Welcome to the
Special Semester on
New Trends in Calculus of Variations
Linz, October 13 – December 12, 2014
http://www.ricam.oeaw.ac.at/specsem/specsem2014

Organizer
Maitine Bergounioux, Universite d'Orleans, France

Local Organizer
Karl Kunisch, University of Graz & RICAM, Austria
Otmar Scherzer, University of Vienna & RICAM, Austria

Workshops
Workshop 1: Shape and topological optimization
October 13-17, 2014

Workshop 2: Variational methods in imaging
October 27-31, 2014

Workshop 3: Geometric control and related fields
November 17-21, 2014

Workshop 4: Optimal Transport in the Applied Sciences
December 08-12, 2014

Schools
School 1: Imaging
October 22-24, 2014

School 2: Optimal Transport in the Applied Sciences
December 02-05, 2014
Workshop 1: Shape and topological optimization
October 13-17, 2014

Organizers
Édouard Oudet, Université Joseph Fourier Grenoble, France
Martin Rumpf, Universität Bonn, Germany

Main topics
The optimization of geometry and topology of shapes with applications in engineering and geometry
processing requires the combination of a variety of mathematical tools among them different implicit shape
representations, relaxation theory, homogenization, duality techniques, and optimal transportation methods.
The workshop will bring together experts on geometry, regularity theory, structural mechanics, numerical
analysis, and optimization to discuss recent trends, identify synergies between different disciplines, and
explore new directions.

List of speakers
Gregoire Allaire (Paris)
Andrés León Baldelli (Oxford)
Soeren Bartels (Freiburg)
Eric Bonnetier (Grenoble)
Elie Bretin (Lyon)
Dorin Bucur (Chambery, France)
Blanche Buet (Lyon)
Giuseppe Buttazzo (Pisa)
Charles Dapogny (Rutgers)
Ilaria Fragala (Milan)
Pedro Freitas (Lisbon)
Harald Garcke (Regensburg)
Helmut Harbrecht (Basel)
Antoine Henrot (Nancy)
Michael Hintermüller (Berlin)
Francois Jouve (Paris)
Victor Kovtunenko (Graz)
Simon Masnou (Lyon)
Georgios Michailidis (Paris)
Yannick Privat (Paris)
Michael Stingl (Erlangen)
Anca-Maria Toader (Lisboa)
Bozhidar Velichkov (Pisa)
David Vicente (Orléans)
Benedikt Wirth (Münster)
Abstracts

“A LINEARIZED APPROACH TO WORST-CASE DESIGN IN SHAPE OPTIMIZATION”
Grégoire ALLAIRE  CMAP, Ecole Polytechnique

Abstract

The purpose of this work is to propose a deterministic method for optimizing a structure with respect to its worst possible behavior when a ‘small’ uncertainty exists over some of its features. The main idea of the method is to linearize the considered cost function with respect to the uncertain parameters, then to consider the supremum function of the obtained linear approximation, which can be rewritten as a more classical function of the design, owing to standard adjoint techniques from optimal control theory. The resulting “linearized worst-case” objective function turns out to be the sum of the initial cost function and of a norm of an adjoint state function, which is dual with respect to the considered norm over perturbations. This formal approach is very general, and can be justified in some special cases. In particular, it allows to address several problems of considerable importance in both parametric and shape optimization of elastic structures, in a unified framework. This is a joint work with Charles Dapogny (LJK, CNRS).

“Quasi-periodic fracture patterns in thin films under homogeneous loads”
Andrés A. León Baldelli  Mathematical Institute, Oxford University, Oxford, UK

Abstract

Structuration of complex crack patterns, observed in three- and two-dimensional systems under tensile loads, can be successfully tackled with the Variational Approach to fracture. Unlike in other approaches, mechanisms of crack path selection follow an energetic argument of unilateral stability. Based on a first order, linear, two-dimensional, variational model of a brittle thin film issued from asymptotic analysis, I will show the numerical implementation of the fracture problem and a large-scale numerical investigation of the emergence of morphologically robust complex patterns of quasi-periodic transverse cracks, in competition with mechanisms of interfacial debonding. Furthermore, evolution of crack patterns along monotonic load paths is constrained by the physical irreversibility constraint.

This is a joint work with B. Bourdin, Department of Mathematics and Center for Computation & Technology, Louisiana State University, Baton Rouge, LA, USA, and C. Maurini, Sorbonne University, UPMC Univ Paris 6, CNRS, UMR 7190 Institut Jean Le Rond d’Alembert, Paris, France.

“Numerical solution of bilayer bending problems”
Sören Bartels  Department of Applied Mathematics, University of Freiburg, Germany

Abstract

Thin elastic bilayer structures arise in various modern applications, e.g., in the fabrication of nanotubes or microgrippers. The mechanical behavior is characterized by large isometric deformations with large curvature in one direction. The mathematical modeling leads to a nonlinear fourth order problem with nonlinear pointwise constraint. The reliable and efficient numerical treatment is therefore challenging. We prove the convergence of a finite element discretization within the framework of Γ-convergence and discuss the convergence of an iterative solution method. The work is based on results by Friesecke, James, and Müller (2002) as well as Schmidt (2007) and extends methods for the approximation of large bending problems. The talk represents joint research with Andrea Bonito (University of Texas, A& M) and Ricardo H. Nochetto (University of Maryland, College Park).

“On phase field approximations of Willmore Flow”
Bretin Elie  ICJ, INSA de Lyon, Batiment Leonard de Vinci, France

Abstract

This presentation introduces two different phase field models for the approximation of Willmore flow. For each of the models, I will analyze its sharp interface limit and I will present a series of numerical simulations to illustrate their behavior in both smooth and singular situations. Finally, I will explain how to take into account efficiently some additional constraints on the area and on the volume of the evolving interfaces. Most of this work has been done in collaboration with Edouard Oudet and Simon Masnou.
Evolution laws for some models of materials combining plasticity and fracture

Eric Bonnetier  Laboratoire Jean Kuntzmann, Université de Grenoble-Alpes, Grenoble France

Abstract

We study models of materials that can combine several mechanisms of energy dissipation: plasticity, visco-plasticity or visco-elasticity and fracture. The latter is in fact regularized using the Ambrosio-Tortorelli functional in the spirit of the work of B. Bourdin, G. Francfort and J.J. Marigo: the shape of cracks is approximated by a phase field. Fixing the associated regularization parameter, we define time evolutions as limits of sequences of solutions to semi-discretized problems when the time step tends to 0. We show existence of time evolutions in cases where we can control the product of the local elastic energy density with the phase field. We report some numerical simulations that show that the dissipation mechanisms may be non exclusive. This is joint work with L. Jakabčín and S. Labbé.

Shape optimization with Robin boundary conditions

Dorin Bucur  Laboratoire de Mathmatiques (LAMA) UMR 5127, Universit de Savoie, France

Abstract

In this talk I will discuss shape optimization problems with Robin boundary conditions on the free part. For general shape functionals, the existence of a solution may not occur, but for a suitable class of energy type functionals one can prove the existence of a solution and some partial regularity results. The main tools are of free discontinuity type. As main example, one could consider the minimization of the first Robin eigenvalue of the Laplacian, among arbitrary open sets of prescribed measure, contained in a given design region.

Discrete varifolds and regularization of the generalized curvature

Blanche Buet  Institut Camille Jordan, Université Lyon 1, France

Abstract

We investigate a volumetric surface discretization model that aims at being both accurate and able to handle the presence of singularities (singularities like in soap films and bubbles for instance). We believe that it could be a suitable tool to handle in a general setting the minimization of functionals defined on surfaces as the area functional or the Willmore functional. The idea to build this discrete object is simple: given a surface and some mesh of the space, each cell is associated with a non-negative number (the area in the cell) and a plane (a mean tangent plane). This is a natural way to discretize surfaces in the spirit of varifolds and it has the advantage to extend easily to any finite dimension or codimension. Varifolds have proved to be useful when dealing with geometric variational problems in the continuous setting since they were introduced by F. Almgren as he was interested in finding critical points of the area functional in a broader class than parametrized surfaces. A sub-class of varifolds, called integral (rectifiable) varifolds provide a set of generalized surfaces with compactness properties and a consistent notion of generalized curvature (called first variation). The point is that not only the discretization we propose can be endowed with a structure of varifold but also a great part of objects used for surface representation and discretization (triangulation, cloud points, level sets etc.) so that we can use varifolds tools to study in some unified setting different way of discretizing surfaces.

An important point to overcome is that these structures are generally not rectifiable (i.e. not regular enough) so that we address the following question: how to ensure that the limit of a sequence of such discrete surfaces is regular? or in a more technical way, what conditions on a sequence of varifolds (not supposed rectifiable nor with bounded variation) ensure that the limit varifold has bounded first variation? The first variation is not well-adapted to discrete structures that is why we define a regularized form of the first variation, allowing us to exhibit an energetic condition ensuring that a limit of a sequence of varifolds has bounded first variation. We use this regularized form to build approximate Willmore energies Γ–converging in the class of varifolds to the Willmore energy. This regularized first variation also provides a notion of approximate curvature, allowing to recover both regular and singular part of the curvature, which we numerically test. It is a joint work with my advisors Gian Paolo Leonardi and Simon Masnou.

Dirichlet-Neumann shape optimization problems

Giuseppe Buttazzo  Dipartimento di Matematica
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Abstract

We consider spectral optimization problems of the form

\[
\min \left\{ \lambda_1(\Omega; D) : \Omega \subset D, \ |\Omega| = 1 \right\},
\]

where \(D\) is a given subset of the Euclidean space \(\mathbb{R}^d\). Here \(\lambda_1(\Omega; D)\) is the first eigenvalue of the Laplace operator \(-\Delta\) with Dirichlet conditions on \(\partial \Omega \cap D\) and Neumann or Robin conditions on \(\partial \Omega \cap \partial D\). The equivalent variational formulation

\[
\lambda_1(\Omega; D) = \min \left\{ \int_{\Omega} |\nabla u|^2 \ dx + k \int_{\partial D} u^2 \ d\mathcal{H}^{d-1} : u \in H^1(D), \ u = 0 \text{ on } \partial \Omega \cap D, \ \|u\|_{L^2(\Omega)} = 1 \right\}
\]

reminds the classical drop problems, where the first eigenvalue replaces the total variation functional. We prove an existence result for general shape cost functionals and we show some qualitative properties of the optimal domains.

“A level-set based mesh evolution method for shape optimization”

Charles Dapogny  Department of Mathematics, Rutgers University, New Brunswick (NJ), USA

Abstract

The purpose of this joint work with Grégoire Allaire and Pascal Frey is to propose an original numerical method for shape and topology optimization in two and three space dimensions, which allows to account for arbitrarily large deformations of the shape from one iteration to the next while benefiting from the accuracy of an explicitly discretized shape at each iteration of the evolution process.

The key idea is to combine two descriptions of a shape - namely a meshed representation and an implicit representation (using the framework of the level set method) -, switching consistently from one to the other depending on their relevance with respect to the operation of interest:

- Equipping a shape \(\Omega\) with a simplicial mesh (i.e. composed of triangles in 2d, of tetrahedra in 3d) is an efficient way to perform accurate mechanical analysis on it (e.g. to calculate the Von Misses stress in the context of linear elastic structures) by using the Finite Element method;
- The level set method is one method of choice for tracking the motion of an evolving shape \(\Omega(t)\) with respect to a given velocity field \(V\); it mainly consists in describing \(\Omega(t)\) via a scalar function \(\phi(t, \cdot)\) defined on the whole ambient space \(\mathbb{R}^d\) (a large computational domain \(D\) in numerical practice), in which case the motion of the shape can be rephrased as a PDE for \(\phi\).

The main ingredients of the proposed mesh evolution method are the following two operators, which enable comings and goings between these two complementary descriptions of shapes:

- On the one hand, a numerical algorithm for calculating the signed distance function \(d_\Omega\) to a domain \(\Omega\) (e.g. supplied by the datum of a mesh) at the vertices of a (simplicial) mesh \(T\) of a computational domain \(D\).
- Conversely, a meshing algorithm for implicit geometries, that is, a numerical method for meshing the negative subdomain of a scalar function \(\phi : D \rightarrow \mathbb{R}\) defined at the vertices of a (simplicial) mesh of \(D\).

“Geometric issues in PDE problems at infinity”

Ilaria Fragalà  Politecnico di Milano

Abstract

This talk will be focused on some topics regarding the interplay between geometry and PDEs.

We shall start from two PDE problems which to some extent can be seen as the limit, for \(p \to +\infty\), of Serrin’s overdetermined problem for the \(p\)-Laplacian. Inspired and motivated by these problems, we shall move to geometry by giving some new results for shapes in the Euclidean space, which may have an autonomous interest. Finally we shall go back to PDEs to see what the geometric results entail.

Based on some recent joint works with Graziano Crasta (Università di Roma “La Sapienza”).

“Sharp inequalities for eigenvalues of the Laplace operator with Robin boundary conditions”

Pedro Freitas  Universidade de Lisboa
Abstract

We give a counterexample to the long standing conjecture that the ball maximises the first eigenvalue of the Robin eigenvalue problem with negative parameter among domains with the same volume. Furthermore, we show that the conjecture holds in two dimensions, provided that the boundary parameter is small. These results are complemented with a numerical study, including an exploration of the behaviour of higher eigenvalues.

This is joint work with David Krejčířík and P.R.S. Antunes.

"Phase Field Approaches for Shape and Topology Optimization"

Harald Garcke  Universität Regensburg, Fakultät für Mathematik, Germany

Abstract

Shape and topology optimization problems for structural and fluid optimization problems are solved with a phase field method. In this approach a perimeter regularization will be approximated by a Cahn-Hilliard type energy. In the talk I will derive first order necessary conditions and discuss the sharp interface limit of the phase field method. Finally, I will present numerical computations which demonstrate that the approach can be applied for complex shape and topology optimization problems.

"Comparison of formulations and strategies for thickness control in shape and topology optimization via a level-set method"

MICHAILIDIS Georgios  CMAP, Ecole Polytechnique, 91128 Palaiseau, France, michailidis@cmap.polytechnique.fr

Abstract

(joint work with Prof. ALLAIRE Grégoire and Prof. JOUVE François)

Shape and topology optimization methods usually result in optimized structures that violate industrial fabrication constraints related to a notion of thickness. For example, in casting, too thick, thin, or closely spaced features should be avoided. Post-treating the optimized shape is usually a non-trivial task and can lead to a complete loss of its optimal characteristics. Therefore, it seems preferable to integrate thickness constraints in the optimization algorithm.

A first difficulty towards this direction is the formulation of thickness constraints for continuous structures. Different approaches have been presented in the literature, which present significant differences between them. Moreover, different strategies for their application can be followed that can result in very different optimized shapes.

We compare several formulations for imposing a maximum or minimum feature size, in the framework of shape and topology optimization using the level-set method. We focus both on theoretical and numerical problems in their application and show numerical results.

"On parametric shape optimization"

Helmut Harbrecht  Mathematisches Institut, Universität Basel

Abstract

Shape optimization is indispensable for designing and constructing industrial components. Many problems that arise in application, particularly in structural mechanics and in the optimal control of distributed parameter systems, can be formulated as the minimization of functionals defined over a class of admissible domains.

The present talk aims at surveying on parametric shape optimization with elliptic or parabolic state equation. Especially, the following items will be addressed:

• first and second order optimality conditions
• the discretization of shapes
• existence and convergence of approximate shapes
• efficient numerical techniques to compute the state equation.

"Elastic energy, total mean curvature and isoperimetric inequalities"

Antoine Henrot  Institut Élie Cartan - Université de Lorraine

Abstract
Following L. Euler, we define the elastic energy of a plane regular compact set $K \subset \mathbb{R}^2$ as $E(K) = \frac{1}{2} \int_{\partial K} C^2 ds$ where $C$ is the curvature of the boundary. We will denote by $A(K)$ the area of $K$. In this talk, we investigate the problem $\min \{E(K), A(K) = A_0\}$ and prove the new isoperimetric inequality $A(K)E(K)^2 \geq \pi^2$ for simply connected domains (with equality only for the disk). We also look for similar inequalities in three dimension. In particular we look at the minimization of the total mean curvature $\int_{\Sigma} H$ where $H$ is the mean curvature of the surface $\Sigma$. This is joint works with Dorin Bucur (in 2-D), Jérémie Dalphin, Simon Masnou and Takéo Takahashi (in 3-D).

“Shape and Topological Sensitivity Based Methods in Tomographic Reconstruction and Image Segmentation”

Michael Hintermüller  Humboldt-Universität zu Berlin, Institute for Mathematics, Germany

Abstract

For various tomographic reconstruction tasks, including electrical impedance, fluorescent optical diffusion or magnetic induction tomography, respectively, topological sensitivity calculus is developed in order to detect hidden inclusions in the region of interest. It is further demonstrated that higher order expansions are required to obtain reliable topological identification. In a second part of the talk, topological sensitivities are used for image segmentation based on the Mumford-Shah functional. Besides the segmentation, the handling of image modulations due to coil sensitivities in MRI is discussed.

“Recent Advances in Shape and Topology Optimization via the Level Set Method in an Industrial Context”

Francois Jouve  Laboratoire J.L.Lions, University Paris Diderot (Paris 7), Paris, France

Abstract

Joint work with Grgoire Allaire and Georgios Michailidis (CMAP, Ecole Polytechnique, Palaiseau, France), and supported by the Rodin consortium.

Shape and topology optimization via the level set method has started attracting the interest of an increasing number of researchers and industrial designers over the past years. A large number of academic problems, using various objective functions and constraints, have been successfully treated with this class of methods, showing its efficiency and flexibility.

But real industrial applications may involve more complex and mixed constraints than classical optimal design problems. Moreover, they are sometimes not easy to formulate from a mathematical point of view, and even more difficult to handle numerically. Examples of such real life problems will be shown at the conference.

“Object identification based on optimality conditions. Helmholtz problem”

Victor A. Kovtunenko  Institute for Mathematics and Scientific Computing, KF-University of Graz, NAWI Graz, 8010 Graz, Austria, and Lavrent’ev Institute of Hydrodynamics, Siberian Branch of RAN, 630090 Novosibirsk, Russia, E-mail: victor.kovtunenko@uni-graz.at

Abstract

This is joint work with Karl Kunisch (University of Graz).

The problem of identification of a geometric object and reconstruction of its geometric and physical parameters from given measurements has numerous applications in the engineering and biomedical sciences in the context of nondestructive testing. From a mathematical point of view, object identification is an inverse problem, which belongs to the field of shape and topology optimization. Methods of topological analysis are inherently connected with singular perturbations. In fact, for the task of identification, a trial geometric object put in a test domain is examined by reducing the trial object from a finite to an infinitesimal one. Classic methods, however, are frequently restricted to simple shapes of the test object given in parameterized form and to prescribed boundary conditions. Commonly, either Dirichlet (the sound soft) or Neumann (the sound hard) conditions are assumed a-priori. For identifying arbitrary geometric and physical variables, we suggest a Robin type (the surface impedance) condition with unknown parameter, which plays a crucial role. Within iterative approaches, a geometric test object is reconstructed iteratively in the descent direction of an objective function. However, iterative methods have large computational costs. Within non-iterative approaches, a test object is to be reconstructed directly from a far field asymptotic pattern. There are well known sampling and probe techniques. Nevertheless, the main difficulty concerns numerical
instability and low resolution of imaging in the discrete counterpart. To improve stability and resolution properties of object imaging we suggest a novel direct approach based on optimality conditions and level sets. We utilize the necessary optimality conditions for finding extrema of an objective function with respect to trial geometric variables. Henceforth we can reconstruct the test object directly from the extremal values which associate an imaging function with respect to input data and measured output data. For geometric realization of the imaging function deduced from proper measurements, we relate the respective (multiple) images to level set functions. Hence, the test object can be imaged precisely from its zero sets. As result we obtain a robust and highly accurate numerical method for object identification. The optimality conditions based concept has a broad scope. Here we specify in detail the model Helmholtz problem. From optimality conditions of the respective objective functional the imaging function is derived which is suitable for high precision identification of the center an arbitrary geometric object under unknown boundary conditions. For its numerical implementation we suggest an original Petrov-Galerkin based enrichment method within generalized FEM. This improves significantly the accuracy of discretization in comparison with the standard solvers of the Helmholtz equation.

The research is supported by the Austrian Science Fund (FWF) in the framework of the SFB F32 “Mathematical Optimization and Applications in Biomedical Sciences” and the research projects P26147-N26.

REFERENCES


“A new phase field model for the approximation of interfacial energies of multiphase systems”
Simon Masnou Institut Camille Jordan, University Lyon 1, France

Abstract

We address the problem of approximating the interfacial energies of multiphase systems which can be found in material sciences or image processing. We propose a new multiphase field approximation model which has several advantages when the surfaces tensions satisfy a suitable embedding property (namely the $\ell^1$-embeddability):

1. the $\Gamma$-convergence to the multiphase perimeter can be proven;
2. the model can be explicitly derived from the surface tensions;
3. it is convenient for the robust numerical approximation of the associated gradient flow, and we study several applications.

It is a joint work with Elie Bretin (Institut Camille Jordan, INSA Lyon, France)

“Optimal shape and location of actuators or sensors in PDE models”
Yannick Privat CNRS & Universit Pierre et Marie Curie (Paris 6) Laboratoire Jacques-Louis Lions

Abstract

We investigate the problem of optimizing the shape and location of actuators or sensors for evolution systems driven by a partial differential equation, like for instance a wave equation, a Schrödinger equation, or a parabolic system, on an arbitrary domain $\Omega$, in arbitrary dimension, with boundary conditions if there is a boundary, which can be of Dirichlet, Neumann, mixed or Robin. This kind of problem is frequently encountered in applications where one aims, for instance, at maximizing the quality of reconstruction of the solution, using only a partial observation. From the mathematical point of view, using probabilistic considerations we model this problem as the problem of maximizing what we call a randomized observability constant, over all possible subdomains of $\Omega$ having a prescribed measure. The spectral analysis of this problem reveals intimate connections with the theory of quantum chaos. More precisely, if the domain $\Omega$ satisfies some quantum ergodic assumptions then we provide a solution to this problem. These works are in collaboration with Emmanuel Trlat (Univ. Paris 6) and Enrique Zuazua (BCAM Bilbao, Spain).

“The Adjoint Method in Optimization of Eigenvalues and Eigenmodes”
Anca-Maria Toader CMAF, Av. Prof. Gama Pinto, 2, 1649-003 Lisboa, and Faculdade de Ciências da Universidade de Lisboa

Abstract
The Adjoint Method goes back to the works of Pontryagin in the framework of Ordinary Differential Equations. In the eighties, J. Cea employed the Adjoint Method in a practical way, from the perspective of Lagrange multipliers. Since then, applications of the Adjoint Method were successfully used in Shape Optimization, Topology Optimization and very recently to optimize eigenvalues and eigenmodes (eigenvectors). The main contribution of this study is to show how the Adjoint Method is applied to the optimization of eigenvalues and eigenmodes. The general case of an arbitrary cost function will be detailed. In this framework, the direct problem does not involve a bilinear form and a linear form as usual in other applications. However, it is possible to follow the spirit of the method and deduce N adjoint problems and obtain N adjoint states, where N is the number of eigenmodes taken into account for optimization. An optimization algorithm based on the derivative of the cost function is developed. This derivative depends on the derivatives of the eigenmodes and the Adjoint Method allows one to express it in terms of the the adjoint states and of the solutions of the direct eigenvalue problem. This method was applied in [1] for material identification purposes in the framework of free material design. In [2] this study is applied to optimization of microstructures, modeled by Bloch wave techniques.


“A New Algorithm for the Optimal Design of Anisotropic Materials”
Michael Stingl Department of Mathematics, Friedrich-Alexander-Universität Erlangen-Nürnberg

Abstract
A new algorithm for the solution of optimal design problems with control in parametrized coefficients is discussed. The algorithm is based on the sequential convex programming idea, however, in each major iteration a model is established on the basis of the parametrized material tensor. The potentially nonlinear parametrization is then treated on the level of the sub-problem, where, due to block separability of the model, global optimization techniques can be applied. Theoretical properties of the algorithm are discussed. The effectiveness of the algorithm in terms of computation time as well as quality of the solution with respect to global lower bounds is demonstrated by a series of numerical examples. Examples range from free material optimization problems via parametric and discrete material optimization problems (e.g. optimal orientation problems) to two-scale material design.

“Lipschitz continuity of eigenfunctions on optimal sets”
Bozhidar Velichkov Laboratoire Jean Kuntzmann (LJK), Université Joseph Fourier, Tour IRMA, BP 53, 51 rue des Mathématiques, 38041 Grenoble Cedex 9 - FRANCE, Email: bozhidar.velichkov@imag.fr

Abstract
This talk is based on a recent joint work with Dorin Bucur, Dario Mazzoleni and Aldo Pratelli, in which we study the optimal sets \( \Omega^* \subset \mathbb{R}^d \), of unit measure, for very general spectral functionals \( F(\lambda_1(\Omega), \ldots, \lambda_p(\Omega)) \),
\[
\min \{ F(\lambda_1(\Omega), \ldots, \lambda_p(\Omega)) : \Omega \subset \mathbb{R}^d, |\Omega| = 1 \},
\]
the main result being the global Lipschitz regularity of the eigenfunctions \( u_1, \ldots, u_p \in H^1_0(\Omega^*) \) of the Dirichlet Laplacian on the optimal set \( \Gamma^* \).

In this talk we will concentrate our attention to the special case
\[
F(\lambda_1(\Omega), \ldots, \lambda_p(\Omega)) = \lambda_k(\Omega),
\]
and we will obtain the precise bound on the global Lipschitz constant of the \( k \)th eigenfunction \( u_k \) on the optimal domain \( \Omega_k \), extended by zero on its complementary
\[-\Delta u_k = \lambda_k(\Omega_k)u_k \quad \text{in} \quad \Omega_k, \quad u_k = 0 \quad \text{on} \quad \mathbb{R}^d \setminus \Omega.\]

The main technical difficulty in this case comes from the estimate of the gradient \(|\nabla u_k|\) on the boundary \( |\partial \Omega_k| \).

“Anisotropic Energy for detection of thin tubes and its \( \Gamma \)-convergence approximation”
David Vicente University of Orleans, France
Abstract

Detecting thin objects in 3D volumes, for instance vascular networks in medical imaging, has been of interest for some time. Particularly, tubular objects are everywhere elongated in one principal direction which varies spatially and are thin in the other two perpendicular directions. In this talk, we introduce an energy functional which depends on a pair \((f, g)\) where \(f\) is a function and \(g\) is a Riemannian metric which captures the local geometry of the image \(g\). The metric is in a domain suitable for tubular geometry. Formally, the energy takes the form

\[
\int_{\Omega} (f - g)^2 \, dx + \int_{\mathcal{S}_f} \mathbf{g}(x, \nu_f)^{\frac{1}{2}} \, d\mathcal{H}^{n-1} + \gamma \int_{\Omega \setminus \mathcal{S}_f} |\nabla f|^2 \, dx.
\]

This functional is derived from the energy introduced by Mumford and Shah, except for the second and the third terms which may be interpreted as the anisotropic surface with respect to the dual metric plus a regularization term for the metric. Its appropriate domain for \(f\) is the set of special functions with bounded variation \(SBV\). We prove an existence result for the minimizing problem. Then, we perform an approximation in the sense of \(\Gamma\)-convergence and prove it. Finally, we show numerical results.

“Optimal fine-scale structures in composite materials”

Benedikt Wirth  Institute for Computational and Applied Mathematics, Einsteinstraße 62, 48149 Münster, Germany

Abstract

A very classical problem consists in optimizing the structure of a composite material, for instance to achieve high rigidity against a prescribed mechanical loading. In the simplest case, the material is a composite of void and the elastic base material. The problem then reduces to finding the optimal topology and geometry of the structure. One typically aims to minimize a weighted sum of material volume, structure perimeter, and structure compliance (a measure of the inverse structure stiffness). This task is not only of interest for optimal material designs, but also represents a prototype problem to better understand biological structures. The high nonconvexity of the problem makes it impossible to find the globally optimal design; if in addition the weight of the perimeter is chosen small, very fine material structures are optimal that cannot even be resolved numerically. However, one can prove an energy scaling law that describes how the minimum of the objective functional scales with the model parameters. Part of such a proof involves the construction of a near-optimal design, which typically exhibits fine multi-scale structure in the form of branching and which gives an idea of how optimal geometries look like. (Joint with Robert Kohn)
# List of Participants

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<td><a href="mailto:buet@math.univ-lyon1.fr">buet@math.univ-lyon1.fr</a></td>
</tr>
<tr>
<td>Buoso Davide</td>
<td>University of Padova</td>
<td><a href="mailto:dbuoso@math.unipd.it">dbuoso@math.unipd.it</a></td>
</tr>
<tr>
<td>Burazin Kreimier</td>
<td>University of Osijek</td>
<td><a href="mailto:krburazin@mathos.hr">krburazin@mathos.hr</a></td>
</tr>
<tr>
<td>Buttazzo Giuseppe</td>
<td>University of Pisa</td>
<td><a href="mailto:buttazzo@dm.unipi.it">buttazzo@dm.unipi.it</a></td>
</tr>
<tr>
<td>Chamakuri Nagaiah</td>
<td>RICAM, Linz</td>
<td><a href="mailto:nagaiah.chamakuri@oeaw.ac.at">nagaiah.chamakuri@oeaw.ac.at</a></td>
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<tr>
<td>Dapogny Charles</td>
<td>Rutgers University</td>
<td><a href="mailto:dapogny@ann.jussieu.fr">dapogny@ann.jussieu.fr</a></td>
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<tr>
<td>Dayrens Francois</td>
<td>University Lyon 1</td>
<td><a href="mailto:dayrens@math.univ-lyon1.fr">dayrens@math.univ-lyon1.fr</a></td>
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<tr>
<td>Delgado Gabriel</td>
<td>IRT-SystemX</td>
<td><a href="mailto:gndelgad@gmail.com">gndelgad@gmail.com</a></td>
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<tr>
<td>Diacu Florin</td>
<td>University of Victoria</td>
<td><a href="mailto:diacu@uvic.ca">diacu@uvic.ca</a></td>
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<tr>
<td>Effland Alexander</td>
<td>University of Bonn</td>
<td><a href="mailto:alexander.effland@ins.uni-bonn.de">alexander.effland@ins.uni-bonn.de</a></td>
</tr>
<tr>
<td>Fragala Ilaria</td>
<td>Politecnico di Milano</td>
<td><a href="mailto:ilaria.fragala@polimi.it">ilaria.fragala@polimi.it</a></td>
</tr>
<tr>
<td>Freitas Pedro</td>
<td>University of Lisbon</td>
<td><a href="mailto:freitas@ciic.fc.unil.pt">freitas@ciic.fc.unil.pt</a></td>
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<tr>
<td>Gangl Peter</td>
<td>Johannes Kepler University Linz</td>
<td><a href="mailto:gangl@numa.uni-linz.ac.at">gangl@numa.uni-linz.ac.at</a></td>
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<tr>
<td>Garcke Harald</td>
<td>University Regensburg</td>
<td><a href="mailto:harald.garcke@ur.de">harald.garcke@ur.de</a></td>
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<tr>
<td>Geihe Benedict</td>
<td>Bonn University</td>
<td><a href="mailto:benedict.geihe@ins.uni-bonn.de">benedict.geihe@ins.uni-bonn.de</a></td>
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<tr>
<td>Giacomini Matteo</td>
<td>CMAP Ecole Polytechnique</td>
<td><a href="mailto:matteo.giacomini@polytechnique.edu">matteo.giacomini@polytechnique.edu</a></td>
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<tr>
<td>Harbrecht Helmut</td>
<td>University of Basel</td>
<td><a href="mailto:helmut.harbrecht@unibas.ch">helmut.harbrecht@unibas.ch</a></td>
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<tr>
<td>Henrot Antoine</td>
<td>Université de Lorraine</td>
<td><a href="mailto:antoine.henrot@univ-lorraine.fr">antoine.henrot@univ-lorraine.fr</a></td>
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<tr>
<td>Hintermüller Michael</td>
<td>Humboldt-Universität zu Berlin</td>
<td><a href="mailto:hint@math.hu-berlin.de">hint@math.hu-berlin.de</a></td>
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<tr>
<td>Iglesias Jose A.</td>
<td>University of Vienna</td>
<td><a href="mailto:jose.iglesias@univ.ac.at">jose.iglesias@univ.ac.at</a></td>
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<tr>
<td>Jouve François</td>
<td>Université Paris Diderot</td>
<td><a href="mailto:jouve@ljll.univ-paris-diderot.fr">jouve@ljll.univ-paris-diderot.fr</a></td>
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<tr>
<td>Kalise Dante</td>
<td>RICAM, Austrian Academy of Sciences</td>
<td><a href="mailto:dante.kalise@ricam.oeaw.ac.at">dante.kalise@ricam.oeaw.ac.at</a></td>
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<tr>
<td>Keuthen Moritz</td>
<td>TU Munich</td>
<td><a href="mailto:keuthen@ma.tum.de">keuthen@ma.tum.de</a></td>
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<tr>
<td>Kmotunenko Victor</td>
<td>University of Graz</td>
<td><a href="mailto:victor.kmotunenko@uni-graz.at">victor.kmotunenko@uni-graz.at</a></td>
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<tr>
<td>Kunisch Karl</td>
<td>KFU graz</td>
<td><a href="mailto:karl.kunisch@uni-graz.at">karl.kunisch@uni-graz.at</a></td>
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<tr>
<td>León Baldelli André A</td>
<td>University of Oxford</td>
<td><a href="mailto:a.leon.baldelli@gmail.com">a.leon.baldelli@gmail.com</a></td>
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<tr>
<td>Mali Olli</td>
<td>University of Jyväskylä</td>
<td><a href="mailto:olli.mali@jyu.fi">olli.mali@jyu.fi</a></td>
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<tr>
<td>Masnou Simon</td>
<td>University of Lyon 1</td>
<td><a href="mailto:masnou@math.univ-lyon1.fr">masnou@math.univ-lyon1.fr</a></td>
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<tr>
<td>Michailidis Georgios</td>
<td>Ecole Polytechnique</td>
<td><a href="mailto:michailidis@cmap.polytechnique.fr">michailidis@cmap.polytechnique.fr</a></td>
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<tr>
<td>Misur Marin</td>
<td>University of Zagreb</td>
<td><a href="mailto:pfobos@gmail.com">pfobos@gmail.com</a></td>
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<tr>
<td>Moore Stephen Edward</td>
<td>RICAM</td>
<td><a href="mailto:stephen.moore@ricam.oeaw.ac.at">stephen.moore@ricam.oeaw.ac.at</a></td>
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<tr>
<td>Nardi Giacomo</td>
<td>Ecole Normale Superieure de Cachan</td>
<td><a href="mailto:nardi@ceremade.dauphine.fr">nardi@ceremade.dauphine.fr</a></td>
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<tr>
<td>Oudet Edouard</td>
<td>Université Joseph Fourier</td>
<td><a href="mailto:edouard.oudet@imag.fr">edouard.oudet@imag.fr</a></td>
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<tr>
<td>Paganini Alberto</td>
<td>ETHZ</td>
<td><a href="mailto:alberto.paganini@sam.math.ethz.ch">alberto.paganini@sam.math.ethz.ch</a></td>
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<td>Peters Michael</td>
<td>University of Basel</td>
<td><a href="mailto:michael.peters@unibas.ch">michael.peters@unibas.ch</a></td>
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<td>Phan Duc Duy</td>
<td>RICAM</td>
<td><a href="mailto:duy.phan-du@oeaw.ac.at">duy.phan-du@oeaw.ac.at</a></td>
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<td>Privat Yannick</td>
<td>CNRS &amp; Univ. Pierre et Marie Curie (Paris 6)</td>
<td><a href="mailto:yannick.privat@upmc.fr">yannick.privat@upmc.fr</a></td>
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<td>Provenzano Luigi</td>
<td>Università degli Studi di Padova</td>
<td><a href="mailto:proz@math.unipd.it">proz@math.unipd.it</a></td>
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<td>Ring Wolfgang</td>
<td>University of Graz</td>
<td><a href="mailto:wolfgang.ring@uni-graz.at">wolfgang.ring@uni-graz.at</a></td>
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<td>Rodrigues Sergio</td>
<td>RICAM, OeAW</td>
<td><a href="mailto:sergio.rodrigues@ricam.oeaw.ac.at">sergio.rodrigues@ricam.oeaw.ac.at</a></td>
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<td>Ruffini Berardo</td>
<td>Institut Fourier, Grenoble</td>
<td><a href="mailto:berardo.ruffini@sns.it">berardo.ruffini@sns.it</a></td>
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<tr>
<td>Rumpf Martin</td>
<td>University of Bonn</td>
<td><a href="mailto:martin.rumpf@uni-bonn.de">martin.rumpf@uni-bonn.de</a></td>
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<td>Semmler</td>
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<td>Monika</td>
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<td>Huidong</td>
<td>RICAM</td>
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ACCOMMODATION

for our invited speakers and for those who receive financial support we have booked rooms at:
University Guesthouse: "Hotel Sommerhaus"
Address: Julius-Raab-Straße 10, 4040 Linz
http://www.sommerhaus-hotel.at/en/
Check-in desk: open from 0-24 h; English speaking
Breakfast included, Shower/toilet in every room, 10 minutes walk to university, indoor swimming pool,
internet connection in every room, fitness room, music room...

If support on accommodation has been agreed upon by the organizers, accommodation will directly be
paid by RICAM (those with double rooms shared with a non participating person, will be asked to pay
for the difference themselves when they move out).

For the regular participants: please take care for your own bookings. You can find recommendations
of Hotels on our website!

REIMBURSEMENT

to all who have been granted support:
Keep ALL the ORIGINAL RECEIPTS (boarding passes, passenger receipts, train tickets, taxi receipts,
tram/bus tickets ... everything) otherwise we will NOT be able to transfer money to your accounts!!!
There is NO CASH involved in the reimbursements.
In Linz you will receive a form where you can write down all your expanses and hand it in.

YOU CAN REACH RICAM VIA

Linz Airport to university and hotel:
Shuttle bus (see link below) to main train station and then take tram
or taxi (approx. 40 Euro).

Linz main train station ("Linz Hauptbahnhof", Hauptbhf.) to university and hotel:
Purchase with cash a MIDI (1 hour, € 2) or MAXI (24 hours, € 4) ticket from a ticket machine or from
a tobacco store ("Trafik"). Take tram 1 or 2 (stops directly at the underground of the train station) into
the direction of “JKU Universität” and get off at the stop “JKU Universität” (last stop).

Vienna Airport ("Schwechat") to Vienna train station ("Wien-Westbahnhof"):
There is a shuttle bus every 30 minutes directly to the Viennese train station.
If you take the Train, use “Schnellbahn - S7” in direction "Wien Floridsdorf" via “Wien Mitte -
Landstraße” (U3, Underground) to “Wien-Westbahnhof”

Vienna Central Station (Westbahnhof) - Train from Vienna to Linz:
https://westbahn.at (cheaper tickets!)
www.oebb.at/en
PUBLIC TRANSPORT MAP „LINZ LINIEN“

https://www.linzag.at
WHERE TO FIND RICAM

the workshop takes place in
RICAM, Altenbergerstraße 69, 4040 Linz
Science Park Building 2, 4th floor, room no. 416-2

Special Semester Office:
Verena GRAFINGER
Science Park 2, 4th floor, room no. 456
fax machine, copy machine, office supplies ...

Opened: Monday – Friday 9:00 a.m. – 12:00 a.m.
Monday and Wednesday until 2:30 p.m.
**WORKSHOP SCHEDULE**

**Registration**: Monday 8:15 – 8:45, Science Park2, 4th floor
We will be there to help if questions arise and to hand out your personal folders and name badges.

**Opening**: from 8:45 (depends on workshop(school) in seminar room 416-2
Let us most politely ask you to try to be on time for the opening.

**COFFEE BREAKS & EVENING SNACKS**

Coffee breaks - as mentioned on the workshop timetable - take place in room no. 416-1 (small seminar room, next to the big one).
In the evenings there is the possibility to have access to this seminar room to come together.
Small snacks and drinks are available.

**INTERNET**

w-Lan connection possible all over the campus and in all RICAM offices
w-Lan-name: ricam
Password: agodaricamo

**COMPUTER ROOM**

If needed room no. 413.
Username and password on the screen.

**TECHNICAL SUPPORT**

If you need any help concerning w-lan, laptops, etc. please contact:
Florian TISCHLER or Wolfgang FORSTHUBER
Room no. 458

**PLUGS IN AUSTRIA**

please, see photo
## RESTAURANTS & FOOD

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<tr>
<td><strong>Check your dish:</strong></td>
<td><a href="http://www.jku.at/content/e213/e175/e6780">http://www.jku.at/content/e213/e175/e6780</a></td>
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<tr>
<td><strong>At University campus</strong></td>
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<tr>
<td>A) Mensa</td>
<td>Mo-Fri</td>
<td>11:15 – 13:30</td>
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<td>B) Choice (in Mensa)</td>
<td>Mo-Thu</td>
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<td>Fri</td>
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<td>C) Kepler’s Restaurant</td>
<td>Mo-Thu</td>
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<td>Fri</td>
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<td>D) Café (in Mensa)</td>
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<td>Fri</td>
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<td>E) Ch@t (Cafe Keplergebäude)</td>
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<td>Fri</td>
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<td>F) Science Cafe (Science Park3)</td>
<td>Mon-Thu</td>
<td>08:00 – 16:00</td>
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<td>Fri</td>
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<td>G) Cafe SASSI (Bankengebäude)</td>
<td>Mon-Fri</td>
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<tr>
<td><strong>KHG Mensa</strong></td>
<td>Mengerstraße 23</td>
<td>11:00 - 13:00</td>
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<tr>
<td></td>
<td>Tel: 0732 244011</td>
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<tr>
<td><strong>„Bella Casa“ - Pizzeria</strong></td>
<td>Aubrunnerweg 1a</td>
<td>Open daily 11:00-15:00 and 17:00 - 24:00</td>
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<tr>
<td></td>
<td>Tel: 0732 245646</td>
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<tr>
<td><strong>„Jadegarten“ – Chinese Restaurant</strong></td>
<td>Aubrunnerweg 11</td>
<td>Open daily 11:00 – 23:00</td>
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<td></td>
<td>Tel: 0732 750160</td>
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<tr>
<td><strong>Burgers</strong></td>
<td>Altenbergerstraße 6-8</td>
<td>Mon-Thu</td>
<td>10:30 – 22:00</td>
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<td>Tel: 050 66 66 66</td>
<td>Fri-Sat</td>
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<td>Sun</td>
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<tr>
<td><strong>Pizza Mann</strong></td>
<td>Freistädter Straße 313</td>
<td>Open daily 11:00 – 03:00</td>
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<td></td>
<td>Tel: 05 10 10 10</td>
<td>(Online order)</td>
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<td><a href="http://www.pizzamann.at">www.pizzamann.at</a></td>
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<tr>
<td><strong>Subway</strong></td>
<td>Freistädter Straße 313</td>
<td>Open daily 08:30 – 24:00</td>
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<tr>
<td></td>
<td>Tel.: 05 995 9910</td>
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<td><a href="http://linz.suborder.at">http://linz.suborder.at</a></td>
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<tr>
<td><strong>Burger Checker</strong></td>
<td>Freistädter Straße 313</td>
<td>Mon – Sun</td>
<td>11:00 – 14:00 and 17:00 – 20:30</td>
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<td>Tel.: 0660 1101 200</td>
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<tr>
<td><strong>„Goldener Hof“ – Chinese Restaurant</strong></td>
<td>Freistädter Straße 315</td>
<td>Open daily 11:30 – 14:30 and 17:30 – 23:00</td>
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<td>Tel: 0732 24 40 42</td>
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<tr>
<td><strong>„RaabMensa.Lounge.Restaurant. Bar“ – Hotel Sommerhaus</strong></td>
<td>Julius Raab-Straße 10</td>
<td>Lounge, Bar:</td>
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<tr>
<td></td>
<td>Tel: 0732 24570</td>
<td>Mon – Thu</td>
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<td>Hot food daily:</td>
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<td><strong>Mc Donalds &amp; Mc Cafe</strong></td>
<td>Freistädter Straße 298</td>
<td>Mon – Thur</td>
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<td>Sun</td>
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<tr>
<td><strong>Supermarket „Winkler Markt“</strong></td>
<td>Altenbergerstraße 40</td>
<td>Mon – Thur</td>
<td>07:30 – 18:30</td>
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<td>Sunday closed!</td>
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<td><strong>Supermarket “Penny”</strong></td>
<td>Johann-Wilhelm-Klein-Strasse 58</td>
<td>Mon – Fri</td>
<td>7:30 – 19:00</td>
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<td>Sunday closed!</td>
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<td>Supermarket „Hofer“</td>
<td>Freistädter Straße 401</td>
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<td>Supermarket „Billa“</td>
<td>Freistädter Straße 400</td>
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<td><strong>Sunday closed!</strong> Mon-Fri</td>
<td>07:40 – 20:00</td>
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<tr>
<td></td>
<td>Sat</td>
<td>07:40 – 18:00</td>
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![Map of the area showing supermarket locations]
PHYSICIANS, HOSPITALS AND PHARMACIES

The following physicians have offices in the area of Hotel Sommerhau and the university:

Dr. Winfried Mraczansky  
Altenbergerstraße 43  
4040 Linz  
Phone +43 (0) 732 245655  
Mon 8–11:30 and 16–17:30  
Tue 8–11:30, Thu 8–11:30  
Wed 8–11:30 and 16–17:30  
Fri 8–11

Dr. Kurt Kellermair  
Freistädter Straße 41  
4040 Linz  
Phone +43 (0) 732 730595  
Mon 8–12 and 17–19  
Tue 9–12, Wed 8–11  
Thu 8–11 and 16–19  
Fri 8–11

Dr. Gottfried Maria Jetschgo  
Pulvermühlstraße 23  
4040 Linz  
Phone +43 (0) 732 254121

Should you need medication the doctor will give you a prescription which you can take to any pharmacy to pick up the medicine. Usually, you will have to pay for a small part of the medication yourself. Pharmacies are also the only places which sell over-the-counter drugs like pain relievers etc. The pharmacy nearest to the campus is located in the Winkler-Markt building (nr.12). After hours, a sign in any pharmacy’s window will always tell you the nearest pharmacy on duty. The general hospital in Linz is Allgemeines Krankenhaus (AKH Linz), Krankenhausstraße 9. It provides an emergency room. In addition, Linz has a number of specialized hospitals, some of which also have emergency rooms. In case of a medical emergency, call 144.

EMERGENCIES

In case of emergencies, here are a few useful phone numbers to remember:

Fire Department 122  
Police 133  
Medical Emergencies 144  
Emergency calls at the University campus 8144 (for urgent cases), otherwise 9100  
Europe-wide general emergency call 112  
Car Breakdown 120 or 123  
Mountain Rescue 140  
Information about physicians on duty after hours 141  
Intoxication hotline 01/4064343

Note that the europe-wide general emergency number 112 can be called in particular from any cell phone even without a valid subscription or prepaid SIM card inserted.

VACCINATION

NO vaccinations necessary!

WEATHER FORECAST FOR AUSTRIA

http://www.wetter.at/wetter/oesterreich/oberoesterreich/linz

We wish you all a very pleasant time in Linz!
Social Event: Höhenrausch
Wednesday, October 15

Start of the Guided Tour: 16:00
We will meet at 15:45 at the entrance of MOVIENTO (Cinema) in OÖ Kulturquartier
OK Platz 1
4020 Linz
Tram Stop (1, 2): Taubenmarkt or Mozartkreuzung (travel time: about 20 min. in the tram from University)
Entrance via PASSAGE Shopping center (just follow the signs on the floor) or via U:hof (Ursulinenhof)
http://hoehenrausch.at/en

If you don’t want to participate, please let the secretary (Verena Grafinger) know as soon as possible.
# Timetable

**Workshop 1: Shape and topological optimization**  
October 13 - 17, 2014

<table>
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<tbody>
<tr>
<td>08:15 - 08:45</td>
<td>REGISTRATION</td>
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<tr>
<td>08:45 - 09:00</td>
<td>Opening</td>
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<tr>
<td>09:00 - 09:45</td>
<td>Guiseppe Buttazzo</td>
<td>Gregoire Allaire</td>
<td>Dorin Bucur</td>
<td>Ilaria Fragalà</td>
<td>Francois Jouve</td>
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<td>10:00 - 10:45</td>
<td>Pedro Freitas</td>
<td>Anca-Maria Toader</td>
<td>Michael Stingl</td>
<td>Helmut Harbrecht</td>
<td>Eric Bonnetier</td>
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<td>11:15 - 12:00</td>
<td>Elie Bretin</td>
<td>Benedikt Wirth</td>
<td>Soeren Bartels</td>
<td>Michael Hintermüller</td>
<td>Antoine Henrot</td>
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<td>12:00 - 13:30</td>
<td>Lunch Break</td>
<td>Lunch Break</td>
<td>Lunch Break</td>
<td>Lunch Break</td>
<td>Closing</td>
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<tr>
<td>13:30 - 15:30</td>
<td>Discussion Time</td>
<td>Discussion Time</td>
<td>13:30 – 15:00 Fast forward Session</td>
<td>Discussion Time</td>
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<td>15:30 - 16:00</td>
<td>15:30 - 16:15</td>
<td>Yannick Privat</td>
<td>15:00 Start Excursion</td>
<td>Bozhidar Velichkov</td>
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<td>16:10 - 16:50</td>
<td>16:30 - 17:15</td>
<td>Blanche Buet</td>
<td>16:00 Guided Tour “Höhenrausch”</td>
<td>Michailidis Georgios</td>
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<td>16:50 - 17:10</td>
<td>17:30 – 18:00</td>
<td>Coffee Break</td>
<td>Coffee Break</td>
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<td>17:10 - 17:40</td>
<td>Charles Dapogny</td>
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<td>David Vicente</td>
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<td>17:50 - 18:20</td>
<td>Andres Leon Baldelli</td>
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<td>Victor Kvtunenko</td>
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<td>19:30</td>
<td>Conference Dinners at Keplers (JKU Mensa)</td>
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