

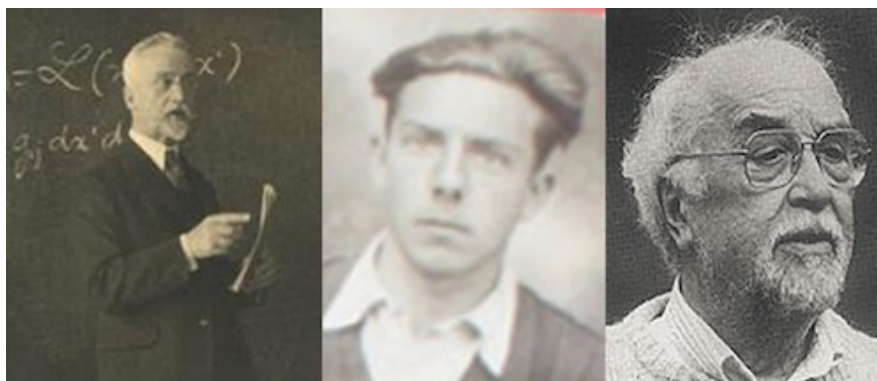


Foundations of Geometric Structures of Information

Montpellier 4-6 February 2019

PRESENTATION

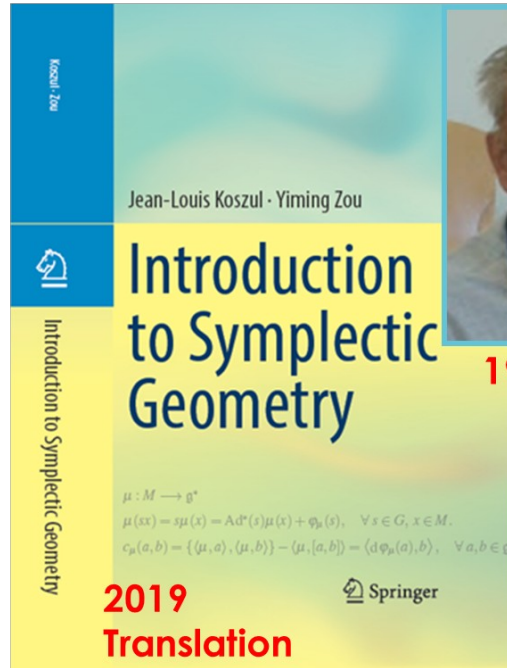
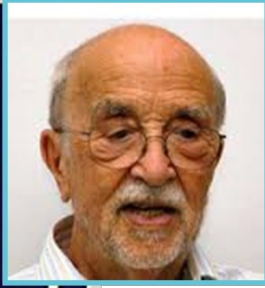
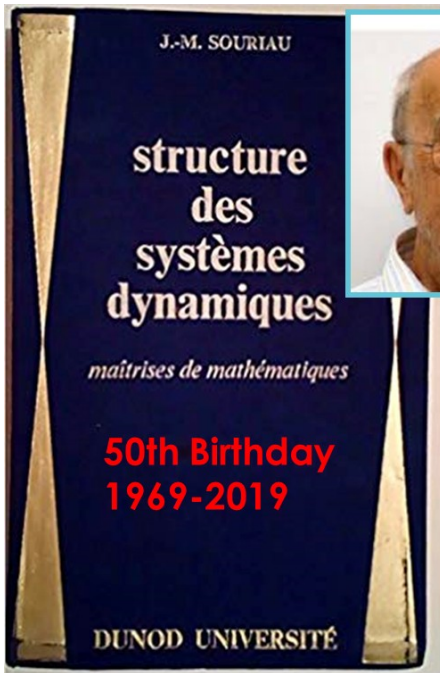
A seminar on Topological and Geometrical Structures of Information has been organized at CIRM in 2017, to gather engineers, applied and pure mathematicians interested in the geometry of information. This year FGS'I'19 conference will be focused on the foundations of geometric structures of information. It is dedicated to the triumvirat Cartan - Koszul - Souriau and their influence on the field.



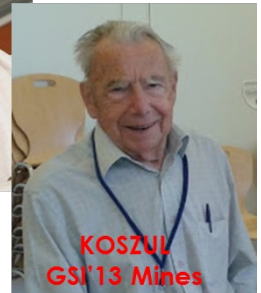
For the 50th birthday of Jean-Marie Souriau Book "Structure des systèmes dynamiques" published in 1969, and Jean-Louis Koszul Book Translation by Springer "Introduction to Symplectic Geometry", FGS'I'19 will celebrate the influence of the Triumvirate Elie Cartan (ENS, 1888), Jean-Louis Koszul (ENS, 1940) and Jean-Marie Souriau (ENS, 1942) on Foundations of Geometric Structure of Information. Both Koszul and Souriau were influenced by Elie Cartan works on symmetric homogeneous spaces. Jean-Louis Koszul has developed theory of hessian geometry introducing Koszul forms that are fundamental structures in Information Geometry. In parallel Souriau has developed in the framework of Geometrical Mechanics applied for Statistical Mechanics, a Lie Group Thermodynamics in Homogeneous Symplectic Manifold. Based on Souriau cocycle, this thermodynamics defines a generalized Fisher metric where the Gibbs Maximum Entropy density is covariant with respect to dynamic groups of Physics.

Elie Cartan started his career at Montpellier, where he was appointed in 1894 as lecturer in mathematics and assistant professor of astronomy at the Faculty of Sciences of Montpellier. We can read in one letter: "Je fus nommé maître de conférences à Montpellier. Je garde le meilleur souvenir que j'ai passé en province, à Montpellier d'abord. Ce furent des années de méditation dans le calme, et tout ce que j'ai fait plus tard est contenu en germe dans mes travaux murement médités de cette période. [I was appointed lecturer at Montpellier. I keep the best memory I have spent in the province, in Montpellier first. It was years of calm meditation, and everything I did later is germinating in my meditated works of that period.]»

FGS'I'19 workshop will federate researchers and Engineers coming from Pure/Applied Mathematics, Geometrical Mechanics and Statistical Physics and Information Theory, to explore new foundations of Geometric Science of Information based on structures emerging from Koszul and Souriau works.



1921-2018



PLANNING

Monday, February 4, 2019

- 09:00 - 10:00 Registration (Hall)
- 10:00 - 11:00 Aissa Wade - Sur le problème d'intégration des variétés de Jacobi holomorphes.
- 11:00 - 11:30 Coffee break (Hall)
- 11:30 - 12:30 Anton Alekseev - The Cartan model of equivariant cohomology and the Kirillov-Kostant-Souriau Poisson structure
- 12:30 - 14:30 Lunch break
- 14:30 - 15:30 Patrick Iglesias-Zemmour - Symplectic Diffeology
- 15:30 - 16:00 Coffee break (Hall)
- 16:00 - 17:00 Panel session: Symplectic geometry and localization techniques in Mathematical Physics, led by D.Calaque

Tuesday, February 5, 2019

- 10:00 - 11:00 Dmitry Alekseevsky - The Vinberg theory of homogeneous convex cones, 66 years later
- 11:00 - 11:30 Coffee break (Hall)
- 11:30 - 12:30 Misha Gromov - Probability and Dimension.
- 12:30 - 14:30 Lunch break
- 14:30 - 15:30 Yann Ollivier - Are natural gradient and the extended Kalman filter the same thing?
- 15:30 - 16:00 Coffee break (Hall)
- 16:00 - 17:30 Panel session: Tribute to J-L Koszul and J-M Souriau, led by F. Barbaresco and M. Boyom
- 20:00 - 22:30 Dinner at La Diligence

Wednesday, February 6, 2019

- 09:00 - 10:00 Vasily Pestun - Localization in geometry and physics
- 10:00 - 10:30 Coffee break (Hall)
- 10:30 - 11:30 John Baez - From Classical to Quantum and Back
- 11:30 - 11:45 Coffee break (Hall)
- 11:45 - 12:45 Michel Brion - Automorphism groups of complex projective varieties

TALKS

Anton Alekseev (Geneva Univ.)

Title: The Cartan model of equivariant cohomology and the Kirillov-Kostant-Souriau Poisson structure

Abstract: By definition, the equivariant cohomology of a G -space M is the cohomology of the space $M_G := M \times_G EG$, where EG is the total space of the universal G -bundle $EG \rightarrow BG$. In the case when M is a manifold and G is a compact connected Lie group, the celebrated theorem of H. Cartan shows how to compute the G -equivariant cohomology of M over reals using differential forms on M . The Cartan model makes use of the Weil algebra $Wg = Sg^* \otimes \wedge g^*$. We will show that the dual of the Weil algebra can be naturally identified with the space of differential forms on g^* whereas the differential and the G -action are defined by the Kirillov-Kostant-Souriau (KKS) Poisson structure. If time permits, we will discuss the generalization of this structure to the case of non-commutative Weil algebras and Lie group valued moment maps.

The talk is based on joint works with E. Meinrenken and C. Woodward.

Dmitri ALEKSEEVSKY (Moscow IITP)

Title: The Vinberg theory of homogeneous convex cones, 66 years later

Abstract: We review shortly the basic results of the theory of homogeneous convex cones, developed by E.B. Vinberg in the early 60s, which includes the theory of duality of convex cones, the classification of self-dual homogeneous convex cones in terms of compact Jordan algebras, description of homogeneous convex cones in terms of left symmetric algebras (Koszul-Vinberg algebras) and as the cones of positively defined matrices in Vinberg matrix T -algebra, application to description of homogeneous convex domains and homogeneous Kähler manifolds. We consider different developments of these results and shortly discuss their applications to information geometry, multivariate statistical analysis, convex optimisation, homogeneous Riemannian and pseudo-Riemannian Hessian manifolds, and supergravity (description of homogeneous scalar target manifolds for $N=2$ supergravity in dimension $D=5,4,3$).

John BAEZ (Riverside UC)

Title: From Classical to Quantum and Back

Abstract: Edward Nelson famously claimed that quantization is a mystery, not a functor. In other words, starting from the phase space of a classical system (a symplectic manifold) there is no functorial way of constructing the correct Hilbert space for the corresponding quantum system. In geometric quantization one gets around this problem by equipping the classical phase space with extra structure: for example, a Kähler manifold equipped with a suitable line bundle. Then quantization becomes a functor. But there is also a functor going the other way, sending any Hilbert space to its projectivization. This makes quantum systems into specially well-behaved classical systems!

In this talk we explore the interplay between classical mechanics and quantum mechanics revealed by these functors going both ways.

Michel BRION (Grenoble Univ.)

Title: Automorphism groups of complex projective varieties

Abstract: Consider a complex projective algebraic variety X . The automorphism group $\text{Aut}(X)$ is known to be a "locally algebraic group", extension of a discrete group by a complex connected algebraic group. The discrete part (the group of components of $\text{Aut}(X)$) is quite mysterious; in particular, it is not necessarily finitely generated, as shown by recent work of Lesièvre and Dinh-Oguiso. The talk will discuss some basic properties of automorphism groups, and then present classes of varieties for which the group of components of $\text{Aut}(X)$ is an arithmetic group.

Misha GROMOV (Paris IHES)

Title: Probability and Dimension.

Abstract: I will try to expose a geometric view on some aspect of probability and its applications.

Patrick IGLESIAS-ZEMMOUR (Aix-Marseille Univ.)

Title: Symplectic Diffeology

Abstract: I will discuss how symplectic geometry can be extended to diffeology, where the spaces run from singular quotients to infinite dimension. We shall see how this formal framework works on a few examples: from the construction of the moment map in this context to the construction of a prequantized bundle as a quotient of the space of paths, for any parasymplectic form (closed 2-form) on (almost) any diffeological space. I will discuss also the parasymplectic structure of the space of geodesics, even when it is not a manifold etc.

Yann OLLIVIER (Paris Facebook)

Title: Are natural gradient and the extended Kalman filter the same thing?

Abstract: The natural gradient is a fundamental object of statistical learning, one of the most canonical iterative algorithms to learn the parameters of arbitrary statistical models. The extended Kalman filter is fundamental in many engineering applications involving signal processing or control, such as GPS tracking. This filter is a generic tool to estimate the current state of a dynamical system from noisy measurements of some part or some function of the system. In the nonlinear case, the equations of the extended Kalman filter are complex and have been debated. We build a systematic correspondence between these two objects, viewing the extended Kalman filter as a natural gradient descent in the abstract space of trajectories of the system, and conversely the natural gradient as an extended Kalman filter on its parameter viewed as a static system.

Vasily PESTUN (Paris IHES)

Title: Localization in geometry and physics

Abstract: Even though supersymmetry has not yet been found in nature, it played a major role in the constructions of theoretical physics and physical mathematics for several decades. In certain situations, supersymmetric path integrals over the functional spaces of field configurations can be computed by localization to a locus of smaller dimension. I will review some of the classical localization results in geometry and their contemporary counterparts in modern quantum field theory.

Aissa WADE (Penn State Univ.)

Title: Sur le problème d'intégration des variétés de Jacobi holomorphes.

Abstract: En bref, une variété de Jacobi holomorphe est une variété complexe X munie d'un fibré en lignes holomorphe L avec un crochet de Lie sur le faisceau de sections holomorphes de L définissant un opérateur bi-différentiel de premier ordre. En fait, les variétés de Jacobi holomorphe sont des cas particuliers de structures de Jacobi-Nijenhuis. Dans cet exposé, nous discutons le problème d'intégration des variétés de Jacobi holomorphes. Nous montrons qu'elles s'intègrent en des groupoïdes de contact complexes.

PANEL SESSIONS

SYMPLECTIC GEOMETRY AND LOCALIZATION TECHNIQUES IN MATHEMATICAL PHYSICS led by Damien Calaque

with Anton Alekseev, Mathieu Anel, Patrick Iglesias-Zemmour, Vasily Pestun and Aissa Wade

On the one hand, Souriau's work has emphasized the relevance of symplectic geometry in physics. On the other hand, various localization formulae have proven to be of importance both in mathematics and physics, culminating with various kinds of index theorems. Localization techniques are related to symplectic geometry via symplectic reduction and equivariant cohomology. The panel will discuss the historical importance of this circle of ideas, how they connect to some work of Cartan, Koszul and Souriau, and how they still influence the current research in mathematical physics.

The session will start with a short presentation of panel members. Each panel member will say a few words on his/her experience/relation with symplectic geometry and/or localization methods. Then the panel chair will give a brief presentation of the topic, which will be followed by an open and free discussion between panel members. We will finally conclude with a few questions from the audience.

TRIBUTE TO J-L KOSZUL AND J-M SOURIAU, led by Frédéric Barbaresco and Michel N'Guiffo-Boyom

Jean-Louis Koszul and Jean-Marie Souriau contributions to foundations of Geometric Structures of Information, with Fisher Metric extension (2nd Koszul Form , Koszul-Fisher metric, Souriau-Fisher metric and Lie Groups Thermodynamics). Koszul Topology (Koszul- Vinberg- Nijenhuis), Koszul Geometry (Affine Lie Group representation), « la théorie des modèles statistiques homologiques » (2013- 2017) and the last « formule bord de Koszul » (2015)

Letmotiv will be « Fisher metric » and obstruction to equivariance (class of cohomology; non-equivariant case where the coadjoint action on moment map is modified with a 1-cocycle to be equivariant).

- Dmitri ALEKSEEVSKY (Koszul-Vinberg Characteristic Function and Algebra)
- Misha GROMOV (Geometry and Probability, Fisher Metric)
- Yann OLLIVIER (Fisher Metric and Machine Learning)
- Patrick IGLESIAS-ZEMMOUR (Covariant Souriau Lie Group Thermodynamic)
- Michel N'Guiffo-Boyom (Koszul Vinberg, Koszul Homology, Information Geometry)
- Frédéric Barbaresco (Koszul-Souriau-Fisher metric, Lie groups thermodynamics)

PARTICIPANTS

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Salmon	Joseph	Univ. Montpellier
Thanwerdas	Yann	Inria
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Vernicos	Constantin	Colombiere
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Wolak	Robert	Uniwersytet Jagiellonski
ZEGLAOUI	Ahmed	Université de Saïda
Zelenyuk	Yuliya	University of the Witwatersrand, Johannesburg
Zhang	Jun	University of Michigan

PRACTICAL INFORMATION

Location:

Lectures will take place at the [Maison des Etudiants Aimé Schoenig \(Richter\)](#)

The access is from tramway station Rives du Lez (line 1-3-4). From the city center, exit tramway to the left (line 1-4) or forward (line 3) towards the shores of river Le Lez. Cross the bridge and continue forward under the building of ESEQ to find the Maison des Etudiants.

Dinner of the conference:

There will be a dinner of the conference on Tuesday 5th February evening. It will take place at [La Diligence](#) at 8pm. The diner will be offered to speakers. Other participants who wish to join the diner should pay 40 euros at registration on Monday 5th February.

A vegetarian menu for the dinner will be available upon request at registration.

Suggestions of restaurants:

[Trinquéfougasse O'Sud](#), [Vilain Garçon](#), [Jap'Asian](#) and other restaurants next to the bassin Jaques Coeur

[Le bistro ASPTT](#) (237 Route de Vauguières)

[L'Arlequin](#) (esplanade de l'Europe)

[L'Oracle](#) and many other food places in Antigone's walking area

[La brasserie du Théâtre](#), [Diligence](#), [La maison de la Lozère](#), [la Tomate](#) and many other places in Montpellier's downtown "l'écusson"

Related upcoming conferences:

On the occasion of the 50th birthday of J-M Souriau's book Structure des Systèmes Dynamiques, another conference in honor of J-M Souriau will be organized in Paris-Diderot university at 27-31 May 2019 : souriau2019.fr

The 63th SOURIAU COLLOQUIUM will be held from June 30th to July 5th 2019 in the historical city of Arpino, 100 kilometers south east of Rome, in Italy.

<http://www.memocsevents.eu/wordpress/cossevita/souriau-colloquium/>