Control and analysis of PDE systems

In honor of the 60th anniversary of Marius Tucsnak

Bordeaux, France

Monday, November 29th, 2021 – Wednesday, December 1st, 2021

Mon. Nov. 29th.	**Tue. Nov. 30th.**	**Wed. Dec. 1st.**
Opening	09:00 – 09:45 George Weiss	09:00 – 09:45 Jean-Pierre Raymond
10:15 – 10:30 *Presentation of M. Tucsnak by J.-P. Puel*	09:45 – 10:30 Julie Valein	09:45 – 10:30 Debayan Maity
10:30 – 11:15 Jean-Michel Coron	*Break*	*Break*
11:15 – 12:00 Otared Kavian	11:00 – 11:45 Mario Sigalotti	11:00 – 11:45 Ana Leonor Silvestre
12:00 – 12:15 *Presentation of the posters by F. Boyer*	11:45 – 12:30 Birgit Jacob	11:45 – 12:30 Jean-Pierre Puel
Lunch break	*Lunch break*	*Ending*
14:00 – 14:45 Luz de Teresa	14:00 – 14:45 Karine Beauchard	
14:45 – 15:30 Karim Ramdani	14:45 – 15:30 Ioan R. Ionescu	
Break	*Break*	
16:00 – 16:45 Olivier Glass	16:00 – 16:45 Franck Sueur	
16:45 – 17:30 Sergei A. Avdonin		
	17:15 – 22:00 *Social event*	

Preamble

This workshop aims to bring together scientists (in particular applied mathematicians and control theorists) interested in systems governed by evolution partial differential equations modeling phenomena coming from fluid mechanics and biology. The considered subjects include, but are not limited to, the analysis, the control and the identification of infinite dimensional dynamical systems coming from fluid mechanics, fluid-structure interactions, population dynamics.

On this occasion we intend to celebrate the 60^{th} anniversary of our colleague and friend Marius Tucsnak.

Short biography of Marius Tucsnak.

After having obtained the master in mathematics-mechanics of the Bucharest University in 1985, Marius Tucsnak worked for two years in the Research Institute for Textile Industry, in Bucharest. Between 1987 and 1990 he had an appointment as junior research scientist of the Institute of Mathematics of the Romanian Academy (IMAR). From 1990 to 1992 Marius Tucsnak followed a PhD program, under the supervision of Jean-Pierre Puel and he defended his PhD in 1992 at the University of Orléans. In 1992 he was appointed as assistant professor at the University of Versailles and he defended his "habilitation" (HDR) in 1995 at the University Pierre et Marie Curie (Paris 6). Marius Tucsnak has been hired as full professor at the University Henri Poincaré (Nancy 1) in 1997. From 2009 to 2015 he was the head of the Élie Cartan Institute, which is the mathematics research department in Nancy. Since 2015 he is professor and holder of an excellency chair at the University of Bordeaux.

Marius Tucsnak's webpage:
`https://www.math.u-bordeaux.fr/~mtucsnak/`

Organizers.

- Sylvain Ervedoza, *Université de Bordeaux, France*
- Karim Kellay, *Université de Bordeaux, France*
- Jérôme Lohéac, *Université de Lorraine, France*
- Takéo Takahashi, *Inria Nancy, France*

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- ANR Project TRECOS ANR-20-CE40-0009.

The conference will take place in the conference room at the Institut de Mathématiques de Bordeaux, Building A33, 351 cours de la libération, Talence.

Invited speakers.

- Sergei A. Avdonin, *University of Alaska, USA*
- Karine Beauchard, *ENS Rennes, France*
- Jean-Michel Coron, *Université Pierre et Marie Curie, France*
- Olivier Glass, *Université Paris-Dauphine, France*
- Ioan R. Ionescu, *Université Paris 13, France*
- Birgit Jacob, *University of Wuppertal, Germany*
- Otared Kavian, *Université de Versailles, France*
- Debayan Maity, *TIFR Bangalore, India*
- Jean-Pierre Puel, *Université de Versailles, France*
- Karim Ramdani, *Inria Nancy, France*
- Jean-Pierre Raymond, *Université Toulouse 3, France*
- Mario Sigalotti, *Inria, Paris, France*
- Ana Leonor Silvestre, *Instituto Superior Técnico, Portugal*
- Franck Sueur, *Université de Bordeaux, France*
- Luz de Teresa, *Universidad Nacional Autonoma de México, Mexico*
- Julie Valein, *Université de Lorraine, France*
- George Weiss, *Tel Aviv University, Israel*

Abstracts

Speakers abstracts

Sergei A. Avdonin, *University of Alaska, USA*
Monday, November 29$^{\text{th}}$, 16:45 – 17:30
New Developments in Control Theory for Differential Equation Networks: from Trees to General graphs
Abstract. Under differential equation networks we understand differential equations on metric graphs coupled by certain vertex matching conditions. These models play a fundamental role in many problems of science and engineering. Recent interest in control and inverse theory for partial differential equations on metric graphs is motivated by applications to important problems of classical and quantum physics, chemistry, biology, and engineering. For trees, i.e. graphs without cycles, various types of control and inverse problems were studied in the literature, but almost nothing was done for graphs with cycles. In this talk we describe controllability results for the wave equation on general compact graphs. Our approach combines spectral and dynamical methods. First we prove the shape and velocity controllability using the dynamical approach — we reduce these problems to the Volterra integral equations of the second kind. Then we prove exact controllability using the spectral approach — the method of moments and properties of vector exponential families.

Karine Beauchard, *ENS Rennes, France*
Tuesday, November 30th, 14:00 – 14:45
A unified approach of obstructions to small-time local controllability for scalar-input systems
Abstract. TBA

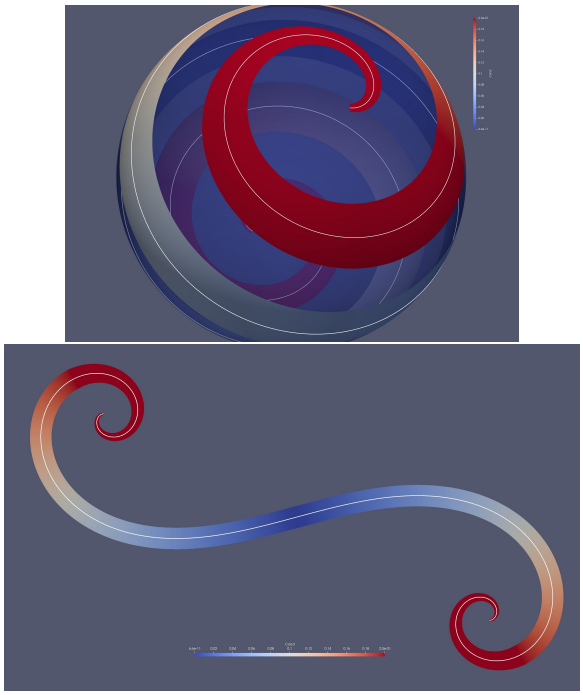
Jean-Michel Coron, *Université Pierre et Marie Curie, France*
Monday, November 29th, 10:30 – 11:15
Obstruction to the small-time local controllability for a KdV control system
Abstract. This talk is devoted to the local null-controllability of the nonlinear KdV equation equipped the Dirichlet boundary conditions using the Neumann boundary control on the right. Lionel Rosier proved in 1997 that this KdV system is small-time locally controllable for all non-critical lengths and that the uncontrollable space of the linearized system is of finite dimension when the length is critical. Concerning critical lengths, Emmanuelle Crépeau and I proved in 2004 that the same result holds when the uncontrollable space of the linearized system is of dimension 1, and later Eduardo Cerpa in 2007 , and then Eduardo Cerpa and Emmanuelle Crépeau in 2007 established that the local controllability holds for large time for all other critical lengths. We present in this talk a recent joint work with Armand Koenig and Hoai-Minh Nguyen showing that, for a class of critical lengths, the nonlinear KdV system is not small-time locally controllable.

Olivier Glass, *Université Paris-Dauphine, France*
Monday, November 29th, 16:00 – 16:45
Control of solids and vortices in a perfect fluid
Abstract. In this talk, I will discuss two control problems related to models of solids in a perfect fluid. In the first one, I will describe how one can influence the trajectory of solids immersed in a perfect fluid filling a cavity, by means of a control located on the external boundary of the cavity. In the second one, I will describe how one can influence the trajectory of point vortices by controlling a single vortex. The two studies are related, because the point vortex system can be obtained as a limit of the evolution of solids in a perfect fluid.

Ioan R. Ionescu, *Université Paris 13, France*
Tuesday, November 30th, 14:45 – 15:30
Shell design from pre-stressed plates: applications to nano-structures
Abstract. We address the following design problem: what is the shape of a plate and the associated pre-stress that relaxes toward a given three-dimensional shell ? Small deformations and large rotations are used here to model the elastic relaxation into various three-dimensional shapes. The resulting equations for materials with a weak material transversal heterogeneity involve only the thickness, the curvature tensor and the pre-strain/stress moments (see [1]). A special attention is devoted to materials that can be obtained by layer-by-layer crystal growth (molecular beam epitaxy), which possesses an in-plane isotropic

pre-strain. We have found that a rectangular plate could relax both into a cylindrical surface or on a part of a sphere in which case it should have a small diameter with respect to the sphere radius. In both cases, the theoretical estimates have been compared with the experimental realizations and FE numerical computations and we found a very good agreement between all of them.

To overcome the small-area restriction for non-developable surfaces we try in [2] to cover these three-dimensional shells using shell-strips (or shell-ribbons). Since shell-strips have an additional geometric parameter, we show in that under suitable assumptions that relate the width of the strip to the curvature of the shell, we are able to design arbitrary shell surfaces by covering them with shell-strips. As an illustration, we provide optimized covers of the sphere in a variety of different surface-strips relaxed from plate-strips with homogeneous and isotropic pre-stress. Moreover, we propose the design of the torus, of the helicoid and of the non-developable Möbius band, which requires inhomogeneous and anisotropic pre-stress.



A spherical ribbon and the corresponding planar design to obtain it.

References

[1] A. Danescu, I.R. Ionescu, Shell design from planar pre-stressed structures, *Math. Mec. Solids*, 25(6), 2127-2134, 2020.

[2] Danescu A, Ionescu IR, Non-developable shell-strips design from pre-stressed plate-strip. submitted, ArXiV preprint, (2021)

Birgit Jacob, *University of Wuppertal, Germany*
Tuesday, November 30$^{\text{th}}$, 11:45 – 12:30
Controllability and Riesz bases of infinite-dimensional port-Hamiltonian systems
Abstract. The location of the spectrum, the Riesz basis property and controllability of infinite-dimensional linear port-Hamiltonian systems on a 1D spatial domain are studied. This class of systems cover in particular the wave equation, the transport equation and the Timoshenko beam as well as coupled systems.

It is shown that infinite-dimensional linear port-Hamiltonian systems on a 1D spatial domain with full boundary control are exactly controllable and the Riesz basis property is equivalent to the fact that system operator generates a strongly continuous group. Moreover, in this situation the spectrum consists of eigenvalues only, located in a strip parallel to the imaginary axis and they can decomposed into finitely many sets having each a uniform gap. This is joint work with Julia Kaiser and Hans Zwart.

Otared Kavian, *Université de Versailles, France*
Monday, November 29$^{\text{th}}$, 11:15 – 12:00
Remarks on the convergence to equilibrium in some parabolic evolution equations
Abstract. We consider a few examples of parabolic evolution equations in the whole space, linear or nonlinear, for which one can show the existence of a positive equilibrium and then one may prove convergence of positive solutions to a multiple of the equilibrium. We consider a (weekly) nonlinear mutation selection model, known as *replicator-mutator* equation in evolutionary biology. These models involve a nonlocal mutation kernel and a confining fitness potential. We prove that the long time behaviour of the Cauchy problem is determined by the underlying principal eigenelement of the underlying linear operator. To do so, through a minimization problem under constraints, we prove first the existence of such an eigenelement. Then we first analyze the linear evolution problem through the proof of the existence of a spectral gap, by taking advantage of the theory of strongly continuous semigroups of positive operators. We conclude with the analysis of the nonlinear problem.

Debayan Maity, *TIFR Bangalore, India*
Wednesday, December 1$^{\text{st}}$, 09:45 – 10:30
Large time behaviour of a fluid-solid interaction model.
Abstract. We consider several systems modelling the motion of rigid bodies in a viscous fluid. We discuss the long time behavior of solutions in terms of the fluid properties and on the geometric setting. The main focus of this talk will be on the large time behaviour of a solid moving in an unbounded three dimensional incompressible viscous fluid. This is joint work with Sylvain Ervedoza and Marius Tucsnak.

Jean-Pierre Puel, *Université de Versailles, France*
Wednesday, December 1st, 11:45 – 12:30
Boundary controllability as limit of distributed controllability.
Abstract. I consider a controllability system where the control acts in an ϵ-neighborhood ω_ϵ of a part Γ_0 of the boundary. We study the "convergence" of this problem when ϵ tends to 0.
I will recall the case of the wave equation which was treated by Caroline Fabre and myself. Then, I will present the results for the heat equation which is a work in collaboration with Felipe W. Chaves and Mauricio C. Santos.
The limit is a boundary controllability problem. The difficulties are first of all to obtain a sharp estimate of the observability constant and then a passage to the limit where the homogeneous Dirichlet condition is lost for a problem with a right hand side which becomes singular.

Karim Ramdani, *Inria Nancy, France*
Monday, November 29th, 14:45 – 15:30
Homogenization of Materials with Sign-Changing Coefficients
Abstract. We investigate a periodic homogenization scalar problem involving two isotropic materials with conductivities of different signs: a classical material and a metamaterial (or negative material). Due to the sign-changing coefficients in the equations, it is not easy to obtain uniform energy estimates to apply the usual homogenization techniques. Using the T-coercivity approach, we prove well-posedness results for the initial and the homogenized problems and we obtain a convergence result. These results are obtained under the condition that the (negative) contrast between the two conductivities is large or small enough in modulus.

Jean-Pierre Raymond, *Université Toulouse 3, France*
Wednesday, December 1st, 09:00 – 09:45
Approximation of feedback gains stabilizing fluid flows using the pseudo-compressibility method
Abstract. The feedback stabilization of the linearized Boussinesq system by a distributed control, and its approximation by the pseudo-compressible system, have been recently studied by Kevin Le Balc'h and Marius Tucsnak in [1]. Convergence results of the solution of the closed-loop pseudo-compressible model towards the solution of the closed-loop incompressible model have been proved in [1]. In this talk, we are going to complete these reults by establishing convergence rates between the solution of the closed-loop pseudo-compressible model and the solution of the closed-loop incompressible model in the case of a distributed control, and also in the case of a boundary control. This talk is based on joint works with Mehdi Badra [2], [3].

References

[1] K. Le Balc'h, M. Tucsnak, A penalty approach to the infinite horizon LQR optimal control problem for the linearized Boussinesq system. ESAIM Control Optim. Calc. Var. 27 (2021), Paper No. 17, 30 pp.

[2] M. Badra, J.-P. Raymond, Approximation of feedback gains stabilizing viscous incompressible fluid flows using the pseudo-compressibility method, submitted, 2021.

[3] M. Badra, J.-P. Raymond, Approximation of feedback gains using spectral projections - Application to the Navier-Stokes equations, submitted, 2021.

Mario Sigalotti, *Inria, Paris, France*
Tuesday, November 30$^{\text{th}}$, 11:00 – 11:45
Approximate and exact controllability of linear difference equations
Abstract. We study the controllability of linear difference equations with multiple and possibly incommensurable time-delays. One of the major interests in linear difference equations is that, thanks to the method of characteristics, they can be used to describe some 1-D hyperbolic partial differential equations. In this talk we present some recent Hautus-Yamamoto criteria for finite-time approximate and exact controllability, obtained in collaboration with Y. Chitour, S. Fueyo, and G. Mazanti.

Ana Leonor Silvestre, *Instituto Superior Técnico, Portugal*
Wednesday, December 1$^{\text{st}}$, 11:00 – 11:45
Optimal boundary control for steady motions of a self-propelled body in a Navier-Stokes liquid
Abstract. Consider a rigid body $\mathcal{S} \subset \mathbb{R}^3$ immersed in an infinitely extended Navier-Stokes liquid and the motion of the body-fluid interaction system described from a reference frame attached to $\mathcal{S}$. We are interested in steady motions of this coupled system, where the region occupied by the fluid is the exterior domain $\Omega = \mathbb{R}^3 \setminus \mathcal{S}$. In this context, we will focus on self-propelled motion of $\mathcal{S}$, specifically in the following problem: the use of boundary controls v_*, acting on the whole $\partial\Omega$ or just on a portion Γ of $\partial\Omega$, to generate a self-propelled motion of $\mathcal{S}$ with a target velocity $V(x) := \xi + \omega \times x$ and minimize the drag about $\mathcal{S}$. This is a joint work with Toshiaki Hishida (Nagoya University, Japan) and Takéo Takahashi (INRIA Nancy-Grand Est, France).

Franck Sueur, *Université de Bordeaux, France*
Tuesday, November 30$^{\text{th}}$, 16:00 – 16:45
Cost of controllability of the incompressible Euler equations
Abstract. The controllability of the incompressible Euler equations has been obtained twenty years ago by Jean-Michel Coron in 2D and by Olivier Glass in 3D, thanks to a genuinely nonlinear method: the return method. These results establish that it is possible to act at a distance to drive exactly the fluid velocity from a given initial data to a wished target velocity in an arbitrary positive time. The method makes use of a strong auxiliary flow with a flushing property which guarantees the controllability of the linearization of the incompressible Euler equations around this flow. In view of concrete applications it is interesting to determine the cost of controllability of this linearized Euler equations. In this talk I will give the results of our investigations with Vincent Laheurte.

Luz de Teresa, *Universidad Nacional Autonoma de México, Mexico*
Monday, November 29$^{\text{th}}$, 14:00 – 14:45
On the controllability of coupled Stokes and Navier-Stokes systems.
Abstract. In this talk we present some new results on the null controllability of m-coupled Stokes equations. We will consider the situation in which we act only in the first N-dimensional Stokes system and we act only in $N-1$ components of this system. We will consider first and zero-order coupling. The work is in collaboration with Takéo Takahashi and Yingying Wu-Zhang.

Julie Valein, *Université de Lorraine, France*
Tuesday, November 30$^{\text{th}}$, 09:45 – 10:30
Feedback stabilization of parabolic systems with input delay
Abstract. In this talk we study the stabilization of parabolic systems with a finite-dimensional control subjected to a constant delay. Our main result shows that the Fattorini-Hautus criterion yields the existence of such a feedback control, as in the case of stabilization without delay. The proof consists in splitting the system into a finite dimensional unstable part and a stable infinite-dimensional part and to apply the Artstein transformation on the finite-dimensional system to remove the delay in the control. Using our abstract result, we can prove new results for the stabilization of parabolic systems with constant delay: the N-dimensional linear reaction-convection-diffusion equation with $N \geq 1$ and the Oseen system. We end by showing that this theory can be used to stabilize nonlinear parabolic systems with input delay by proving the local feedback distributed stabilization of the Navier-Stokes system around a stationary state. It is a joint work with Imene Aicha Djebour and Takéo Takahashi.

George Weiss, *Tel Aviv University, Israel*
Tuesday, November 30$^{\text{th}}$, 09:00 – 09:45
A class of conservative systems with nonlinear damping
Abstract. We revisit the class of "conservative systems from thin air" introduced by M. Tucsnak and G. Weiss in 2003, and investigate what happens if a nonlinear and possibly unbounded damping term is added.

Posters abstracts

Ismaila Balogoun, *L2SN*
ISS Lyapunov strictification via observer design and integral action control for a Korteweg-de Vries equation
Abstract. The article deals with the output regulation of a Korteweg-de-Vries (KdV) system subject to a distributed disturbance. The control input and the output are located at the boundary. To achieve this objective, we follow a Lyapunov approach. For that, inspired by the strictification methodology proposed in [Praly 2019] in the finite-dimensional context, we construct an ISS-Lyapunov functional for the KdV equation thanks to the use of an observer designed via

the backstepping approach. Then, thanks to this Lyapunov functional, we apply the forwarding method in order to solve the desired output regulation problem.

Mégane Bournissou, *ENS Rennes*
Controllability of the 1D bilinear Schrödinger equation by a power series expansion of the solution
Abstract. We take an interest in the notion of small time local controllability (STLC) around the ground state: for any final time T, any initial data and any target close enough to the ground state, can we find a control such that the solution of the Schrödinger equation steers the initial condition to the target at the final time T? Often, to prove such a result, one can start by looking at the controllability of the linearized equation. Indeed, if the linearized system is controllable, using a fixed-point theorem, one can hope to prove the STLC of the nonlinear system. However, in this work, we are looking at situations where we lose the controllability of the linear system. We wonder whether the following terms of the expansion of the solution can help to recover the directions lost at the first order. More precisely, for the Schrödinger equation, we formulate assumptions under which the quadratic term induces a drift which prevents STLC for regular controls. Moreover, we prove that, in the same functional setting, one can use the cubic term instead to absorb the drift and recover STLC for less regular controls.

Salah-Eddine Chorfi, *Cadi Ayyad University*
Stable determination of several coefficients by one observation in a semilinear parabolic system with dynamic boundary conditions
Abstract. In this work, we study the stable determination of four coefficients appearing in a coupled semilinear parabolic system with dynamic boundary conditions which couple intern-boundary phenomena. We prove a Lipschitz stability result for interior and boundary potentials by means of only one observation component, localized in any arbitrary subdomain. The proof mainly relies on some new Carleman estimates for dynamic boundary conditions.

Baparaou Danhane, *Université de Lorraine*
Output controllability for Linear Time Invariant systems
Abstract. In the state controllability of physical systems, we usually make a strong assumption that we know the whole state of the considered systems. But in practice, the whole state is not often available or not of interest. Only a measurement usually called output is accessible and one might be interested in controlling this output (output controllability) instead of the whole state. Output controllability is very important to be studied because of its applicative importance. For example, considering two cars, one may aim to put a certain distance between them at some time. Note that the state of this system contains at least four variables (the two positions and speeds). Here, one can see that the matter is the one of controlling the difference between the positions not the whole state. Many other real life practical examples can be found, as for instance

in electrical engineering. Unfortunately, the topic of output controllability did not get the same infatuation as the one of state controllability. Consequently, there are few results on that topic in the literature. We will present some of our contributions to the output controllability of Linear Time Invariant systems.

Hugo Parada, *Université Grenoble Alpes*
Global Well-posedness of KdV equation on a Star-Shaped Network and stabilization by saturated controllers
Abstract. In this work we deal with the global well-posedness and stability of the linear and nonlinear Korteweg-de Vries equation on a finite star-shaped network by acting with saturated controls. We obtain the global well-posedness by using Kato smoothing property for the linear case and then using somes estimates and a fixed point argument we deal with the nonlinear system. Finally we obtain the exponential stability using two different kinds of saturation by proving an observability inequality via a contradiction argument.

Pei Su, *Université de Bordeaux*
Control of a water waves system in a pool
Abstract. We are interested in the boundary control problem of the small-amplitude water waves system in a rectangular tank. The model actually we used here is a fully linear and fully dispersive approximation of Zakharov-Craig-Sulem formulation constrained in a rectangle, in particular, with a wave maker. The wave maker acts on one lateral boundary, by imposing the acceleration of the fluid in the horizontal direction, as a scalar input signal. Firstly, we introduce the Dirichlet to Neumann and Neumann to Neumann maps, associated with the certain edges of the domain, so that the system reduces to a well-posed linear control system. Then we consider the stabilizability issue on the gravity and gravity-capillary waves. It turns out that, in both cases, there exists a feedback functional, such that the corresponding control system is strongly stable. Finally, we consider the asymptotic behaviour of the above system in shallow water regime, i.e. the horizontal scale of the domain is much larger than the typical water depth. We prove that the solution of the water waves system converges to the solution of the one dimensional wave equation with Neumann boundary control, when taking the shallowness limit. Our approach is based on a detailed analysis of the Fourier series and the dimensionless version of the evolution operators mentioned above, as well as a scattering semigroup and the Trotter-Kato approximation theorem. This is a joint work with M. Tucsnak (Bordeaux) and G. Weiss (Tel Aviv).

Jiacheng Zhang, *Université de Bordeaux*
Boundary stabilization of 1-D nonlocal transport equation
Abstract. This work aims at looking for some control law that can replace classical proportional control feedback law to stabilize $1D$ transport equation with non-local velocity. We will use a two step alternating control to stabilize the system in more general case.

Walid Zouhair, *Cadi Ayyad University*

Logarithmic convexity and impulsive controllability for the heat equation with dynamic boundary conditions.

Abstract. In this poster, I will present a logarithmic convexity that reflects an observability estimate at a single point of time for the 1-D heat equation with dynamic boundary conditions. As a result, I have established the approximate controllability for the impulsive heat equation with dynamic boundary conditions. In addition, I have obtained an explicit upper bound of the cost of impulse control. In the end, I give a constructive algorithm for computing the impulsive control of minimal L2-norm. I also, present some numerical tests to validate the theoretical results and show the efficiency of the designed algorithm.

List of participants

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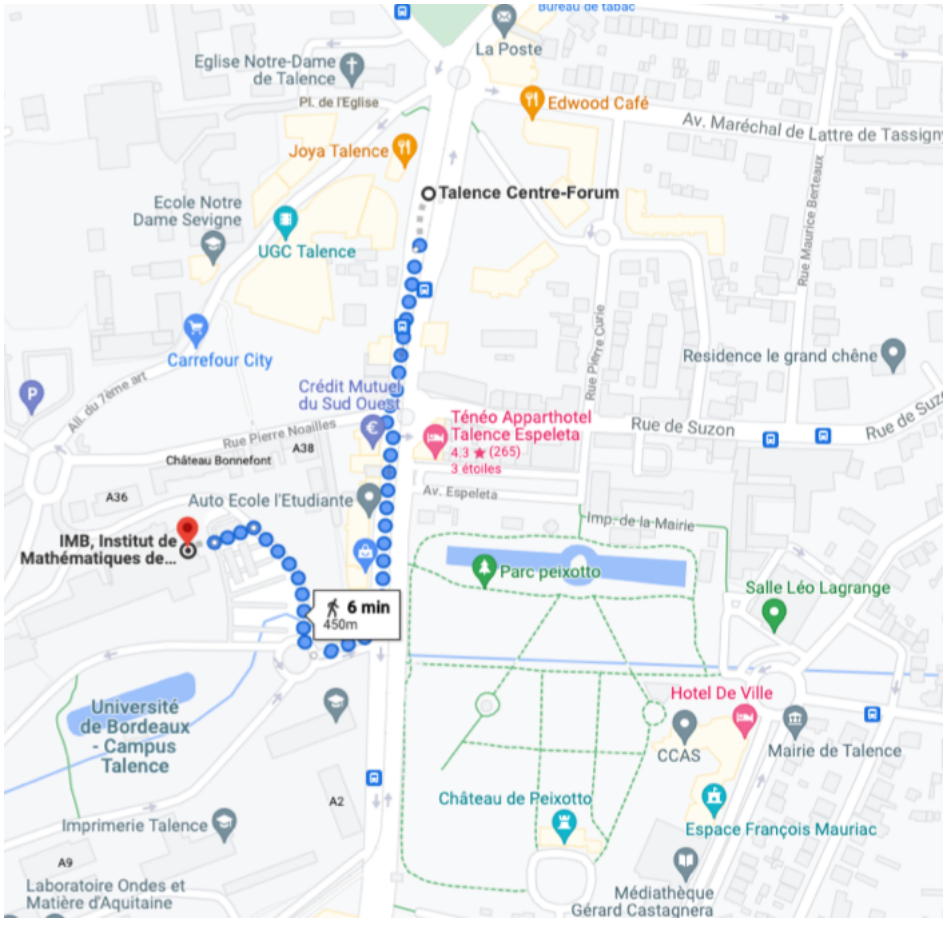
Practical informations

The conference takes place in the conference room at the Institut de Mathématiques de Bordeaux, Building A33, 351 cours de la libération, Talence. Note that accessing the building might require to ring at the main door for entrance.

Transportation in Bordeaux

To reach the Institut de Mathématiques de Bordeaux from the city center, from downtown the easiest is to take the tram B direction *Pessac* and stops at *Forum* (see the figure below). Note that the tickets should be purchased before going up the tram from the vending machine and cannot be bought in the tram.



Between the tram stop Forum and the Institut de Mathématiques de Bordeaux.

When coming directly from the railway station *Gare Saint Jean* to the Institut de Mathématiques de Bordeaux, the easiest is to take the bus 10 direction

Beausoleil and stops at *Mairie de Talence*.

Most of the participants will be at the *Appart Hotel Victoria Garden* (127, Cours de la Somme, 33800 Bordeaux, +33 (0)5 56 33 48 48). It is located at 20 minutes walking distance to the railway station via *rue Furtado* and *rue Lafontaine*, 10 minutes walking distance to *Victoire* along the *Cours de la Somme*) and at 5 minutes from the tram stop *Bergonié* via *rue Jules Delpit*. The trip from the Appart Hotel Victoria Garden to the Institut de Mathématiques de Bordeaux is around 20 minutes using Tram B direction *Pessac*.

The city center of Bordeaux is easily accessible with the tram B, and lies approximately between the tram stops *Victoire* and *Chartrons*.

Social event

The social event will take place on Tuesday November 30^{th}, from *6 pm* to *9:30 pm* at the *Château Pape Clément* (216 Av. Dr Nancel Penard, 33600 Pessac). It includes a visit of the Château Pape Clément, wine tasting and a social dinner.

A bus departing at *5:15 pm* will take the participants from the University to the *Château Pape Clément* and take them back to the University or to the Appart Hotel Victoria Garden (127, Cours de la Somme, 33800 Bordeaux) around *10 pm*.

In case of emergency, contact us:
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