

SCIENCE MEETING – SCIENTIFIC REPORT

Proposal Title: Symposium in honor of Alan Weinstein

Application Reference Number: 4878

1. SUMMARY

Alan Weinstein has deeply influenced various fields of mathematics during the last 40 years, notably the fields of geometry and mathematical physics. The “Symposium in honor of Alan Weinstein” celebrated Alan Weinstein’s 70th birthday. It took place at the Institut Henri Poincaré (Paris), 18-20 July, 2013. The location of the celebration reflects the close contact that Weinstein had with the French mathematical community during the past decades.

During the 3 days of the workshop a total of 18 talks took place, each of them 30 minutes in length followed by a 5-10 minutes question and discussion session. It was attended by 38 registered participants.

All the talks were given by former Ph.D. students of Alan Weinstein. The result was a panoramic overview of Weinstein’s mathematical interests during the whole of his career, allowing to present how Alan Weinstein’s mathematical work has been continued and brought further by the generations of mathematicians that followed him. The focus was on the fields of symplectic geometry and mathematic physics.

The workshop also provided a unique opportunity for former Ph.D. students of Weinstein – belonging to different mathematical generations – to get to know each other and each other’s mathematical work. Further, a few former students who left academia, and now work in Educational Foundations or in the financial world, reported on how their mathematical education affected the activity they are currently undertaking. This made the workshop a very interdisciplinary event.

Scientific Organizer:

Marco Zambon (Universidad Autónoma de Madrid and ICMAT, Spain, marco.zambon@uam.es).

Advisory committee:

Xiang Tang (Washington University in St. Louis, USA),
Ping Xu (Penn State University, USA),
Marco Zambon (Universidad Autónoma de Madrid and ICMAT, Spain).

2. DESCRIPTION OF THE SCIENTIFIC CONTENT OF AND DISCUSSIONS AT THE EVENT

2.1. **Scientific content of the event.** The workshop focussed primarily on the subjects of **symplectic geometry** and **mathematical physics**, and within them:

- Symplectic geometry
- Symplectic topology
- Poisson geometry
- Non-holonomic mechanics
- Theory of supermanifolds
- Lie theory and higher Lie theory
- Partial differential equations
- Foliation theory

Further, a few talks addressed:

- Mathematics education
- The role of mathematical models in modern finance

Among the topics mentioned above, Poisson geometry was a central element of many talks (Lu, Zambon, Fraenkel), as was the case for symplectic geometry (the talks of Oh, Bursztyn, Seyfaddini). The full list of talks and titles is to be found in the Annex.

2.2. **Discussions at the event.** The somewhat informal nature of the workshop allowed for **very active question and discussion sessions** after each talk. We mention here only the most significant instances.

- Xu’s talk generalized a classical result known as Emmerich-Weinstein Theorem. It does so using techniques recently developed and recent theorems about Lie pairs. Unfortunately the limited time didn’t allow for a sketch of the proofs.
- Several talks addressed the role of mathematics in modern finance (Bates, Yan, Qian). These talks caused several questions to arise, in particular as to what extent it is possible to have mathematical models which make reliable predictions or permit to maintain the stability of a financial system. A result of the discussion is that – unlike typical situations in pure mathematics – in finance it is often not clear what the “correct” input to feed into the models is, and this ambiguity affects in a deep way the outcomes of the models.
- Roytenberg’s talk was a nice overview of a topic which is currently quite “hot”, and therefore hard to follow as it is not fully developed and evolves quickly. The topic is the use of differential graded manifolds in order to model two types of singularities: quotient singularities and subspace singularity (i.e., those arising from intersections). While a good part of the audience was familiar with differential graded manifolds, only a small part was aware of how they could be used to model singularity, and in this sense the talk by Roytenberg proved to be very enlightening.
- Tang’s talk “Integration of exact Courant algebroids” reported on very recent work. It proposes, among other things, an integration of Courant algebroids with the property that it contains the integrations of the “subobjects” of Courant algebroids (Dirac

structures). The question about the existence of an integration with this property was posed about 18 years ago, and was reiterated by Weinstein about a year ago, at the beginning of the seminar on integration of Courant algebroids that he instituted at U.C. Berkeley. Several of the people present at the workshop participated, in a way or another, to this seminar, hence were particularly interested in Tang's results.

- Zambon's talk was about deformations of certain structures (coisotropic submanifolds). The talk arose some interest not only because one of the experts on the subject (Oh) was in the audience and asked pertinent questions, but also because it offered a different perspective to several other people who encounter naturally coisotropic submanifolds in their work.
- Fraenkel's talk provided a good illustration of how problem is addressed and progress made over several years. The problem of embedding (locally) singular quotients of symplectic manifolds into a Poisson manifold arose in the 80's. (As pointed out during the workshop, for the first time it was addressed by Darryl Holm). Several students of Weinstein worked on the problem (Davis, Egilsson, Fraenkel), allowing for a nice historical overview of the subject during the talk. Fraenkel's results were in part proven thanks to mathematical software, which takes care of computations that are not achievable by hand. The techniques are very close to algebraic geometry, and during the question session Crainic raised the possibility to approach the problem using techniques of Dirac geometry. Further, Gualtieri pointed out that the embedding problem is in close analogy to a another seemingly unrelated problem, namely whether every singular foliation locally arises from a Lie algebroid. (In both problems, one has to remedy the fact that the Jacobi identity is not satisfied, but choosing suitable extensions).
- Seyfaddini's talk, which fits into the domain of symplectic topology, was probably the one that raised the most interest and questions. This is due to the fact that the results presented were easy to state (even though extremely hard to prove), and that they concerned a setting which doesn't fit within usual symplectic geometry, but rather a "limit" of it. (More precisely, Seyfaddini considered homeomorphisms which are C^0 -limits of symplectomorphisms). Except for few people (Weinstein, Oh), the audience was much more familiar with symplectic geometry than symplectic topology. This talk provided a good illustration of the phenomena that can occur when one replaces symplectomorphisms by homeomorphisms which are C^0 -limits of such.

3. ASSESSMENT OF THE RESULTS AND IMPACT OF THE EVENT ON THE FUTURE DIRECTIONS OF THE FIELD

The workshop allowed to have an overview of the areas of mathematics that Alan Weinstein work on along his whole career. These areas cover a very wide spectrum within mathematics but of course are related to each other, either by having a common final goal (take for example quantization) or by having common techniques. As a result, many participants were exposed to topics that were new to them, but which they could relate to their field of expertise, proving a precious learning experience.

The impact on future research, in the medium-short term, comes from the fact that the workshop addressed **current research problems in which several of the participants gave fundamental contributions and are still actively working**. To mention a few:

- Both the talks of Roytenberg and Zhu were about so-called **higher structures** and their role in modern geometry. The former focussed more on the infinitesimal aspects (differential graded manifolds, L_∞ -algebras), while Zhu focussed on the global ones (Kan complexes). **The interplay between the two points of view** is essential to the future progress in the field. Several participants work actively on higher structures (Blohmann, Laurent-Gengoux, Shapira, Zambon, among others), and profited from the talks and discussions around this topic.
- Only one talk addressed **symplectic topology**, namely the one by Seyfaddini, but that one talk caught lots of attention. Among the participants there were people who gave fundamental contributions to symplectic topology during the last 30 years (Oh and Weinstein among all). The results discussed in the talk are very recent and represent the state of the art, so the talk was particularly profitable for the experts in the audience. In particular, the work on **coisotropic submanifolds** on which Seyfaddini reported should be of importance for work of Viktor Ginzburg on the intersection properties of the leaves of coistropic submanifolds.
- The contribution of Tang represents a consistent step toward a geometrically satisfactory **integration of Courant algebroids**. As mentioned earlier, in particular, it answers a question posed 18 years ago. Some of the people who actively worked on the problem of constructing integrations of Courant algebroids were in the audience, namely Weinstein and Zhu. The main 3 works on this integration problem which have appeared recently were authored by Severa-Li Bland, Metha-Tang and Sheng-Zhu. The workshop gave a strong impulse to the **comparison and eventual unification** of the 3 constructions mentioned. This of course is of big importance in this field of current research, which is taking shape at this moment and hopefully will reach its final form in the next years.

4. ANNEXES

Annex 4a: Programme of the meeting

The programme of the meeting follows on the next page.

Schedule

All the talks will take place in “Amphitheatre Hermite”.

Thursday 18th

10:00-10:10		Opening speech
10:10-10:40	Koiller	Dynamic Markov-Dubins problems
		<i>Tea break</i>
11:00-11:30	Oh	Geometry of generating functions and Lagrangian spectral invariants
11:40-12:10	Filho	Nonlinear stability of counterrotating vortex pairs
		<i>Lunch break</i>
2:00-2:30	Lu	Examples of Poisson brackets
2:40-3:10	Xu	Emmrich-Weinstein Theorem
		<i>Tea break</i>
3:30-4:00	Bates	TBA
4:10-4:40	Yan	Introduction to convertible bonds
5:00-5:30		Open discussion
5:30		<i>Reception</i>

Friday 19th

10:00-10:30	Qian	How to deal with Chinese SOEs
		<i>Tea break</i>
10:50-11:20	Kathotia	From mathematics to mathematics education
11:30-12:00	Roytenberg	Differential Graded Manifolds
		<i>Lunch break</i>
2:00-2:30	Bertelson	Yet another point of view on affine geometry
2:40-3:10	Bursztyn	Generalized Marsden-Weinstein reduction and instantons
		<i>Tea break</i>
3:30-4:00	Tang	Integration of exact Courant algebroids
4:10-4:40	Zambon	Coisotropic submanifolds and deformations
		<i>Break</i>
5:00-5:30	Zhu	Higher Lie groupoids and their actions
8:00		<i>Banquet</i>

Saturday 20th

10:00-10:30	Fraenkel	The Poisson embedding problem
		<i>Tea break</i>
10:50-11:20	Jubin	Differential graded integration
11:30-12:00	Seyfaddini	Rigidity of coisotropic submanifolds and their characteristic foliations

Annex 4b: Full list of speakers and participants.

A full list of participants appears in the next page.

A full list of speakers appears in the following one.

Last Name	First Name	Affiliation
Androulidakis	Iakovos	University of Athens
Bates	Sean	Deutsche Bank
Bertelson	Mélanie	Université Libre de Bruxelles
Blohmann	Christian	MPIM Bonn
Boutet de Monvel	Louis	UPMC
Bursztyn	Henrique	IMPA
Crainic	Marius	Utrecht University
Dias	Carla	Instituto Politécnico de Portalegre
Dito	Giuseppe	U Bourgogne
Fraenkel (McMillan)	Aaron	Boston College
gualtieri	marco	toronto
Holm	Darryl	Imperial College London
Jubin	Benoit	University of Luxembourg
Kathotia	Vinay	The Nuffield Foundation
Koiller	Jair	Fundacao Getulio Vargas
Kosmann-Schwarzbach	Yvette	Ecole polytechnique (retraitee)
Laurent-Gengoux	Camille	Université de Lorraine
Leok	Melvin	University of California, San Diego
LISKER	ROY	Wesleyan University
Liu	Zhangju	Peking University
Lopes Filho	Milton	Universidade Federal do Rio de Janeiro
Lu	Jiang-Hua	The University of Hong Kong
MAAREK	PHILIPPE	IHP
Maeda	Yoshiaki	Keio University
Marle	Charles-Michel	Université Pierre et marie Curie
Nguyen Viet	Dang	paris 7
Oh	Yong-Geun	University of Wisconsin & IBS-Center for Geometry and Physics
PETALIDOU	FANI	ARISTOTLE UNIVERSITY OF THESSALONIKI
Qian	William	Standard Chartered Bank
Roytenberg	Dima	Utrecht University
Schapira	Pierre	University of Paris 6
Seyfaddini	Sobhan	ENS-Paris
Tang	Xiang	Washington University
Voglaire	Yannick	Université du Luxembourg
Weinstein	Alan	University of California, Berkeley
Xu	Ping	Penn State
Yan	Dong	Fore Research & Management, LLP.
Zambon	Marco	Universidad Autonoma de Madrid,ICMAT
Zhu	Chenchang	Uni Gottingen

	Sean Bates	(Deutsche Bank, UK)
	Melanie Bertelson	(Université Libre de Bruxelles, Belgium)
	Henrique Bursztyn	(IMPA, Brazil)
	Milton Lopes Filho	(Univ. Campinas, Brazil)
	Benoit Jubin	(Univ. of Luxembourg, Luxembourg)
	Vinay Kathotia	(The Nuffield foundation, UK)
	Jair Koiller	(Univ. Federal Rio de Janeiro, Brazil)
	Jiang-Hua Lu	(Hong Kong University, China)
Speakers:	Aaron McMillan	(Penn State University, USA)
	Yong-Geun Oh	(Univ. of Wisconsin, USA)
	William Qian	(Standard Chartered Bank, China)
	Dimitry Roytberg	(Univ. Utrecht, The Netherlands)
	Sobhan Seyfaddini	(Ecole Normale Supérieure, France)
	Xiang Tang	(Washington University in St. Louis, USA)
	Ping Xu	(Penn State University, USA)
	Dong Yan	(Fore Research and Management, USA)
	Marco Zambon	(Univ. Autonoma Madrid and ICMAT, Spain)
	Chenchang Zhu	(Univ. Göttingen, Germany)