimasoni (Geneva) gave three lectures on dimers models, which are combinatorial objects which arise in various fields, such as geometry and Teichmuller theory, or more recently knot theory. One of the main goal of the lectures was to show how purely geometrical tools, such as (co)homology, spin structures, or real algebraic curves, can be applied in very natural problems in combinatorics and statistical physics. The fundamental work of Castelyn has also been covered in details.

. The mini-course by Benjamin Audoux (Marseille) was devoted to the categorification of polynomial link invariants and their applications. More precisely, the main goal was to give a complete construction of the Rasmussen invariant, from Khovanov homology, and to prove, in a purely combinatorial way, some of its celebrated applications on the slice genus of knots (Milnor conjecture).

. Nermin Salepci (Lyon) explored topological and geometrical properties of Lefschetz fibrations, with a particular emphasis on the case of dimension 4. The first half of the lectures was devoted to topological properties and known classification results, while the latter half focused on relations to symplectic manifolds and open book decompositions, as well as contact structures on 3-dimensional manifolds.

The short talks by students and postdoc were in general of a remarkable quality, providing a wide spectrum of topics in topology and interactions.
The main objects, as in previous editions, were braid groups, related algebras, generalisations and applications in low dimensional topology. In particular the talks covered notions such as signatures of (positive) braids, braid equivalences in 3-manifolds, Temperley Lieb algebras and Burau (symplectic) generalisations, surface braid groups, virtual and welded braids.
But other short talks broadened very nicely the spectrum of topics of the conference, by addressing topics such as classical and quantum invariants of knots and 3-manifolds, TQFT, mapping class groups (coverings and quantum representations), hyperplane arrangements, categorification (Heegaard–Floer and Khovanov homologies) and applications of dimers to knot theory.

The result is a great overview of current research activity in Europe in low-dimensional topology, focused on braids and related topics.

3)   Assessment of the results and impact of the event on the future directions of the field (up to two pages)

The goal of the doctoral school Winter Braids, is to bring together students in low-dimensional topology and, through these mini-courses, provide them a foundation of common knowledge, which would generate interactions and collaborations amoung the coming generations of researchers in France an Europe on braids and their ramifications.

In this respect, we can safely say after this fourth edition that Winter Braids is becoming a landmark in the European landscape of doctoral schools in mathematics. The always increasing number and diversity of the participants (more than 200 in four editions) is a clear sign. The last edition counted 66 registered participants, among which 50 students or postdocs, with a wide european and international representation (England, Italy, Spain, Greece, Denmark, Sweden, Switzerland, Belgium, Russia, Israel, Brazil, Mexico, Japan, USA and France). The success of the school is also manifested by the fact that many attendants of the first editions were again present in 2014.

Its organisation (itinerary school, with lectures mainly devoted to students and covering several topics in low dimensional topology, short talks only by PhD students and postdocs, full coverage of local expenses and possibly of travel expenses for students) also makes it a quite unique conference in Europe.

In view of this increasing dimension and success, we asked this year to all participants to fill a detailed questionnaire, in order to let us know their appreciation of the conference organisation, and of the various lectures and talks. The results have been very satisfactory, and shall be very useful for the next editions of Winter Braids. The main positive points were the quality of the lectures (their clearness), the possibility to let students and postdoc present their result in front of an international audience, and the pleasant and stimulating atmosphere of the conference. The negative point was the density of the program (as can be judged below): we have decided, for future editions, to reduce the number of talks, and possibly to organise a poster session.

4) Annexes 4a) and 4b): Programme of the meeting and full list of speakers and participants

Annex 4a: Programme of the meeting

	Monday 10th	Tuesday 11th	Wednesday 12th	Thursday 13th
9:00 - 9:30	*Registration*	SALEPCI I	AUDOUX II	CIMASONI III
9:30 - 10:00	PARIS I			
10:00 - 10:30		*Coffee Break*	*Coffee Break*	*Coffee Break*
10:30 - 11:00	*Coffee Break*	PARIS II	SALEPCI II	AUDOUX III
11:00 - 11:30	CIMASONI I			
11:30 - 12:00		Guerville	Egsgaard	SALEPCI III
12:00 - 12:30	Moussard	Bailet	Joergensen	
	Lunch	*Lunch*	*Lunch*	*Lunch*
14:15 - 14:45	AUDOUX I	CIMASONI II	PARIS III	Robert
14:45 - 15:15				Hammarsten
15:15 - 15:45	Ben Aribi	Magot	Maldonado	Diamantis
15:45 - 16:15	Korinman	Cohen	Gobet	Goundaroulis
16:15 - 16:45	*Coffee Break*	*Coffee Break*	*Coffee Break*	
16:45 - 17:15	Bourrigan	Dalvit	de Miranda e Pereiro	
17:15 - 17:45	Feller	Cisneros	Mikhalchishina	

Titles of lectures and short talks (abstracts available at the conference homepage)

MINI COURSES

Benjamin Audoux (Marseille): *The Rasmussen invariant*

David Cimasoni (Genève): *The geometry of dimer models*

Luis Paris (Dijon): *Non orientable mapping class groups*

Nermin Salepci (Lyon): *Lefschetz fibrations*

SHORT TALKS

Pauline Bailet (Nice): *On the monodromy of Milnor fibers of hyperplane arrangements*

Fathi Ben Aribi (Paris): *The L^2-Alexander invariant detects the unknot*

Maxime Bourrigan (Lyon): *Braids, signatures and the Blanchfield form*

Bruno Cisneros (Dijon): *The genus of a virtual braid*

Moshe Cohen (Haifa): *Dimers from knots*

Ester Dalvit (Trento): *Visualization of welded knots and ribbon 2-knots*

Carolina De Miranda e Peirero (Caen): *The Lower Central and Derived Series of the Braid Groups of the Torus and of the Klein bottle*

Ioannis Diamantis (Athens): *Braid equivalence in 3-manifolds with rational surgery description*

Jens Kristian Egsgaard (Aarhus): *The Jones representations of braid groups at q = -1 (Part I)*

Peter Feller (Bern): *The signature of positive braids is linearly bounded by their genus*

Thomas Gobet (Amiens): Temperley-Lieb algebras and Zinno's basis

Dimos Goundaroulis (Athens): *Framization of the Temperley-Lieb Algebra*

Benoit Guerville (Pau): *A topological invariant of line arrangements*

Carl Hammarsten (Washington): *Heegaard Floer Homology and Branched Spines*

Soeren Fuglede Joergensen (Uppsala): *The Jones representations of braid groups at q = -1 (Part II)*

Julien Korinman (Grenoble): *Decomposition of quantum representations*

Miguel Maldonado (Caen): *Mapping class groups and coverings*

Jean-Mathieu Magot (Grenoble): *Combinatorial review of the relation $\Theta = \lambda_{CW} + p_1/4$*

Yuliya Mikhalchishina (Novosibirsk): *Local Representations of braid groups*

Delphine Moussard (Pisa): *Equivariant triple intersections*

Louis-Hadrien Robert (Strasbourg): *Grothendieck groups of Khovanov-Kuperberg algebras*

Annex 4b: Full list of speakers and participants

Pham Anh Minh (Université de Genève)

Arcis Diego (Université de Bourgogne)

Audoux Benjamin (Aix-Marseille Université)

Bailet Pauline (Université Nice-Sophia Antipolis)

Bavard Juliette (Paris VI)

Bégassat Olivier (Paris VII)

Bellingeri Paolo (Université de Caen)

Ben Aribi Fathi (Paris VII)

Bonatti Christian (Université de Bourgogne)

Bourrigan Maxime (ENS Lyon)

Cimasoni David (Université de Genève)

Cisneros Bruno (Université de Bourgogne)

Cohen Moshe (Technion - Israel Institute of Technology)

Corbineau Kévin (Université Grenoble I)

Couture Olivier (Université de Bourgogne)

Dalvit Ester (Università di Trento)

Damiani Celeste (Université de Caen)

Dehornoy Pierre (Université de Grenoble I)

de Miranda e Pereiro Carolina (Universidade de São Carlos)

Diamantis Ioannis (National Technical University of Athens)

Donzeau Cédric (Université de Bourgogne)

Dubouloz Adrien (Université de Bourgogne)

Egsgaard Jens Kristian (Aarhus Universitet)

Epstein Baruch (Technion - Israel Institute of Technology)

Feller Peter (Universität Bern)

Fenn Roger (Sussex University)

Florens Vincent (Université de Pau)

Fuglede Jørgensen Søren (Uppsala Universitet)

Geneste Olivier (Université de Bourgogne)

Gobet Thomas (Université de Picardie)

Goundaroulis Dimos (National Technical University of Athens)

Guerville Benoît (Université de Pau)

Guaschi John (Université de Caen)

Hammarsten Carl(George Washington University)

Ibanez Elsa (Université Montpellier II)

Iqbal Zaffar (Université Grenoble I)

Humbert Philippe (Université de Genève)

Kohli Ben-Michael (Université de Bourgogne)

Korinman Julien (Université Grenoble I)

Kotorii Yuka (Tokyo Institute of Technology)

Lallouche Mickael (Université Montpellier II)

Lecuona Ana (Aix-Marseille Université)

Magot Jean-Mathieu (Université Grenoble I)

Maldonado Miguel (Université de Caen)

Meilhan Jean-Baptiste (Université Grenoble I)

Mikhalchishina Yuliya (Sobolev Institute of Mathematics)

Mignard Michaël (Université de Bourgogne)

Moussard Delphine (Università di Pisa)

Oussama Ajbal (Université de Caen)

Paris Luis (Université de Bourgogne)

Petitjean Charlie (Université de Bourgogne)

Robert Louis-Hadrien (Université de Strasbourg)

Rosalie Martin (Université de Rouen)

Salepci Nermin (Université Lyon I)

Skorokhod Natalia (Technion - Israel Institute of Technology)

Trujillo Negrete Alejandra (Universidad Nacional Autónoma de México)

Vaz Pedro (Université Catholique de Louvain)

Viu Sos Juan (Université de Pau)

Yasuhara Akira (Tokyo Gakugei University)

Yurttas Saadet Oyku (Dicle University)

Wagner Emmanuel (Université de Bourgogne)

Wenzel Ansgar (Sussex University)