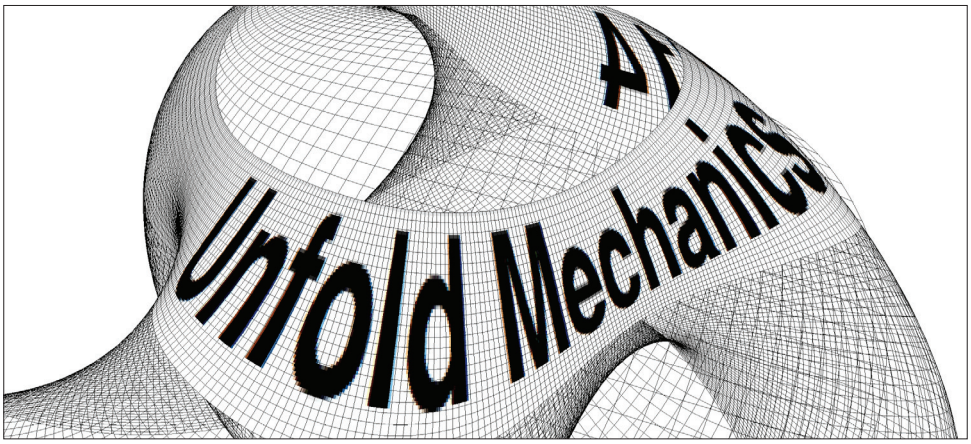
UNFOLD MECHANICS FOR SOUND AND MUSIC

September 11-12, 2014

IRCAM, Paris, France



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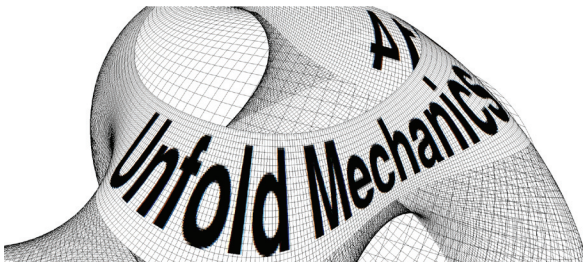

The **Unfold Mechanics|colloquium|2014** takes place, for the first time at IRCAM in Paris, France, from 11 to 12 September 2014.

Geometers will meet acousticians to discuss non-linear vibration, from its modelling to its control, and its potential impact on sound synthesis and music performance. The aim of the colloquium is to present research devoted to geometric methods (in a broad sense) in mechanics and control theory, and intends to facilitate interaction between theory and applications to musical acoustics.

Unfold Mechanics|colloquium|2014 is organized by:

- **IRCAM, UMR 9912 (IRCAM/CNRS/UPMC)**,
  (Instrumental Acoustics Team, 1 place Igor Stravinsky F-75004 Paris)
- **UPMC, Université Pierre et Marie Curie**
  (Institut de Mathématiques, Analyse algébrique, 175 rue du Chevaleret F-75013 Paris)

All informations:
http://activegeometry.sciencesconf.org

Thursday, September 11, 2014

All the conferences held in the Stravinsky room

8:00 am		Registration (Lobby)
9:00 am		Welcome by Gérard Assayag, IRCAM/ UMR STMS Director
9:15 am		**Session 1** - Chairman: Simon Benacchio
	9:15 am	Multisymplectic Geometry with Symmetry. Application to the Reissner Beam - Joël Bensoam
	10:00 am	Multisymplectic Lie Group Variational Integrators Part 1: Derivation and Properties - François Gay-Balmaz
10:45 am		Coffee break (Gallery -2)
11:00 am - 12:00 pm		**Keynote 1** **Multisymplectic Geometry: Some Perspectives - Frédéric Hélein**
12:00 pm		**Session 1** - Chairman: Simon Benacchio
	12:00 pm	Nonlinear Physical Models of Vibration and Sound Synthesis - David Roze
12:30 pm		Discussion
1:00 pm		Lunch - restaurant Brise Miche, place Igor-Stravinsky, 75004 Paris
2:30 pm		**Session 2** - Chairwoman: Florie-Anne Baugé
	2:30 pm	Wave Turbulence in Thin Vibrating Plates. Application to the Sound of Cymbals and Gongs. - Cyril Touzé
	3:15 pm	Multisymplectic Lie Group Variational Integrators. Part 2: Application to a Geometrically Exact Beam in R^3. - Francois Demoures
4:00 pm		Coffee break & Demo/Workshop (Gallery -2)
4:45 pm		**Session 2** - Chairwoman: Florie-Anne Baugé
	4:45 pm	Energy Balanced Models for Acoustic and Audio Systems: a Port-Hamiltonian Approach - Antoine Falaize
	5:30 pm	Graph Models of Wind Instruments - Georges Le Vey
	6:00 pm	Discussion
6:30 pm		Research funds & calls for proposal: A meeting to imagine future collaborations
8:00 pm		Dinner - restaurant Moon Roof, 34 quai d'Austerlitz, 75013 Paris

Friday, September 12, 2014

9:15 am		**Session 3** - Chairman: Olivier Thomas
	9:15 am	Modal Active Control of Linear Structures. Applications to Musical Instruments - Adrien Mamou-Mani- Baptiste Chomette
	9:45 am	Geometric Aspects of Active Constraints - Jean-Pierre Marco
10:30 am		Coffee break & demo/workshop (galery -2 and offices)
11:00 am - 12:00 pm		**Keynote 2** **Smart Structures and Active Control of Vibrations:** **25 Years of Research at ULB - André Preumont**
12:00 pm		**Session 3** - Chairman: Olivier Thomas
	12:00 pm	Active Control vs Sound Synthesis, The Guitar Case - Simon Benacchio
	12:30 pm	Discussion
1:00 pm		Lunch - restaurant Brise Miche
2:30 pm		**Session 4** - Chairman: Baptiste Chomette
	2:30 pm	Nonlinear Modes, Normal Forms and Invariant Manifolds for Vibrations of Nonlinear Musical Instruments - Olivier Thomas
	3:15 pm	Lie Symmetry Group Theory for Turbulence Modelling and Simulation Dina Razafindralandy
4:00 pm		Coffee break & demo/workshop (Gallery -2 and offices)
4:45 pm		**Session 4** - Chairman : Baptiste Chomette
	4:45 pm	Wave Turbulence in Vibrating Plates Christophe Josserand - Thomas Humbert
	5:30 pm	Coordinate Free Formulation of the Vibrations of a Reissner Beam and some Mechanical Consequences - Jean Lerbet
	6:15 pm	Discussion
8:00 pm		Concert «Melancholia» at Ircam in ESPRO (level -4)

Thursday

◆ 9.15 am - 10 am

Multisymplectic Geometry with Symmetry.
Application to the Reissner Beam

Bensoam Joël

Institut de Recherche et Coordination Acoustique/Musique (IRCAM) – UMR 9912 STMS
IRCAM, 1 place Igor Stravinsky F-75004 Paris http://www.ircam.fr/

Although acoustics is one of the disciplines of mechanics, its "geometrization" is still limited to a few areas. The Reissner beam is one of the simplest acoustical system that can be treated in the context of mechanics with symmetry. It seems that the non-linear phenomena can be handled in their intrinsic qualities through the concepts of differential geometry. Using the symmetry of Lie groups, the geometric constructions needed for reduction are presented in the context of the "covariant" approach.

◆ 10 am - 10.45 am

Multisymplectic Lie Group Variational
Integrators Part 1: Derivation and Properties

Gay-Balmaz François

Centre National de la Recherche Scientifique (CNRS) - École Normale Supérieure (ENS)
ENS, 45 rue d'Ulm F-75005 Paris www.cnrs.fr http://www.ens.fr

Multisymplectic variational integrators are structure preserving numerical schemes especially designed for PDEs derived from covariant spacetime Hamilton principles. The goal of this paper is to present a class of multisymplectic variational integrators for mechanical systems on Lie groups. The multisymplectic scheme is derived by applying a discrete version of the spacetime covariant Hamilton principle. The Lie group structure is used to rewrite the discrete variational principle in a trivialized formulation which allows us to make use of the vector space structure of the Lie algebra, via the introduction of a retraction map, such as the Cayley map. In presence of symmetries, we define the covariant momentum maps and derive a discrete version of the covariant Noether theorem. Some aspects of the symplectic character of the discrete temporal and spatial evolution will be given. Further development and applications of this integrator to beam dynamics will be reported in Part 2.

● ● ● **11 am - 12 pm**

Keynote speaker: Hélein Frédéric

Université Paris Diderot-Paris 7, 5 rue Thomas-Mann F-75013 Paris
UFR de Mathématiques et Institut de Mathématiques de Jussieu - Paris Rive Gauche
(UMR 7586), Projet Géométrie et Dynamique, 2 place Jussieu F-75005 Paris

Since Fermat's principle in optics and Least Action principle in mechanics, the calculus of variation has been applied to almost all fundamental laws of mathematical physics with a great success. The resulting equations, known as the Euler-Lagrange equations, can be translated in the form of the Hamilton equations, the meaning of which is independent on the choice of coordinates and can be expounded geometrically. This means that one may

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sometime avoid messy computations. For variational problems with one variable (i.e. the time variable) this leads to the so-called symplectic geometry. For instance Noether's (first) theorem, which is one of the most important result of this theory, connecting symmetries and conserved quantities, has a particularly concise translation in symplectic geometry. However the validity of the calculus of variation and of Noether's theorem is not limited to the calculus of variations with one variable and can be applied to problems with several variables, for instance the four coordinates of our space-time. An analogue of the symplectic geometry, called multisymplectic geometry, can be built. It leads to similar results but also to deep differences. We will present this setting and its motivations, in particular for understanding classical and quantum physics.

Frédéric Hélein is professor at the Université Paris Diderot in mathematics. He has worked on the analysis of elliptic partial differential equations in geometry, geometric completely integrable systems and he is now oriented towards questions in mathematical physics, using e.g. multisymplectic geometry to understand the classical and quantum fields theories. He received his PhD in Mathematics at the Ecole Polytechnique in 1989 under the supervision of Jean-Michel Coron and his Habilitation at the University of Paris Orsay in 1991. He has been professor at the Ecole Normale Supérieure de Cachan since 1991 and 2003. He won the Fermat prize in 1999.

◆ 12 pm - 12.30 pm

Nonlinear Physical Models of Vibration and Sound Synthesis

Roze David (1), Bensoam Joël (2)

(1) Centre National de la Recherche Scientifique (CNRS) – UMR 9912 STMS
IRCAM, 1 place Igor Stravinsky F-75004 Paris http://www.ircam.fr/
(2) Institut de Recherche et Coordination Acoustique/Musique (IRCAM) – UMR 9912 STMS
IRCAM, 1 place Igor Stravinsky F-75004 Paris http://www.ircam.fr/

Sound production in musical instruments is the consequence of interactions and wave propagation that include nonlinear phenomena. Simulating these phenomena will enable sound synthesis software (such as Modalys, developed at IRCAM) to produce more realistic sounds. In order to do so, nonlinear physical models will be implemented in Modalys software using Green-Volterra kernels. Green-Volterra kernels are used to simulate space-time nonlinear dynamical problems. This formalism allows to keep the modal approach and simulate nonlinear dynamics until a given order in the Green-Volterra series. This numerical method has been chosen in order to keep «near real-time» computation time. Interactions solving requires to compute the inverse problem, i.e. compute a force using known displacement or velocity. Green-Volterra kernels of a nonlinear string model and interaction definition will be presented with associated numerical results.

Thursday

◆ 2.30 pm - 3.15 pm

Wave Turbulence in Thin Vibrating Plates.
Application to the Sound of Cymbals and Gongs.

Touzé Cyril

École Nationale Supérieure de Techniques Avancées (ENSTA ParisTech)
ENSTA ParisTech, 828 boulevard des Maréchaux F-91762 Palaiseau CEDEX
http://www.ensta-paristech.fr/fr

Cyril Touzé works on geometrically nonlinear vibrations of thin shell structures. One aspects of his research is devoted to sound synthesis of cymbales ang gong-like instruments. These percussion instruments are known to vibrate in a strongly nonlinear regime, and thus exhibit a broadband Fourier spectrum, with an increase of energy to the high frequency range. This dynamics can be related to the wave turbulence motion displayed by thin plates that are also studied on the theoretical point of view.

◆ 3.15 pm - 4 pm

Multisymplectic Lie Group Variational Integrators.
Part 2: Application to a Geometrically Exact Beam in R^3.

Demoures Francois (1), Ratiu Tudor (1), Gay-Balmaz François (2)

(1) Institute of Technology Lausanne (EPFL)
EPFL, Route Cantonale, CH-1015 Lausanne http://www.epfl.ch
(2) Centre National de la Recherche Scientifique (CNRS) - École Normale Supérieure (ENS)
ENS, 45 rue d'Ulm F-75005 Paris www.cnrs.fr

The focus of this paper is to study and test a Lie group multisymplectic integrator (Part 1) for the particular case of a geometrically exact beam. We exploit the multisymplectic character of the integrator to analyze the energy and momentum map conservations associated to the temporal and spatial discrete evolutions. This allows us to explore the temporal motion of the beam and the spatial evolution of the wave motion through the beam. We discuss the necessary conditions to obtain a stable displacement in space versus time.

Thursday

◆ 4.45 pm - 5.30 pm

Energy Balanced Models for Acoustic and Audio Systems: a Port-Hamiltonian Approach

Falaize Antoine (1), Lopes Nicolas (1), Helie Thomas (1), Matignon Denis (2), Maschke Bernhard (3)

(1) Université Pierre et Marie Curie – UMR 9912 STMS
IRCAM, 1 place Igor Stravinsky F-75004 Paris http://www.ircam.fr/
(2) Institut Supérieur de l'Aéronautique et de l'Espace (ISAE)
Ministère de la Défense ISAE, 10 av. Edouard Belin BP 54032 F-31055 Toulouse CEDEX 4
http://www.isae.fr/
(3) Laboratoire d'Automatique et de Génie des Procédés (LAGEP), CNRS – UMR5007,
Université Claude Bernard-Lyon I (UCBL)
École Supérieure de Chimie Physique Électronique de Lyon, 43 boulevard du 11 novembre 1918
F-69622 Villeurbanne CEDEX http://www-lagep.cpe.fr/

Port-Hamiltonian Systems (PHS) are an extension of Hamiltonian systems, which represent open passive systems structured according to their conservative and dissipative parts, as well as the external sources. They are widely used in engineering as a central tool for the modeling of physical systems, their passive-guaranteed simulation, as well as for control issues. In the first part of this paper, we shall recall the precise definition of port Hamiltonian systems as control systems defined on a manifold B endowed with a Dirac structure, and recall how a Dirac structure may be derived from the topological structure of the system such as graphs of circuits or from covariant formulation of systems of conservation laws. In the second part, different applications in acoustics and electro-acoustics under current development shall be presented.

◆ 5.30 pm - 6 pm

Graph Models of Wind Instruments

Le Vey Georges

École des Mines de Nantes, 4 rue Alfred Kastler BP 20722 F-44307 Nantes CEDEX 3

A modelling approach for wind instruments with toneholes is presented. It departs from the classical one, based on the transmission lines analogy with 1D propagation in ducts, in which the impedance is a central concept. The key theoretical idea is to describe the topology of a wind instrument through a convenient graph, leading to a nonstandard vector boundary value problem for the 1D wave equation on a graph. In a second step this last one is transformed into a standard matrix one, giving an efficient numerical solution method as well as the possibility of formal developments that can be useful for either analysis or design of instruments. Results on elementary ducts with/without toneholes illustrate the method and are also used for checking against the usual method. One feature of the approach is to compute natural frequencies and the eigenmodes at once, even for geometries with large discontinuities. A nice byproduct is the answer to a conjecture formulated 20 years ago by Dalmont and Kergomard for stepped cones.

Friday

◆ 9.15 am - 9.45 am

Modal Active Control of Linear Structures. Applications to Musical Instruments

Mamou-Mani Adrien (1), Chomette Baptiste (2)

(1) Institut de Recherche et Coordination Acoustique/Musique (IRCAM), UMR 9912 STMS IRCAM 1 place Igor Stravinsky F-75004 Paris http://www.ircam.fr/
IMAREV ANR project
(2) Institut Jean Le Rond d'Alembert (IJLRA)
Université Pierre et Marie Curie (UPMC)-Paris 6, 4 place Jussieu F-75005 Paris
http://www.dalembert.upmc.fr/ijlrda/

Modal active control has been successfully applied to the vibration reduction of mechanical systems. This method initialy developped to target the control only on the mode of interest and to minimize the number of actuators and sensors also has the potential for adjusting finely the modal frequencies and dampings of musical instruments. After introducing the modal active control approach, applications on the cello, the guitar, and on a simplified clarinet will be presented, focusing on the effects on the sound and playability of these instruments.

◆ 9.45 am - 10.45 am

Geometric Aspects of Active Constraints

Marco Jean-Pierre

Institut de Mathématiques de Jussieu (IMJ)
Université Pierre et Marie Curie (UPMC)-Paris 6 , 4 place Jussieu F-75005 Paris
http://www.upmc.fr/ - http://www.institut.math.jussieu.fr/

We will give an overview of various geometric formalisms used to describe the dynamics of a mechanical system submitted to an external control by moving holonomic constraints.

● ● ● **11 am - 12 pm**

Keynote speaker: Preumont André J.

Université Libre de Bruxelles (ULB), avenue Franklin Roosevelt 50 - 1050 Bruxelles
Department of Mechanical Engineering and Robotics CP 165/42 Active Structures Laboratory (ULB) http://scmero.ulb.ac.be/index.php

Over the past 25 years, the Active Structures Laboratory of ULB has been pioneering active techniques for vibration control in various applications, mostly related to future space projects, precision engineering and bridges. The emphasis is placed on robustness and on the ability to develop a controller with a limited knowledge of the structure. The talk is divided into several parts:
The first part is devoted to the passive damping with piezoelectric transducers: This technology consists of transforming the vibrational energy into electrical energy which is dissipated in a passive network; it often involves active components (synthetic inductors, negative capacitors) and may be extended to applications requiring a negative damping. The second part focuses of the vibration isolation and damping in large space structures: These applications highlight the importance of collocated control and illustrate how a clever passive design may sometimes compete successfully with an active one. An active member consisting of a linear piezoelectric actuator collocated with a force sensor is

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described (it works like as muscle). The Integral Force Feedback (IFF) controller exhibits very good robustness properties.
Next, the talk applies the IFF controller to the active tendon control of string and cable structures and discusses how the nonlinearities of the cable dynamics may be handled, in order to reduce the numerical effort in building complex models (this part may have some aspects of interest for modeling string instruments). Active vibration control is illustrated with the control of parametric vibration of a cable-stayed bridge.
Finally, the talk includes two additional parts (if time allows) which can be seen as nice examples of mechatronics: one on real-time sound radiation sensor (discrete sensor array and distributed sensor) and one on deformable mirrors actuated with an array of piezoelectric actuators used for adaptive optics.

André Preumont received his MSc in Aeronautics from the university of Liege in 1973 and his PhD in Applied Sciences in 1981. He spent 10 years in industry before moving in academia. He has been a professor of Mechanical Engineering and Robotics at the Université Libre de Bruxelles (ULB) since 1987, full professor since 1991, and director of the Active Structures Laboratory. He is the author of 7 books. He is a member of the Belgian Royal Academy and was the recipient of the Alexander von Humboldt Research Award in 2011. He was a visiting professor at Virginia Tech (USA), UT Compiègne and INSA Lyon (France). He is a Fellow of the American Institute of Aeronautics and Astronautics.

◆ 12 pm - 12.30 pm

Active Control vs Sound Synthesis, The Guitar Case

Benacchio Simon

IRCAM, 1 place Igor Stravinsky F-75004
Paris 3-Sorbonne Universités, UPMC-Paris 6 F-75005 Paris

The modal active control proves to be a suitable way to modify the radiated sound of musical instruments. Beyond this attribute, the control can be used as a tool to study the physical phenomena governing musical instruments' performances. Thanks to this technique, many points usually analyzed using sound synthesis can be studied directly on the instrument. For example, the active control enables the in situ investigation of the mechanical properties' effects on the instruments' sound.
This paper proposes to compare the abilities of active control with these of a physical modelling synthesis method. An acoustic guitar is used as subject. The advantages, the drawbacks and the limits of these two tools are investigated and discussed.

Friday

◆ 2.30 pm - 3.15 pm

Nonlinear Modes, Normal Forms and Invariant Manifolds for Vibrations of Nonlinear Musical Instruments

Thomas Olivier (1), Touzé Cyril (2)

(1) Arts et Métiers ParisTech / LSIS UMR 7296
Arts et Métiers ParisTech, 8 boulevard Louis XIV F-59000 Lille
http://www.lsis.org/fiche/olivier_thomas.html
(2) École Nationale Supérieure de Techniques Avancées (ENSTA ParisTech)
ENSTA ParisTech, 828 boulevard des Maréchaux F-91762 Palaiseau CEDEX
http://www.ensta-paristech.fr/fr

This talk will focus on the concept of nonlinear modes and its applications to nonlinear vibrations of mechanical structures such as strings, plates and shells, viewed as elements of nonlinear musical instruments (string instruments, cymbals, gongs). The considered nonlinearities are geometrical, stemming from large amplitude oscillations with respect to the structures's thickness. The several definitions of nonlinear modes will be given and discussed, with a special focus on invariant manifolds in the phase space. The normal form theory and its link to internal resonance will be also addressed, as a powerful tool to predict the nonlinear modal interactions and to derive accurate reduced order models.

◆ 3.15 pm - 4 pm

Lie Symmetry Group Theory for Turbulence Modelling and Simulation

Razafindralandy Dina (1), Hamdouni Aziz (1), Chhay Marx, Al Sayed Nazir

Laboratoire des Sciences de l'Ingénieur pour l'Environnement (LaSIE) CNRS UMR3474 - Université de La Rochelle, avenue Michel Crépeau F-17042 La Rochelle CEDEX 1
http://lasie.univ-larochelle.fr

Lie group symmetry constitutes a powerful modelling tool in many scientific areas. They allow, for instance, the computation of Green function of linear equations. Through Noether's theorem, it is also known that each symmetry of an equation corresponds to a conservation law. In addition, symmetries are extensively used in litterature to compute self-similar solutions of various equations. In turbulence, vortex solutions of the Navier-Stokes equations was found as special self-similar solutions. Finally, we mention that the symmetries may give an information on the large-time behaviour of the solution. To some extent, the symmetries traduces the physics of the equations.
In this presentation, other applications of Lie symmetry group theory to the modelling and simulation of turbulent flows are shown. More precisely, the Lie symmetries of Reynolds Averaged Navier-Stokes equations are used to retrieve classical but also to exhibit new wall and scaling laws of non-isothermal flows. Next, the development of symmetry preserving closure models for large-eddy flow simulation methods is presented. At last, we show that, at discrete scale, symmetry preservation leads to more robust numerical scheme. To this aim, we examine the construction of invariantized discretization schemes with Cartan's moving frame method.

Friday

◆ 4.45 pm - 5.30 pm

Wave Turbulence in Vibrating Plates

Josserand Christophe (1), Humbert Thomas (2), Touze Cyril (3), Cadot Olivier (3)

(1) Institut d'Alembert, CNRS et UPMC (IDA), CNRS UMR7190 UPMC, 4 place Jussieu F-75005 Paris
(2) Institut d'Alembert, CNRS et UPMC (IDA) UPMC, 4 place Jussieu F-75005 Paris
(3) UME-ENSTA (ENSTA) ENSTA ParisTech, Palaiseau

Wave turbulence has been historically introduced for understanding the statistical equilibrium of water waves at the surface of water. The theory of wave turbulence is based on an expansion of the dynamics for weak perturbations where the nonlinearities intervene through resonant interactions. Elastic plates offer a similar context of dispersive linear wave that interact through nonlinear terms and theoretical predictions of a wave turbulence state in vibrating plates have been made almost ten years ago. In this presentation, we will first present the wave turbulence theory applied to elastic plates. Then comparisons with recent experiments will be discussed, emphasing in particular the role of the dissipation in the dynamics.

◆ 5.30 pm - 6.15 pm

Coordinate Free Formulation of the Vibrations of a Reissner Beam and some Mechanical Consequences

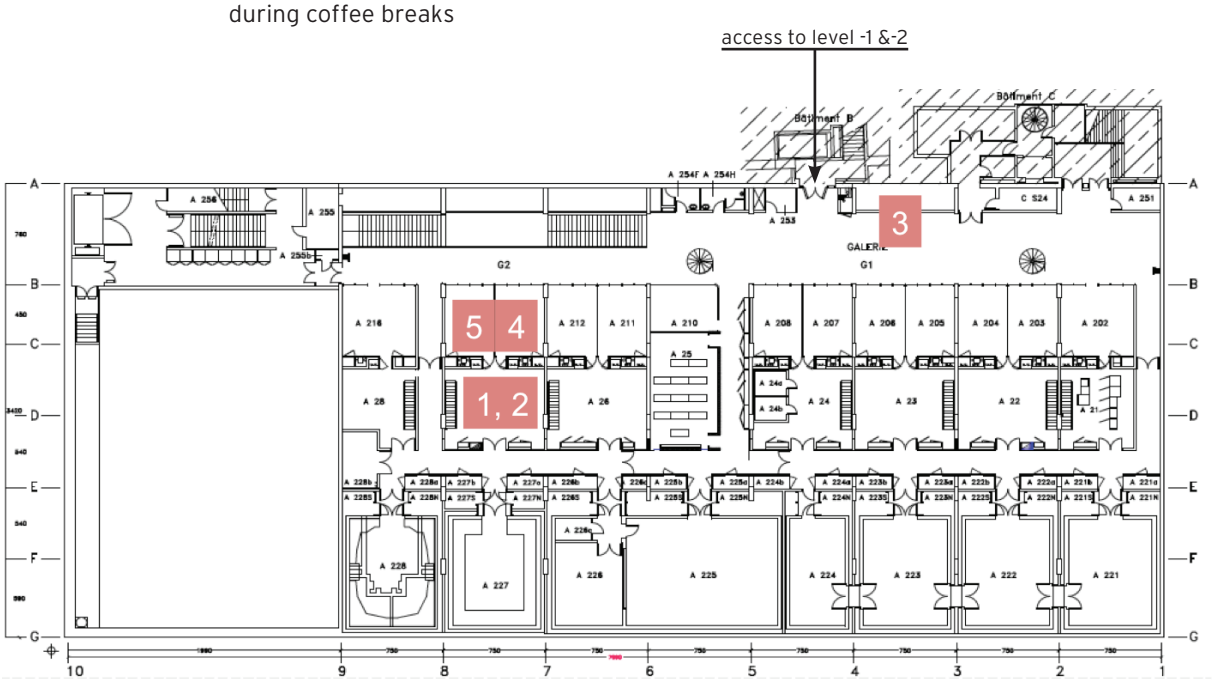
Lerbet Jean

Université d'Evry Val d'Essonne (UEVE), 40 rue du Pelvoux CE1455 Courcouronnes F-91020 Evry https://www.ibisc.univ-evry.fr/

We start from a coordinate free model of a Reissner beam with 6 d.o.f. at each section. The dynamic model is brought back to a partial differential equation in the Lie algebra of the Lie group of Euclidean displacements. A coordinate free linearization with respect to any equilibrium position is done and some interesting results about proper modes are highlighted in the framework of linear elasticity. These calculations are performed without ever using any frame nor coordinate.

Demo/Workshop

during coffee breaks



1 Active control and hybrid musical instruments (office labo7)

2 Presentation and modelling of a robotized artificial mouth playing brass instruments: A port-Hamiltonian system approach (office labo7)

3 New lattices of sound tubes with harmonically related eigenfrequencies (in the galery level -2)

4 Real-time simulation of electroacoustic systems based on Port-Hamiltonian systems (level-1 called - office n. A113)

5 Modalys: a physical modeling synthesis program (level-1 - office n. A114)

Organizing Committee

General Co-Chairs

- Joël Bensoam – IRCAM
- Adrien Mamou-Mani – IRCAM
- Jean-Pierre Marco – UPMC

Scientific committee

- Joël Bensoam – IRCAM
- Baptiste Chomette – UPMC
- Jean Lerbet – Université d'Evry
- Adrien Mamou-Mani – IRCAM
- Jean-Pierre Marco – UPMC

Organization

- Florie-Anne Baugé – IRCAM
- Sylvie Benoit – IRCAM
- Robert Piéchaud – IRCAM

IRCAM, UMR 9912 STMS (IRCAM/CNRS/UPMC/ministère de la Culture et de la Communication)
Instrumental Acoustics Team
1 place I. Stravinsky 75004 Paris, France

UPMC, Université Pierre et Marie Curie
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75252 Paris cedex 05

Acknowledgments:

Ircam-Centre Pompidou
CNRS
UPMC
ANR projet IMAREV

Ircam

Institut de recherche et coordination acoustique/musique

IRCAM, the Institute for Research and Coordination in Acoustics/Music, is one of the world's largest public research centers dedicated to both musical expression and scientific research. A unique location where artistic sensibilities collide with scientific and technological innovation, Frank Madlener has directed the institute since 2006, bringing together over 160 people.

IRCAM's three principal activities — creation, research, transmission — are visible in IRCAM's Parisian concert season, in productions throughout France and abroad, in a new rendezvous created in June 2012, ManiFeste, that combines an international festival with a multidisciplinary academy.

Founded by Pierre Boulez, IRCAM is associated with the Centre Pompidou, under the tutelage of the French Ministry of Culture and Communication. The mixed STMS research lab (Sciences and Technologies for Music and Sound), housed by IRCAM, also benefits from the support of the CNRS and the University Pierre and Marie Curie, as well as Inria (team-project MuTant).

IRCAM TECHNICAL TEAM

Éric de Gélis, Technical Manager

PROGRAM

Olivier Umecker, Graphic Designer

PROCHAINS RENDEZ-VOUS

2e RENCONTRES SUR LES BASES DE DONNÉES ET LES RESSOURCES NUMÉRIQUES

Vendredi 26 septembre, 10h-18h
Ircam, salle Stravinsky

Coordination : **Samuel Goldszmith** (Ircam-Centre Pompidou), **Rémy Campos** (Centre de musique baroque de Versailles).

Entrée libre.

COLLECTIVE SOUND CHECKS

Mercredis 1er et 15 octobre, 5 nocembre, 17 décembre, 14h-18h
Centre Pompidou 13/16

Entrée libre.

LE SAVANT ET LE PRATICIEN

Colloque
Vendredi 14, samedi 15 novembre, 10h-18h
Ircam, salle Stravinsky

Organisation : **Rémy Campos** (Centre de musique baroque de Versailles), **Nicolas Donin** (Ircam-Centre Pompidou).

Entrée libre.

LES ATELIERS DU FORUM

Mercredi 19, jeudi 20, vendredi 21 novembre, 10h-18h
Ircam

Informations : admin-forum@ircam.fr
Programme détaillé et inscription : forumnet.ircam.fr

MUSIQUE SAVANTE ET MUSIQUES ACTUELLES : ARTICULATIONS

Colloque
Lundi 15, mardi 16 décembre, 10h-18h
Ircam, salle Stravinsky et Maison de la Recherche

Coordination : **Moreno Andreatta** (Ircam-CNRS-UPMC), **Jean-Michel Bardez** (SFAM), **Philippe Cathé** (université Paris-Sorbonne).

Entrée libre.

MATH'N POP

Lundi 15 décembre, 19h
Centre Pompidou, Petite salle

Coordination : **Jean Dhombre**s (CNRS), **Caroline Raynaud** (Bpi-Centre Pompidou).

Entrée libre.

INTERNATIONAL WEB AUDIO CONFERENCE

Lundi 26, mardi 27 janvier, 10h-18h
Ircam, salle Stravinsky et Studio 5

Organisation : **Samuel Goldszmith, Norbert Schnell** (Ircam), **Raphaël Troncy** (Eurecom).

Sur inscription : http://wac.ircam.fr

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