



Geometric Science of Information *SEE/SMF GSI'19 Conference* *ENAC, Toulouse*

GSI'19 General Chairmen: Frédéric BARBARESCO*, Frank NIELSEN**
& Stephane PUECHMOREL***

(*) President of SEE ISIC Club (Ingénierie des Systèmes d'Information de Communications) &
THALES Land & Air Systems, (**) Ecole Polytechnique/LIX & LIX & Sony CSL Tokyo, (***) ENAC



GSI'19
Geometric Science of Information
4th Edition
Toulouse, 27th-29th August 2019





Thanks to ENAC administration & Local Organizing Team



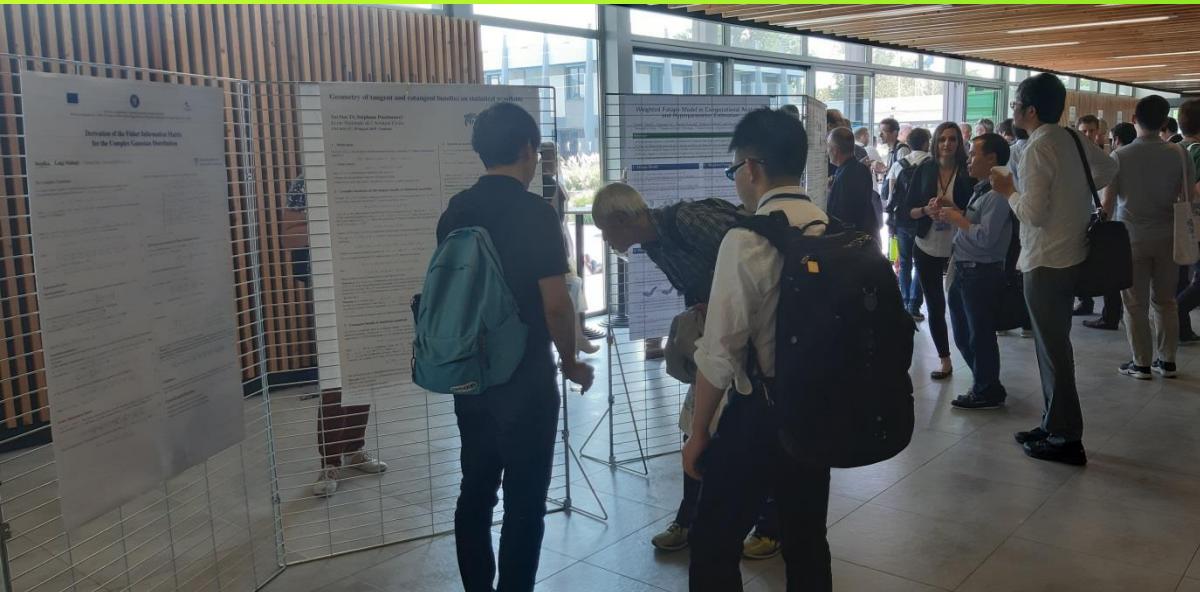


Thanks to 180 GSI'19 Attendees





Thanks to GSI'19 Attendees (Posters)





Thanks ENAC for
cocktail with
Wine Master
& Cheese Master
of G7 & GSI'19





Thanks to ENAC for Gala Diner





Thanks to GSI'19 Keynote

« Pierre (de) FERMAT : lawyer, philologist and illustrious mathematician... but enigmatic »

J.-B. HIRIART-URRUTY
(JBHU)

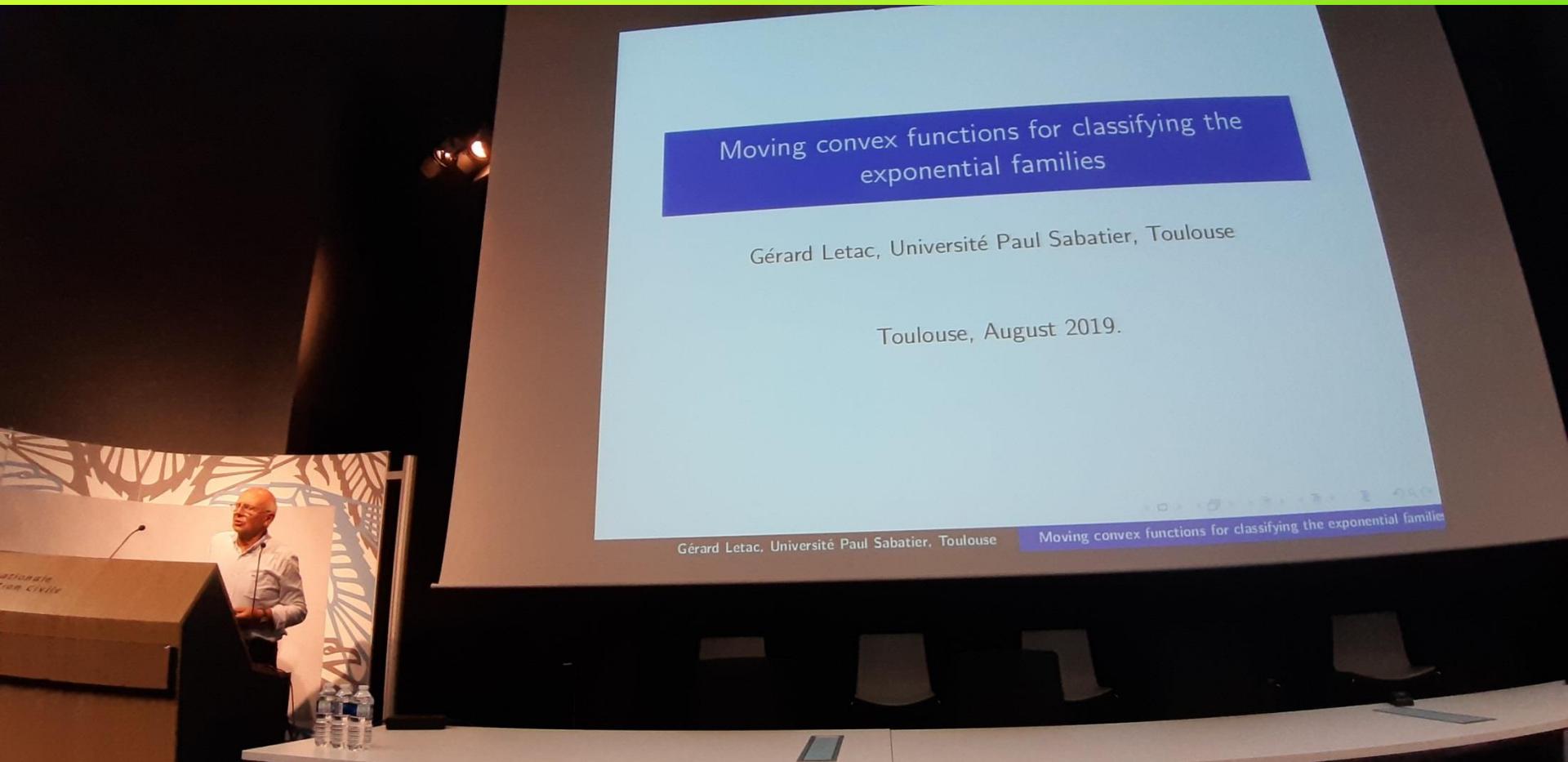
UNIVERSITÉ
TOULOUSE III
PAUL SABATIER

Université de Toulouse

Jean-Baptiste Hiriart-Urruty



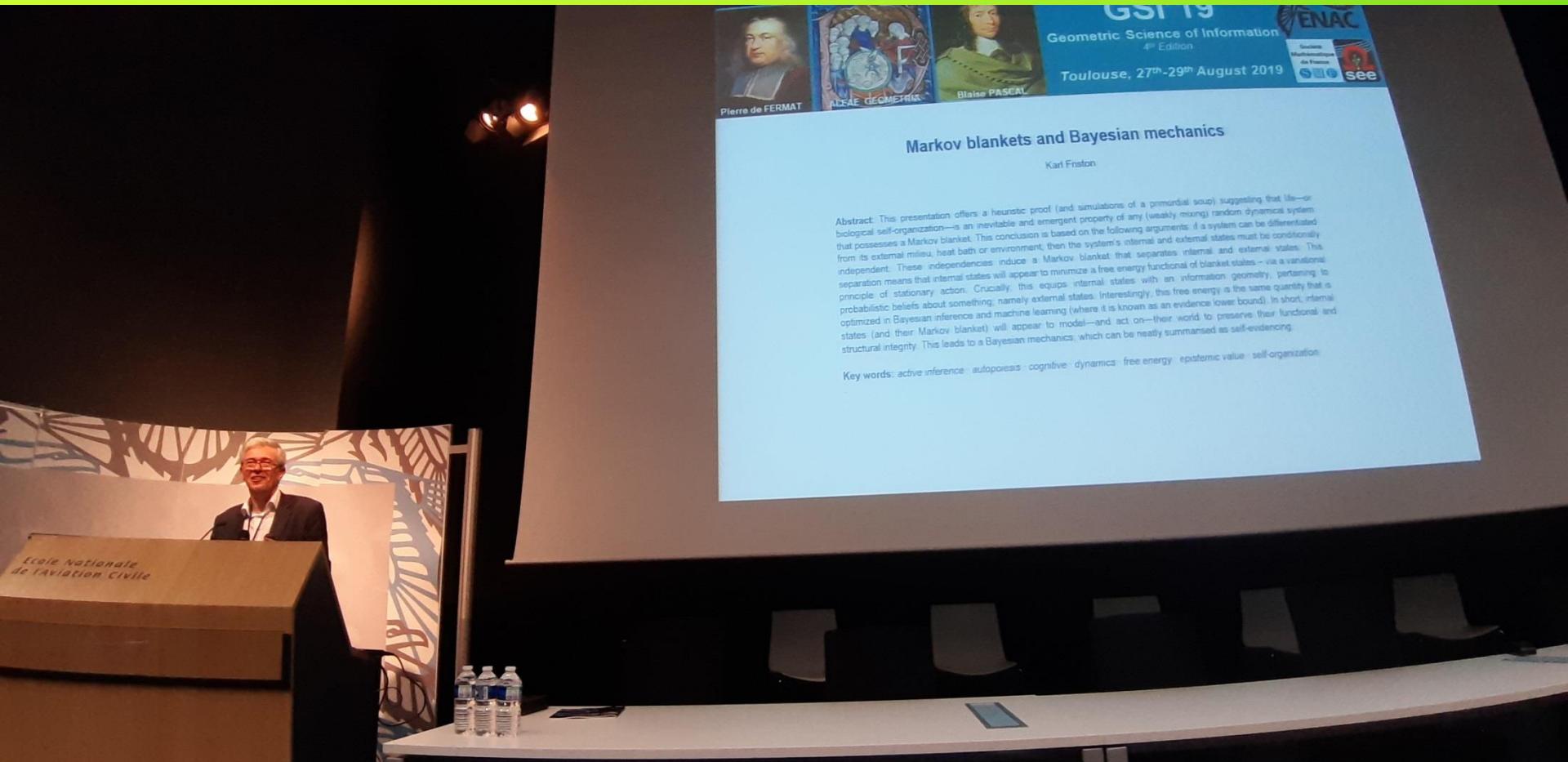
Thanks to GSI'19 Keynote



Gérard LETAC



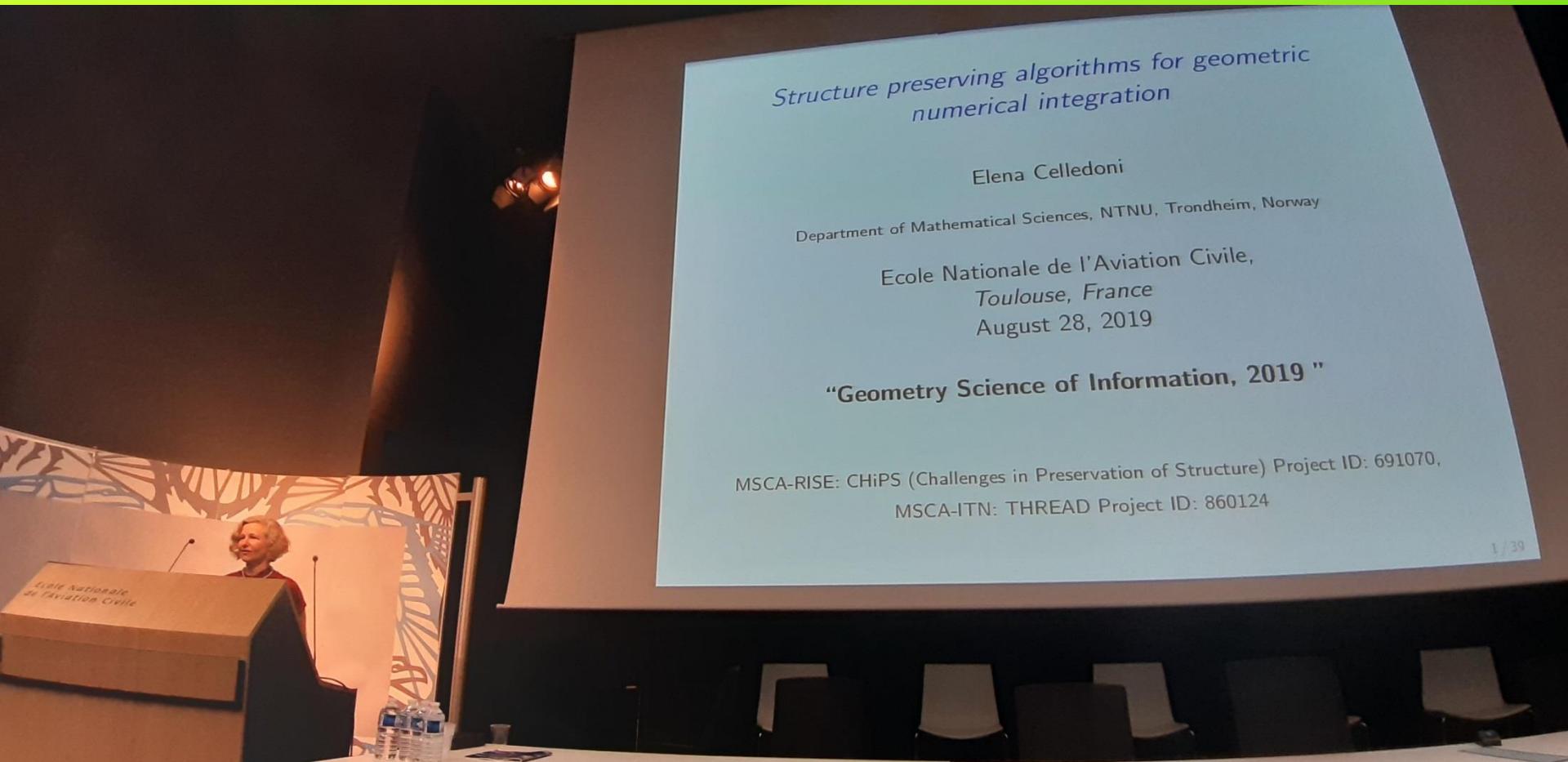
Thanks to GSI'19 Keynote



Karl FRISTON



Thanks to GSI'19 Keynote



Elena CELLEDONI



Thanks to GSI'19 Keynote

LEONHARD EULER
KÖNIGSBERG :
MATHEMUSICAL PROBLEM

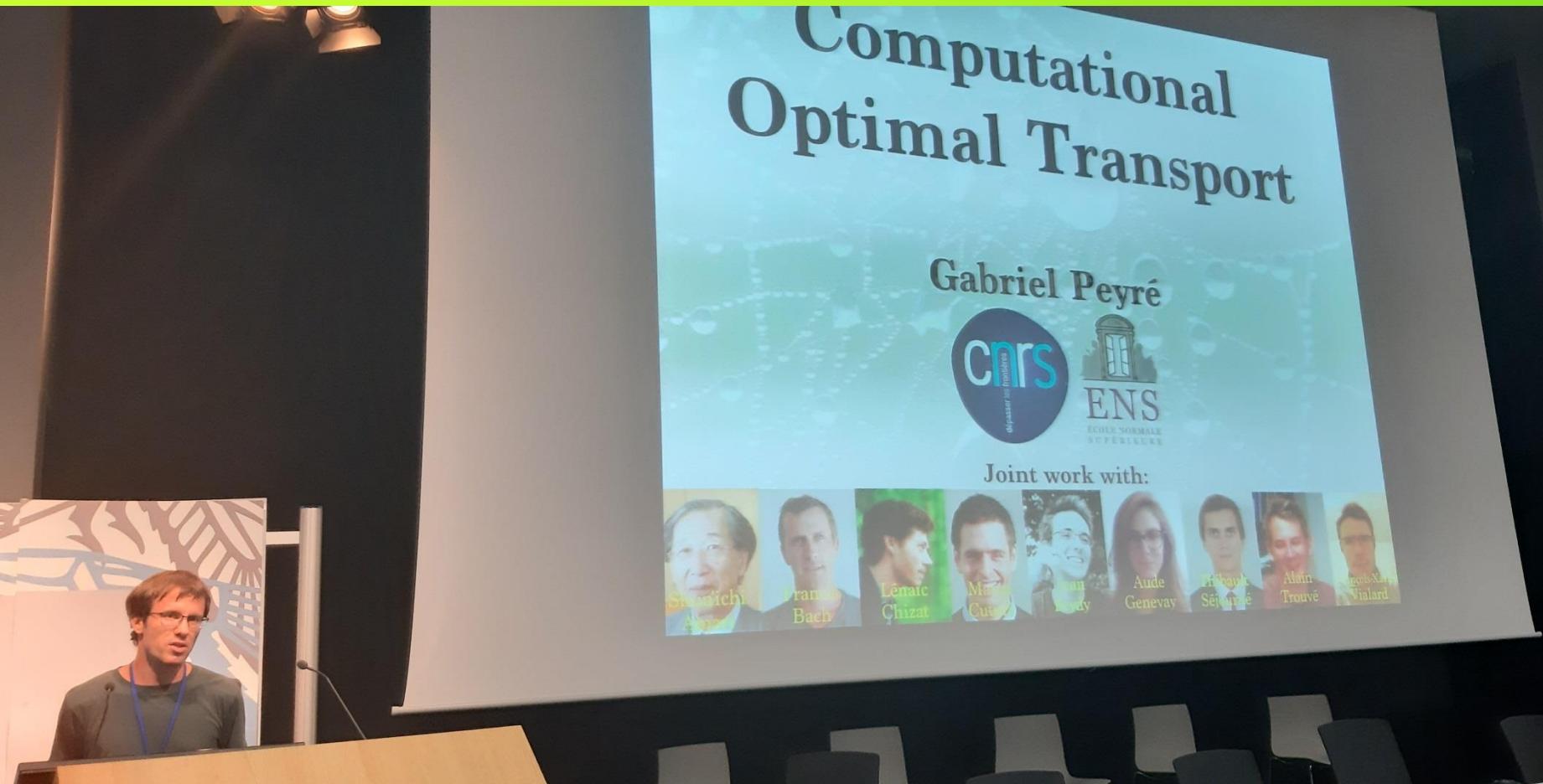
Euler s'appuie sur le speculum musicum pour poser des problèmes théoriques tout à fait proches à ceux qu'il exposa, quelques années auparavant, dans d'autres écrits mathématiques*

*M.Andreatta 2008
© Euler 1739 / 1774

Gilles BAROIN



Thanks to GSI'19 Keynote



Gabriel PEYRE



GSI'19: 18 sessions

Probability on Riemannian Manifolds

Optimization on Manifold

Shape Space

Statistics on Non-linear Data

Lie Group Machine Learning

Statistical Manifold and Hessian Information Geometry

Monotone Embedding and Affine Immersion of Probability Models

Non-parametric Information Geometry

Divergence Geometry

Computational Information Geometry

Wasserstein Information Geometry/Optimal Transport

Geometric Structures in Thermodynamics and Statistical Physics

Geometric and Structure-Preserving Discretizations

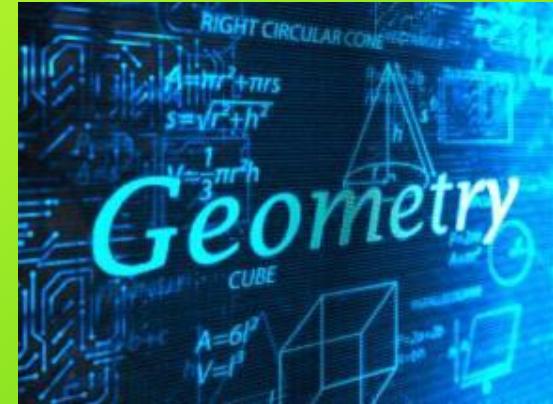
Geometry of Quantum States

Geometry of Tensor-Valued Data

Geometric Mechanics

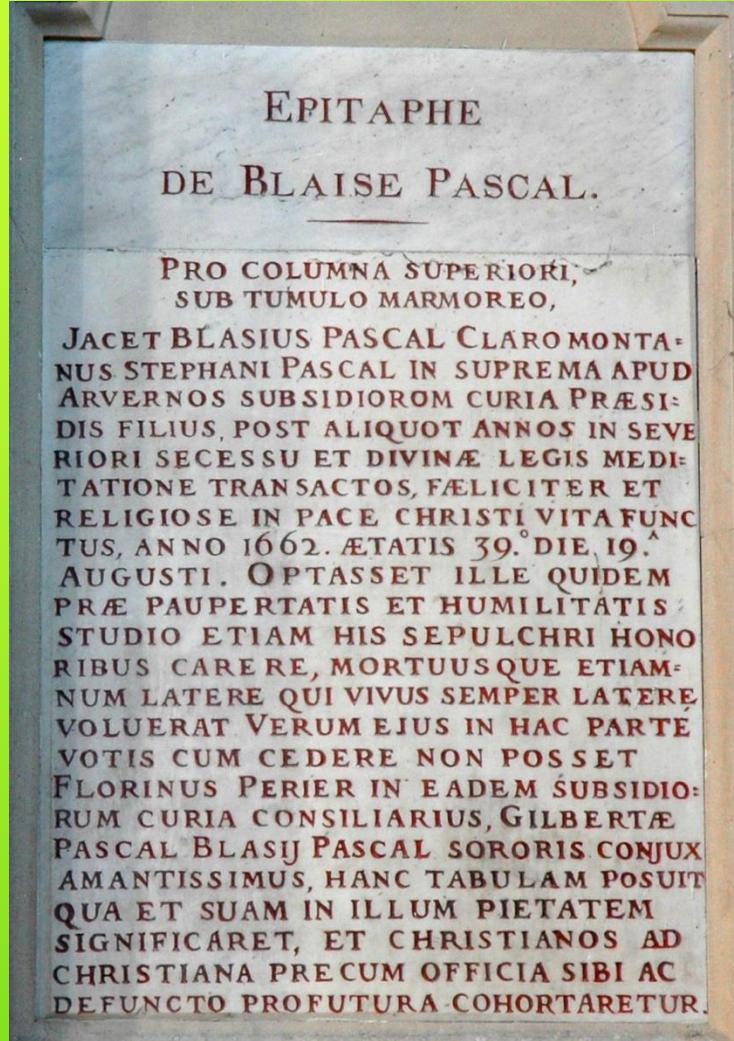
Geometric Science of Information Libraries

Poster Session

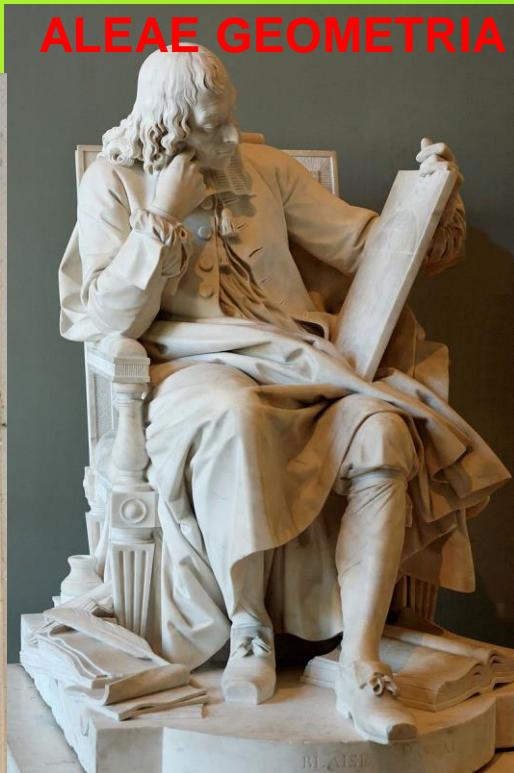




We hope that Blaise pascal is proud of GSI'19



ALEAE GEOMETRIA



Geometry
of Chance



Information Geometry

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Special Issue:

Information Geometry and Optimal Transport

Submission Deadline: 20th December 2019

Optimal transport is an interdisciplinary field of mathematics at the intersection of probability, analysis, and geometry. Originally conceived by Monge in 1781 as a problem of finding the most efficient transportation of resources, the modern framework was developed by Kantorovich and others in the early 1900s as a problem of finding optimal coupling between two probability measures characterizing the transported resource. In recent decades, the field of optimal transport has flourished due to its deep connections with many different areas of mathematics and ever expanding applications in other fields. Connections between the geometry of optimal transport (Wasserstein geometry) and information geometry have also started to emerge. The aim of this special issue is to explore some of these developments and their applications of this promising area of research.

Topics include but are not limited to:

- Wasserstein-Fisher Rao geometry and entropy-related transportation
 - Displacement interpolation and convexity
 - Regularity theory of optimal transport and its relation to information geometry
 - Talagrand inequalities and the relationship between Wasserstein distances and relative entropy
 - Log-divergences and their applications in economics
 - Wasserstein natural gradient and application to data/image analysis
 - Geometric frameworks to machine learning and computer graphics,
- Guest Editor:
Jun Zhang (University of Michigan)

INFORMATION GEOMETRY, SPRINGER JOURNAL

<https://www.springer.com/mathematics/geometry/journal/41884>



Volume 1 · Number 1 · 2018

Information Geometry

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Giovanni Pistone (Torino)

Constantino Tsallis (Rio de Janeiro)



Special Issue:

Affine Differential Geometry and Hesse Geometry: A Tribute and Memorial to Jean-Louis Koszul Submission Deadline: 30th November 2019

Jean-Louis Koszul (January 3, 1921 – January 12, 2018) was a French mathematician with prominent influence to a wide range of mathematical fields. He was a second generation member of Bourbaki, with several notions in geometry and algebra named after him. He made a great contribution to the fundamental theory of Differential Geometry, which is foundation of Information Geometry. The special issue is dedicated to Koszul for the mathematics he developed that bear on information sciences.

Both original contributions and review articles are solicited. Topics include but are not limited to:

- Affine differential geometry over statistical manifolds
- Hessian and Kahler geometry
- Divergence geometry
- Convex geometry and analysis
- Differential geometry over homogeneous and symmetric spaces
- Jordan algebras and graded Lie algebras
- Pre-Lie algebras and their cohomology
- Geometric mechanics and Thermodynamics over homogeneous spaces

Guest Editor:

Hideyuki Ishi (Graduate School of Mathematics, Nagoya University)



Lie Group Machine Learning and Lie Group Structure Preserving Integrators

Guest Editors:

Frédéric Barbaresco
frederic.barbaresco@thalesgroup.com

Prof. Elena Celledoni
elena.celledoni@ntnu.no

Prof. François Gay-Balmaz
francois.gay-balmaz@imd.ens.fr

Prof. Joël Benoam
benoam@ircam.fr

Deadline for manuscript submissions:
6 January 2020

Message from the Guest Editors

Machine/deep learning explores use-case extensions for more abstract spaces as graphs and differential manifolds. Recent fruitful exchanges between geometric science of information and Lie group theory have opened new perspectives to extend machine learning on Lie groups to develop new schemes for processing structured data.

Structure-preserving integrators that preserve the Lie group structure have been studied from many points of view and with several extensions to a wide range of situations. Structure-preserving integrators are numerical algorithms that are specifically designed to preserve the geometric properties of the flow of the differential equation such as invariants, (multi)symplecticity, volume preservation, as well as the configuration manifold. They also naturally find applications in the extension of machine learning and deep learning algorithms to Lie group data.

This Special Issue will collect long versions of papers from contributions presented during the GSI'19 conference, but it will be not limited to these authors and is open to international communities involved in research on Lie group machine learning and Lie group structure-preserving integrators.

Special Issue "Lie Group Machine Learning and Lie Group Structure Preserving Integrators"

Keywords

- Lie groups machine learning
- orbits method
- symplectic geometry
- geometric integrator
- symplectic integrator
- Hamilton's variational principle



mdpi.com/si/30856

https://www.mdpi.com/journal/entropy/special_issues/Lie_group

Special Issue



Geometry and Topology in Statistics

Guest Editor:

Prof. Stéphane Puechmorel

Ecole nationale de l'aviation civile (ENAC), Université Fédérale de Toulouse, 7 Avenue Edouard Belin, FR-31055 Toulouse CEDEX, France

stephane.puechmorel@enac.fr

Deadline for manuscript submissions:

29 February 2020

Message from the Guest Editor

One can expect that the development of statistical geometry will be a major trend in the next decade. Due to numerous applications in data analysis, artificial intelligence and signal processing, along with a strong potential for new theoretical results, this emerging axis of research is of increasing interest among both the geometry and statistics communities.

This Special Issue aims at publishing papers of high-quality related to information geometry, geometric statistics, topology for learning and data analysis.

Some of the scientific topics of interest may include, but are not limited to: probabilities on manifolds, shape space, optimal transport, statistical manifolds, geometry of graphs, topology in data, geometry in artificial intelligence, estimation and sampling in high dimensions.

Submissions describing applications are welcome.

Special Issue
"Geometry and Topology in Statistics"

Keywords

- information geometry
- topological data analysis
- hessian geometry
- shape space
- optimal transport

https://www.mdpi.com/journal/mathematics/special_issues/geometry_topology



[mdpi.com/si/28877](https://www.mdpi.com/si/28877)

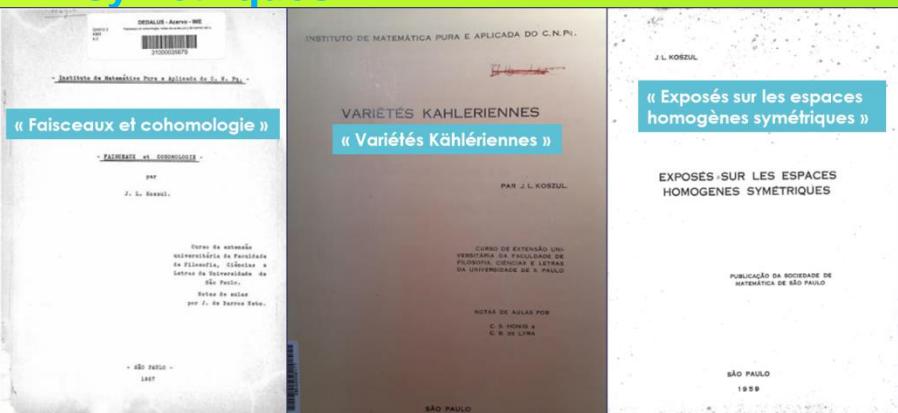
Special Issue



Jean-Louis Koszul was
foreign member of **São Paulo**
Academia of Sciences

Jean Louis Koszul Lectures at São Paulo:

- **Faisceaux et Cohomologie**
- **Variétés Kählériennes**
- **Exposés sur les espaces homogènes symétriques**



São Paulo
Journal of
Mathematical
Sciences

São Paulo Journal of Mathematical Sciences
SPRINGER
Editor-in-Chief: **Claudio Gorodski**

<https://www.springer.com/mathematics/journal/40863>

2nd Workshop São Paulo Journal of Mathematical Sciences



Jean-Louis Koszul in São Paulo His Work and Legacy

13-14 November 2019

Auditorium Antônio Giloli, Institute of Mathematics and Statistics
University of São Paulo

Speakers:

- Dmitri Alekseevsky (IITP Moscow)*
- Michel Nguiffo Boyom (Montpellier)
- Ugo Bruzzo (SISSA/UFPB)
- Rui Loja Fernandes (UI, Urbana - Champaign)
- Luiz Antonio Barrera San Martin (Unicamp)
- Ivan Struchiner (USP)
- Dirk Töben (UFSCar)

Scientific Committee

- Claudio Gorodski (USP)
- Marcos M. Alexandrino (USP)
- Frédéric Barbaresco (Thales)
- Michel Nguiffo Boyom (Montpellier)

Round-table with the Editorial Board of the São Paulo Journal of Mathematics



* To be confirmed



IME USP



Les Houches seminar 2020

- Title: **Joint Structures and Common Foundation of Statistical Physics, Information Geometry and Inference for Learning**
 - ***Geometric Structures of Statistical Physics and Information***
 - Statistical Mechanics and Geometric Mechanics
 - Thermodynamics, Symplectic and Contact Geometry
 - Lie groups Thermodynamics
 - Relativistic and continuous media Thermodynamics
 - Symplectic Integrators
 - ***Physical structures of inference and learning***
 - Stochastic gradient of Langevin's dynamics
 - Information geometry, Fisher metrics and natural gradient
 - Monte-Carlo Hamiltonian methods
 - Variational inference and Hamiltonian controls
 - Boltzman machine





Les Houches





GSI'21 in ...

Paris

Candidates of local host:

- IPP (Institut Polytechnique de Paris)
- Mine ParisTech
- Sorbonne University (SCAI lab)
- Institut Henri Poincaré
- ... ?



Trimester 2019 Labex CIMI, Toulouse « Statistics with Geometry & Topology »

Trimester « Statistics with Geometry & Topology », Toulouse, Aout-Sept. 2019

- Opening Event: **Geometric Science of Information** (GSI 19), 27-29 August 2019, ENAC
- **Geometric Statistics**, 30 Aout au 6 Septembre
- **Information Geometry**, 14 au 19 Octobre 2019, IMT
- **Topology for Learning and Data Analysis**, 29 Septembre-4 Octobre 2019, IMT
- **Computational Aspects of Geometry**, 6-8 Novembre 2019, IMT

<https://perso.math.univ-toulouse.fr/statistics-geometry-and-topology/>

CIMI thematic semester

Statistics with Geometry and Topology

August-November

2019

Mini courses

Topics

- Information geometry
- Topology for learning and data
- Computational algebraic geometry
- Optimization and statistical applications

M. BOYOM

F. CHAZAL

A. CUEVAS

R. ELDAN

P. MASSART

B. MICHEL

E. MILLER

G. PISTONE

X. PENNÉC

D. STEURER

A. TROUVÉ

C. ULHER

Thematic weeks

Aug 26 Aug 29 Geometric Science of Information (GSI 19)

Aug 30 Sep 6 Information geometry

Sep 29 Sep 4 Topology for Learning and Data Analysis

Nov 6 Nov 8 Computational Aspects of Geometry

Local Organisers:

F. Costantino, F. Gamboa, D. Hennion, T. Klein, A. Le Brigand, F. Nicol, E. Pauwels

Scientific Committee:

M. Arnaudon, F. Barbaresco, J. Bigot, A. Galves, J-B. Lasserre, X. Pennec, S. Puechmorel

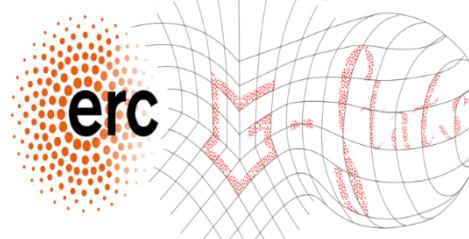
WebPage:

<http://www.cimi.univ-toulouse.fr/>



Statistics with Geometry and Topology thematic semester

Geometric statistics workshop, Aug. 30 to Sept. 5



Schwarz Amphi

- Fri 30/08:
 - 14h - 17h: [Susan Holmes](#) (Statistical methods in treespace: motivation and basics)
- Mon. 02/09
 - 09h - 12h: [Susan Holmes](#) (Geometrical Methods for Heterogeneous Data)
 - 14h - 17h: [Ezra Miller](#) (Sampling from stratified spaces. 1: Stratified spaces)
- Tues. 03/09
 - 09h - 12h: [Ezra Miller](#) (Sampling from stratified spaces. 2: Behavior of Fréchet means)
 - 14h - 15h : [Stephan Huckeman](#) (On the Central Limit Theorem for Fréchet Means: Theory and Applications)
 - 15h30 - 16h30: [Thomas Hotz](#) (Universal, non-asymptotic confidence sets for extrinsic and intrinsic means)
- Wed. Sept 4
 - 09h - 12h: [Xavier Pennec](#) (Statistics on Riemannian manifolds and affine connection spaces)
 - 15h30 - 16h30: [Alice Le Brigant](#) (Optimal Riemannian quantization for air traffic management)
- Thur. Sept 5
 - 09h - 12h: Xavier Pennec (Barycentric subspace analysis, non-asymptotic empirical mean)
 - 14h - 15h: [Nina Miolane](#) (Submanifold Learning using Variational Autoencoders)
 - 15h30 - 16h30: [Alfred Kume](#) (Maximum likelihood estimation for shape analysis)

Location: IMT, building 1R2, Université Paul Sabatier (Metro line B towards Ramonville)



SPRINGER GSI'19
Best paper Award
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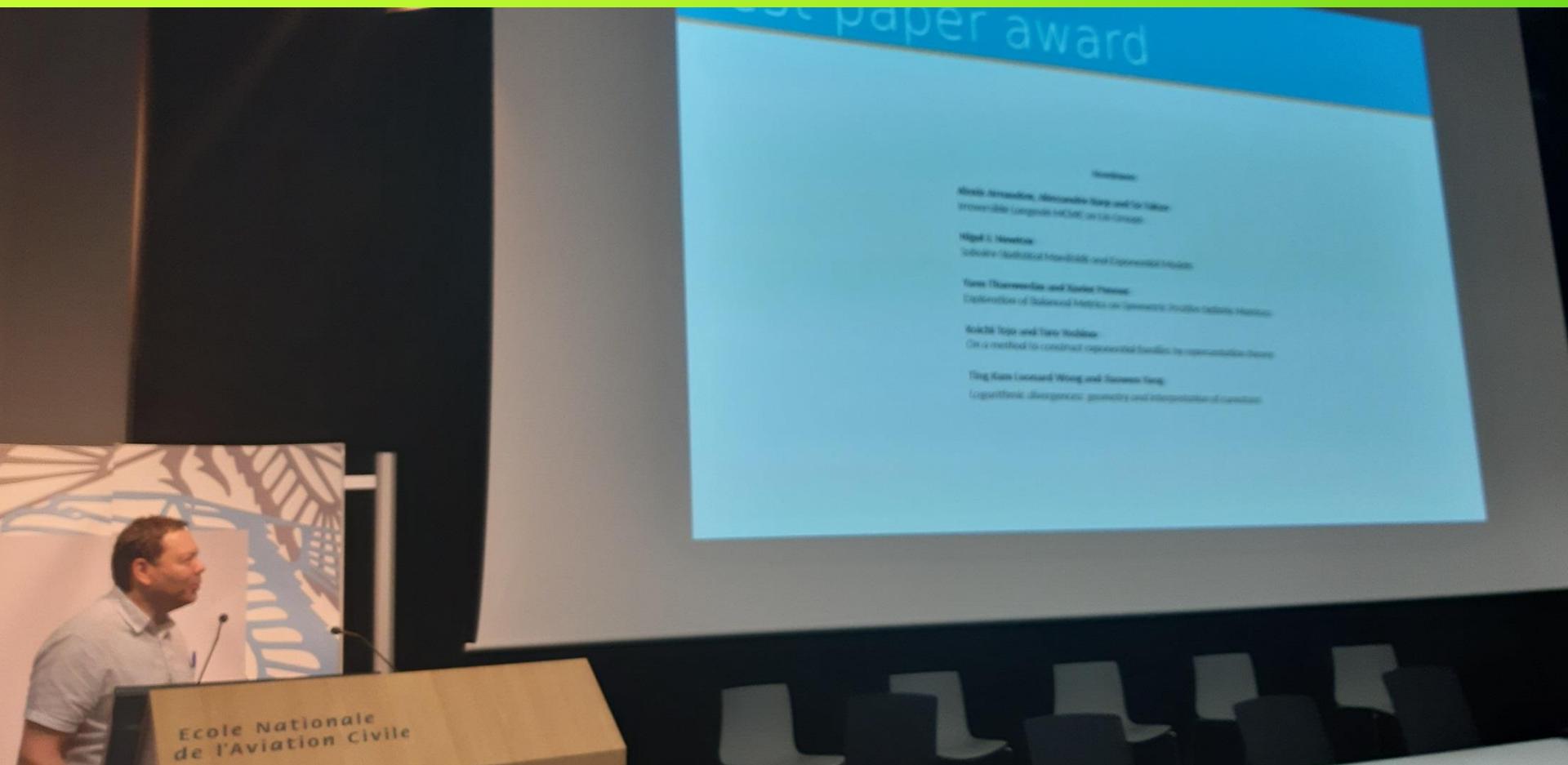




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Best paper Award

Short list of 5 nominees



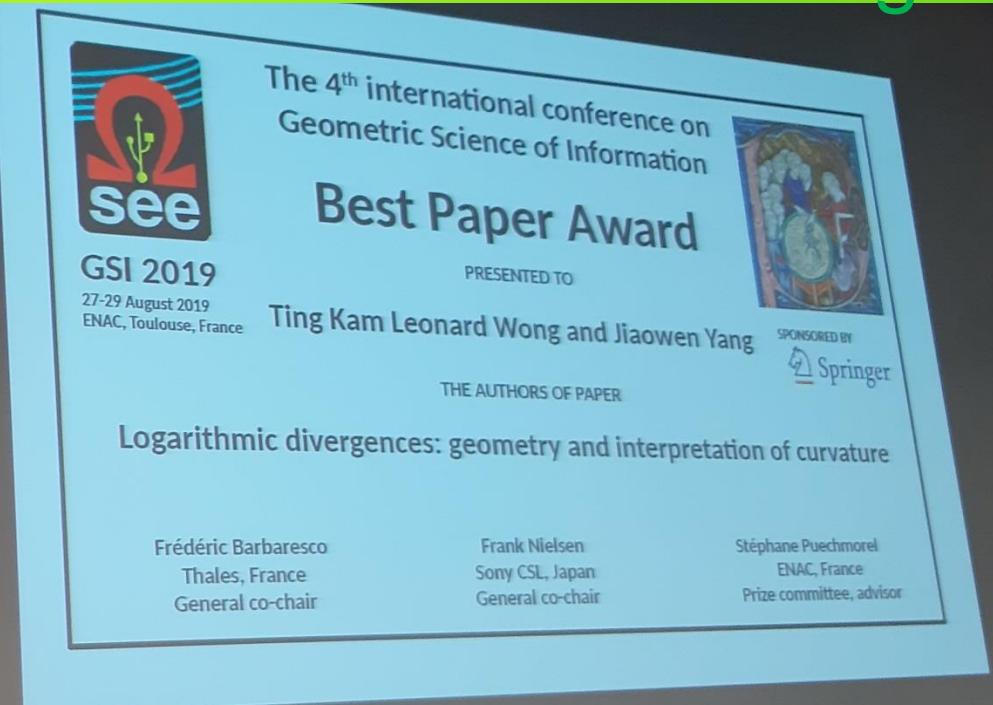
SPRINGER GSI'19

Best paper Award



Logarithmic divergence: geometry and interpretation of curvature

by Ting Kam Leonard and Jiaowen Yang





SPRINGER GSI'19

Best paper Award

Logarithmic divergence: geometry and interpretation of curvature

by Ting Kam Leonard and Jiaowen Yang

