GDRE CONEDP CNRS-INDAM-UP in Control of PDE's

Partial differential equations, optimal design and numerics, Benasque, Spain, August 31 2011

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Outline

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A **GDRE** is a *Groupement De Recherche Européen*.

It is a research structure between CNRS and partner institutions in Europe in an important scientific domain.

Groupements de Recherche are made to structure, organize, create synergies in important domains of research and to form and facilitate integration of young researchers: doctoral students, post-doc,...

It offers support from partner institutions to create a structured network, in particular for:

summer schools, thematic schools, conferences, scientific invitations and collaborations, theses in cotutelle . . .

Our motivations for a GDRE in control of PDE's:

- Control of PDE's exists since the seventies
- It is at the edge of many theoretical mathematical domains as well as of other domains of sciences.
- It is strongly and richly developing in many directions of mathematics theoretically, as well as numerically
- Moreover, there is an explosion of applicative domains which in turn generates new mathematical challenges
- It attracts a lot of talented young researchers in particular in France and Italy

Motivations for a GDRE project between France and Italy in Control of PDE's :

Strong mathematical collaborations for several years

- in Control Theory
- and in related domains such as inverse problems, optimal control

There exists an important tradition of collaboration in mathematics between France and Italy and in particular under the GDRE structure.

Three other GDRE have been created between France and Italy in NonCommutative Geometry, Algebraic Geometry and Mathematical Physics

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The **GDRE CONEDP** is for its French part composed of a **GDR n^o** 3362 created by the CNRS on January 2010.

The agreement for the "Groupement de Recherche Européen" (GDRE) CONEDP involves: the CNRS, INdAM for Italy and the University of Provence

The three institutions give financial support to the GDRE

Privileged partner nodes in Spain in Control of PDE's:

with two strong teams in Control of PDE's and related domains:

BCAM, Bilbao, head: Enrique Zuazua

Sevilla, head: Enrique Fernández-Cara

and a node in Chile: head Axel Osses

The GDRE CONEDP is structured into 4 themes :

- 1. Control and Stabilization of PDE's : general tools, recent developments and applications
- 2. Control and Stabilization of PDE's : applicative domains
- 3. Numerical analysis and simulation of control problems
- 4. Interactions between Control Theory and other domains of mathematics

Theme 1 is divided into

- Carleman inequalities and applications
- Energy methods and applications to control and stabilization of reversible PDE's
- Spectral, frequency, non-harmonic methods and number theory methods for control of PDE's
- Micro-local analysis and applications in control theory
- Interaction between finite and infinite dimensions in control theory
- Non-linear methods in control theory

Theme 2 is divided into

- Control of nonlinear hyperbolic PDE's (conservation and balance laws, networks)
- Control of fluids and fluid-structure interactions
- Control of parabolic equations and reaction-diffusion PDE's
- Reduction of number of controls for complex coupled systems

Theme 3 is divided into

- Domain decomposition methods for fluid-structure interactions
- Finite element methods and finite differences for control of PDE's
- Semi-discret methods and descente-type methods for control of PDE's
- Level set methods and applications in control and optimization of the shape of the control region

Theme 4 is divided into

- Applications of control methods to inverse problems
- Optimal control and dynamic programming for evolution equations in infinite dimensions
- Control of stochastic PDE's

The applications : some examples

- nonlinear control in particular in fluids
- quantic control
- fluid-structure interactions
- control of networks, conservation laws
- control of degenerate equations
- control of road traffic
- control of pollution

generate a strong dynamic of evolutions of the field, raising new mathematical questions on control of PDE's and on numerics

- about 245 members and partners in the GDRE
- including doctoral students and post-doct
- 28 local nodes in France
- 2 in Spain
- 1 in Chile
- 26 in Italy

Coordinators

For France : Fatiha Alabau-Boussouira (University Paul Verlaine-Metz and CNRS)

and as vice-coordinator **Olivier Glass** (University Paris-Dauphine)

For Italy : Piermarco Cannarsa (University of Roma Tor Vergata)

and as vice-coordinator **Fabio Ancona** (University of Padova)

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A committee of scientific managing composed of the 4 coordinators and :

5 members on the "french" side :

Jean-Michel Coron (Paris 6)

Gilles Lebeau (Nice)

Jean-Pierre Puel (Versailles)

Emmanuel Trélat (Orléans)

Enrique Zuazua (BCAM, Bilbao)

5 members on the italian side :

Andrei Agrachev (SISSA, Trieste)

Maurizio Falcone (Roma La Sapienza)

Paola Loreti (Roma La Sapienza)

Luciano Pandolfi (Politecinico di Torino)

Benedetto Piccoli (IAC, CNR, Roma)

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The scientific managing committee :

defines the scientific program, evaluates the financial needs and budget.

elaborates the financial annual report and the scientific report

Nodes in France and local coordinators :

- Paris 6 JLL, head : Sergio Guerrero
- Nancy-Metz (IECN-LMAM), head : Marius Tucsnak
- Orléans MAPMO, head : Jérôme Le Rousseau
- Grenoble Jean Kuntmann-Institut Fourier, head : Stéphane Labbé
- Toulouse, IMT, head : Jean-Pierre Raymond
- Orsay, LMO et LSS , head : Yacine Chitour
- Pau, LMA, head : Mehdi Badra
- ENS Cachan, Karine Beauchard
- Nanterre , MODAL'X, head : Luc Miller

- Cergy-Pontoise, LMAGM, head : Armen Shirikyan
- Mines-Patistech, CAOR et CAS, head : Pierre Rouchon
- INRIA Rocquencourt, MACS, REO, SISYPHE, head : Mazyar Mirrahimi
- Versailles, LMO, head : Luc Robbiano
- Nice, Jean Dieudonné, head : Gilles Lebeau
- Marseille, LATP, head : Assia Benabdallah
- Strasbourg, IRMA, head : Bopeng Rao
- Besançon, LMB, head : Cédric Dupaix
- Toulouse, LAAS, head : Christophe Prieur

- Valenciennes, LAMAV, head : Serge Nicaise
- Clermont Ferrand, LM, head : Olivier Bodart
- Pôle Léonard de Vinci, head : John Cagnol
- Toulon, IMATH, head : Paola Goatin
- Polytechnique, CMAP, head : Ugo Boscain
- Compiègne, LMA, head : Stéphane Mottelet
- Bretagne Occidentale, LM, head : Pierre Cardaliaguet
- Lyon, Camille Jordan, INSA et ECL, head : Jean-Pierre Lohéac
- ENS Cachan Bretagne, head : Arnaud Debussche

- ESIEE, head : Bernadette Miara

Partners in Spain and Chile /

- Sevilla (Spain), head Enrique Fernández-Cara
- Bilbao (BCAM), head : Enrique Zuazua
- Chile, (4 universities), head : Axel Osses

Nodes in Italy :

- Bari
- Bologna
- Brescia
- Ferrara
- Firenze
- L'Aquila
- Lecce
- Politecnico di Milano
- Milano-Bicocca

- Milano
- Modena
- Padova
- Pavia
- Piemonte Orientale
- Scuola Normale di Pisa
- Pisa
- IAC CNR Roma
- Roma LUISS

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- Roma La Sapienza
- Roma Tor Vergata
- Roma Tre
- Politecnico di Torino
- Trieste, SISSA
- Udine
- Venezia

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Past meetings of the GDRE and supported meetings:

- First conference of the GDRE project, IHP, Paris, October 14-16 2009, organizers : F. Alabau-B. and O. Glass.
- GDRE international conference at CIRM Luminy, January 25-29 2010. Organizers : F. Alabau-B., F. Ancona, F. Boyer, J. Le Rousseau.
- CIME session on Control of PDE's, Cetraro (Italy), July 19-23 2010. Organizers : P. Cannarsa and J.-M. Coron. Five courses given which will be published as Springer Lecture Notes.
- Opening Ceremony of the GDRE CONEDP in presence of INSMI-CNRS, DERCI-CNRS, Italian Embassy, IHP, October 12 2010
- IHP trimester in Control of PDE's October-December 2010

- Modelling and Control of Nonlinear Evolution Equations Workshop at SISSA, Trieste, May 24-27, 2011
- Workshop program of INdAM, GDRE CONEDP, "New trends in Analysis and Control of Nonlinear PDE's", June 13-15 2011, Roma.
- OPTPDE, BCAM summer school, Challenges in Applied Control and Optimal Design, July 4-8 2011, Bilbao, Spain
- Partial Differential Equations, Optimal Design and Numerics, August 28 - September 9 2011, Benasque International Center of Science, Pedro Pascual, Benasque, Spain (with partial financial support from the GDRE).

GDR meetings in France:

- Node: Clermont-Ferrand: june 2011
- Node: Orléans: september 26–27 2011
- Node: Marseille: november 21–23 2011

Planned meetings in 2012 :

- Thematic CNRS school of the GDRE ConEDP: Control of PDE's, interactions and application challenges, CIRM, Luminy, November 5th–9th 2012 with courses on stochastic equations and control theory, planification and trajectory tracking, state estimation and filtering. and degenerate parabolic PDE's and applications to environment (climatology and oceanology) and two thematic half-days on 1D hyperbolic systems and applications to canal control and traffic and on control challenges in oceanology and climatology and plenary conferences.
- Thirteen International Conference on Hyperbolic Problems: Theory, Numerics and Applications, Padova, June 25-29 2012

GDR meetings:

- Node: Toulouse in 2012

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- Node: Grenoble in 2013

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Other connected meetings :

- IFAC Workshop on Control of Distributed Parameter Systems, Toulouse, July 20-24 2009, organizers : D. Matignon et C. Prieur
- The "Groupe de travail Contrôle" at Paris 6. Organizers : J.-M. Coron, O. Glass and S. Guerrero

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The GDRE project supports in particular young researchers with:

- sessions of courses organized to form doctoral students and post-doctoral fellows
- financial support from the GDRE to attend courses and conferences,
- grants for short stay in partner countries.

The GDRE gives great opportunities to organize structured research with support from CNRS (INSMI and DERCI), INDAM and UP.

It also attracts cofunding with financial and scientific support by ANR, PRIN, ERC grants, CIME, universities, ...

The Benasque bi-annual meeting organized in the International Benasque Center is very much appreciated by the community in control and optimization for PDE's. So:

Our special thanks to the organizers:

Enrique Zuazua and Giuseppe Buttazzo

and to the director of the Center:

Manuel Asorey

We also thank the support team of the Benasque Center for the logistic:

Tracey, Ana, David

and the BCAM team:

Miguel and Magaly

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Thanks for your attention

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