PROGRAM
&
BOOK OF ABSTRACTS

Workshop GEC-Beihang: Ecole Centrale de Marseille - Thursday 21 Mai 2015

09h00-09h30	Accueil - Cafe salle 224	
	AMPHI 3	
09h30-10h00	Officiels France/China (Ecole Centrale de Marseille President; Consult of China Republic in Marseille; VP EC; Beihang...)	
10h00-10h30	Plenary GEC / Ecole Centrale de Marseille On the modeling of imperfect interfaces **Frédéric Lebon (LMA)**	
10h30-11h00	Plenary Beihang: Experimental Characterization of the Tip Leakage Flow in a Laboratory Scale Compressor **Ma Hongwei (BUAA)**	
11h00-11h20	Photo - Cafe Break	
	Session: Fluid Mechanics - Amphi 3	
11h20-11h45	AXIOOM Advanced eXperiments and simulations of cOmplex flOws in TurboMachines: **X. OTTAVY (ECL)**	
11h45-12h10	Flow Characteristic Investigation on a new kind of airfoil-shaped bluff body by Large Eddy Simulation: **Liu Yuying (BUAA)**	
12h10-12h45	Validity and Modification of Conventional Turbulence Models for Corner Separation based on Turbulence Transportation Analysis: **SUN Jinjing (ECL)**	
12h45-14h00	Lunch - Crous	
	Session: Fluid Mechanics salle 235 /233	Session: Solid Mechanics and Materials salle 220
14h00-14h25	The progress on the breakup mechanism of a cross liquid jet: **Huang Yong (BUAA)**	Experimental investigation and modeling of mechanical behaviors of advanced ceramic composites at high temperature: **Shi Duoqi (BUAA)**
14h25-14h50	Instability of a stably stratified boundary layer on a vertical wall **Jun Chen (ECM) and Stéphane LE DIZES**	Wave-based numerical homogenization method to study periodic structures: **C. Zhou (ECL)**
14500-15h15	Aerodynamic and acoustic analysis of the tip-leakage flow on a single airfoil, from experiment to large-eddy simulation: **Bo LI and J. Boudet (ECL)**	Microstructure-sensitive modeling of scatter in HCF crack formation: **Yang Xiaoguang (BUAA)**
15h15-15h40	An extension of slender-body theory for moderate aspect ratio bodies **Zhanle YU and Christophe ELOY (ECM)**	Sound insulation performance of plate with interconnected piezoelectric networks: **K. J. YI (ECL,BUAA)**
15h40-16h00	Cafe Break salle 224	
	Session: Fluid Mechanics salle 235/233	Session: Solid Mechanics and Materials salle 220
16h00-16h25	3D visualization and tomographic particle image velocimetry measurement for vortex breakdown of delta wing: **Gao Qi (BUAA)**	Micro and nano-structures for acoustic band gaps engineering in micro-electro-acoustic devices: **YU Du (ECL)**
16h25-16h50	Active experimental characterization of the instability modes of turbomachinery (Calypso Project): **Lu ZHANG and J. Scott (ECL)**	Product Innovation Management Based on New Technology and Material: **Zhang Rong (BUAA)**
16h50-17h15	Modelling of Nonlinear Impedance of Micro-Resonators: **Li Xiaodong (BUAA)**	Relationship between the rubbing surface and the squeal occurrence: Investigation of third-body effect: **N. Singla (ECL)**
17h15-17h40	Numerical turbulence: **L. Shao (ECL)**	Optimization of the dynamic behavior of vehicle structures by means of passive interface controls: **Xingrong HUANG (ECL)**
19h30-23h30	"GALA" Diner Restaurant les Arcenaulx	

Workshop GEC-Beihang: Ecole Centrale de Marseille - Friday 22 Mai 2015

	Session 2: Control/Intelligent Systems salle 235 /233	Session: Energy/Physics/Electronics/Photonics salle 220	
09h00-09h25	Electromechanical coupling of periodical piezoelectric composite in wave domain: **Yu Fan (ECL,BUAA)**	Rhodopsin-based photovoltaic materials and nanosystems. **Yan Xiang (BUAA)**	
09h25-09h50	Segmentation of tesselated model and its applications in CNC machining: **Xu Shixin (BUAA)**	Fluid simulations of edge plasma turbulence in tokamaks for magnetic fusion: **Serre Eric (ECM)**	
09h25-10h15	Multi-scale homogenization of 1D periodic structures **Xiangkun Sun (ECL)**	Solar spectral selective coatings and electrochromic devices for solar energy and energy efficiency windows in green buildings: **Diao Xungang (BUAA)**	
10h15-10h40	An Efficient Multimodal 2D-3D Feature-based Approach to Automatic Facial Expression Recognition: **Huibin LI (ECL)**	Functionalization of magnetic nanoparticles with ferrocene for electrochemical enzymatic biosensing: **Fabiang Chen (ECL)**	
10h40-11h00	Cafe Break salle 224		
	Pedagogy salle 235/233	Session: Energy/Physics/Electronics/Photonics salle 220	Session: Chemical engineering/Biophysics salle 225
11h00-11h25	Project Activity and Professional Development at ECPk Jean-Marc CAMELIN (ECP), YIN Chuantao (ECPk), TANG Hongzhe (ECPk), ZHANG Wei (ECPk), TANG Le (ECPk), NIU Wei (ECPk), SONG Meng (ECPk), YU Lei (ECPk), Véronique LE COURTOIS (ECL-ECPk), XU Ping (ECPk), YU Liming (ECPk), Anne SPASOJEVIC-de BIRÉ (ECP-ECPk)*	The Espace Photonique: a platform for the fabrication of complex optical interference filters: **Michel LEQUIME and Julien LUMEAU (ECM)**	Total Syntheses of Quadrane sesquiterpenes: **Y. Ren (ECM)**
11h25-11h50	Pedagogical Change in Thermodynamics : **Pascal DENIS (ECM) – YUAN Weixing (BUAA)**	Dark fermentative hydrogen production in an anaerobic packed bed biofilm reactor: **A. Sorik (ECM)**	Innovative Heteropolyacid (HPA) Catalysts for Biomass Valorization in Liquid phase Reactions: **Xiaofeng YI (ECL)**
11h50-12h15	Anne Spasovic (ECP) and Veronique Le Courtois (ECL)	Capping and decapping GaAs nanowires with As for preventing oxidation and for epitaxial shell growth: **X. Guan (ECL)**	Multiplex detection of anti-heat shock protein autoantibodies in breast cancer sera: **Yi Shi (ECL)**
12h15-12h40		Online multiclass learning with "bandit" feedback under a Passive-Aggressive approach : **Hongliang ZHONG (ECM)**	Hydrodynamic Study of the MicroGasic Process. Application: Conversion of Syngas to Ultraclean Hydrocarbon Fuels. **Haiqin Quan (ECL)**
12h40-14h00	Lunch - Crous		
14h00-16h00	LABORATORY VISITES		

Thursday 21

Friday 22

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[Session: Fluid Mechanics]

AXIOOM
Advanced eXperiments and sImulations of cOmplex flOws in TurboMachines

Xavier OTTAVY[1], Jérôme BOUDET[1], Marc JACOB[1], Francis LEBOEUF[1], Liang SHAO[1], MA Hongwei[2], Wang Hongwei[2], LU Lipeng[2],
PhD : GAO Feng[1,2], MA Wei[1,2], WEI Wei[2], Gherardo ZAMBONINI[1]
1 : Ecole Centrale de Lyon
2 : Beihang University

Towards a Better Understanding of Complex Flows Encountered in Turbomachines

New regulations about greenhouse gas emissions as well as noise abatement policies require efficient and accurate simulation tools for aircraft engine design. A particularly severe cause of losses in turbo engines is due to secondary flows generated both at the tip and the hub of blades. This holds particularly for tip clearance and hub separated corner flows. Such flows are known to be fully three-dimensional and highly unsteady; they can thus not be accurately tackled with current turbomachinery design tools that solve the flow field using statistical closure for the turbulence modelling. In order to understand, predict, control and eventually reduce these secondary flows and the noise they generate, it is paramount to extend novel Computational Fluid Dynamics techniques to complex geometries encountered in turbomachines. The objective is to develop a methodology to accurately predict the aforementioned separated flows by the use of advanced numerical methods, namely Large-Eddy Simulation. The methods are to be validated in the context of turbomachines, with dedicated experiments, with the objective to provide a better understanding of the highly intermittent flows.

A promising methodology: Large-Eddy Simulation of Turbulent Flows for Turbomachinery Applications

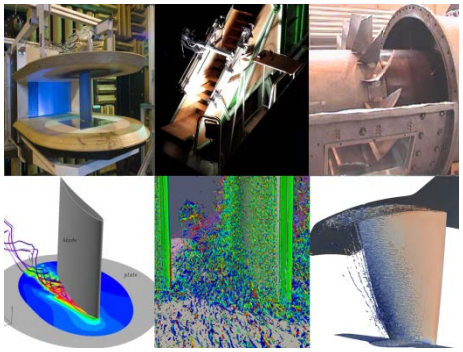
An accurate prediction and in-depth understanding of underlying physical mechanisms is a prerequisite for the control and reduction of secondary flows. This has been achieved by the use of Large-Eddy Simulations (LES). Standard LES subgrid-scale models are not suited for the context of turbomachines, because they are not efficient enough to handle the complex geometries and the three-dimensional unsteady separated flows encountered in such configurations. Among the advanced LES models that attempt to overcome these pitfalls, the “Reynolds Decomposed LES” model family developed by the French partner appears to be promising for turbomachinery applications. But this methodology needed to be adjusted and validated against experimental data. Therefore, in the present study, three experimental configurations of increasing complexity (single airfoil rig, cascade rig and compressor rig) have been addressed, involving physical phenomena such as tip leakage flow and corner separation. Advanced measurement techniques, such as time resolved Particle Image Velocimetry and unsteady wall pressure measurements have been associated with unconventional data processing techniques such as cross-conditional analyses.

Project main results

Computations on the three configurations have shown to which degree of complexity current unsteady CFD methods can be extended and which degree of accuracy can be expected. Additionally, the experimental and numerical results have shed new light into the physical mechanisms of secondary flows. Moreover, the database that is available for the scientific community will provide invaluable information both for modelling issues and for code development and validation. Finally, this project has also promoted Sino-French cooperation in aerospace science, including contracts with industrials.

The advances achieved during this project led to 12 publications in international peer-reviewed journals, 11 peer-reviewed papers presented in conferences and 5 PhD theses (2 of these were jointly supervised).

Indirectly, the studies carried out in AXIOOM have helped 2 researchers from the LMFA to obtain their Habilitation à Diriger les Recherches.



Project AXIOOM – Experimental and numerical assessments of separated flows: 3 opened test cases with increasing complexity (tip leakage flow with a single airfoil, corner separation in a compressor cascade and secondary flows in the rotor of a compressor).

The AXIOOM project is a fundamental research project coordinated by Dr. Xavier OTTAVY in France and by Pr. MA Hongwei in China. It associated the Laboratoire de Mécanique des Fluides et d'Acoustique (UMR CNRS 5509) à l'Ecole centrale de Lyon, in France, and the School of Jet Propulsion at Beihang University of Aeronautics and Astronautics, in China. The project started on January the 1st 2012 and lasted 36 months. ANR grant amounted to 196 k€ and NSFC grant amounted to 106 k€ for a total budget of 302 k€.

Flow Characteristics investigation on a new kind of airfoil-shaped bluff body by Large Eddy Simulation

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Bluff bodies are widely used to hold flames in combustion devices, especially for the propulsion system. Reducing drag of the bluff body is a permanent topic for the gas turbine combustor designer because of the compromise among combustion efficiency, combustion stability and pressure drop. A new kind of airfoil-shaped bluff body is proposed in terms of drag reduction in this work, and the flow characteristics of it confined in a channel at subcritical intermediate Reynolds number (Re=26000) is investigated by Large Eddy Simulation (LES).

The flow characteristics of the airfoil-shaped bluff body were compared numerically with a traditional v-shaped bluff body with same maximum thickness (or blockage ratio), length of chord and different thickness of trailing edge. In which, flow field of v-shaped bluff body was experimentally examined by PIV data in order to verify the numerical results simultaneously. Furthermore, the effects of trailing edge profile slope for airfoil-shaped bluff body were analyzed numerically. The time-averaged streamwise velocities, cross-stream velocities, various Reynolds stresses, drag coefficients, Strouhal numbers, and vorticity field were analyzed in details.

The results show that, the numerical predictions of v-shaped bluff body are in excellent agreement with the measurements both qualitatively and quantitatively ; Compared with v-shaped bluff body, the new airfoil-shaped bluff bodies reduce drag coefficient up to 66%. In other words, the thickness of blunt trailing edge dominate the drag coefficient ; For the airfoil-shaped bluff bodies with same thickness of trailing edge, the one whose sides adjacent to trailing edge has a lower slope would harvests a smaller drag coefficient.

The new kind of airfoil-shaped bluff body proposed in this work has a great potential on the drag reduction, but there is still a long way to go to optimize the profile and to test its holding ability of flame in the flow.

Validity and Modification of Conventional Turbulence Models for Corner Separation based on Turbulence Transportation Analysis

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Turbulence model is one of the key elements for engineering in Computational Fluid Dynamic (CFD). Three-dimensional corner separation in axial compressors has been identified as the main source of total pressure loss and compressor efficiency reduction. Widely used conventional turbulence models failed to accurately predict the corner separation in axial compressors.

Firstly, in this paper the performance of some turbulence models have been evaluated in predicting the corner separation in the NACA65-009 blades Cascade. Static pressure coefficient on the blade surface and total pressure loss at the outlet section are compared to the experiment and LES results. all the RANS models tested with this configuration over-estimated the corner separation. Among the RANS models investigated in this paper, the results with the RSM turbulence model are closest to the experiment and LES results.

In order to accurately predict the corner separation by employing CFD methods, RSM turbulence model modification based on the turbulence transport properties have been studied in the second part of this paper. Turbulent kinetic energy production and dissipation of the flow was discussed and static pressure coefficient on the blade surface and total pressure loss at the outlet section are compared with the experiment and LES results for the modified cases. Local velocity profiles were also given in the blade passage for the validation of the modified RSM turbulence model. an improvement of the predictive accuracy of the turbulence model is finally obtained.

Keywords: corner separation, turbulence model, turbulence transport properties

	Session: Fluid Mechanics salle 235 /233	**Session: Solid Mechanics and Materials salle 220**
14h00-14h25	The progress on the breakup mechanism of a cross liquid jet: **Huang Yong (BUAA)**	Experimental investigation and modeling of mechanical behaviors of advanced ceramic composites at high temperature: **Shi Duoqi (BUAA)**
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[Session: Fluid Mechanics]

The progress on the breakup mechanism of a cross liquid jet

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The breakup process of a liquid cross jet is a key problem in many widely used industrial devices. The understanding to the mechanism of the breakup process is very helpful to the improvement of the design of the related devices. So far many researchers have made contributions to the deep understanding to this breakup process. The primary achievements could be summarized as follow.
With the increase of the velocity of the air flow, the breakup process of the cross liquid jet will undergo column, bag and shear breakup modes. Nearly all the behavior parameters such as trajectory, surface wave length, fluctuation, breakup point, droplet size and velocity etc for the column breakup mode at room temperature and pressure could be predict well by semi-empirical correlations. The stability theory could be applied to this breakup mode to derive the formation of the surface Kelvin-Helmholtz wave. Most of the behavior parameters such as trajectory, surface wave length, fluctuation, breakup point, some bag parameters, droplet size and velocity etc for the bag breakup mode at room temperature and pressure could also be predict well by semi-empirical correlations. The stability theory could also be applied to this breakup mode to derive the combination of the surface Kelvin-Helmholtz and Rayleigh-Taylor waves. More information is needed to understand the formation and breakup of the bags. Much less progress has been made to the understanding of the formation and breakup of the ligaments in the shear breakup mode, although which is the typical mode in practical applications. Some numerical simulation has been made to predict the performance of this breakup mode. The detailed experimental validation is needed for the improvement of the numerical simulation.

Instability of a stably stratified boundary layer on a verticalwall

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Ocean and atmosphere as stratified fluids exhibit internal gravity waves. These waves are known to play an important role in fluid mixing and energy transfer, but there are still debate concerning their sources. It is well-known that internal waves can be generated by direct forcing (interaction with topography, convection, barotropic instabilities) or by transient variations (geostrophic adjustement), but it was also recently shown that they can be spontaneously generated in shear flows. The mechanism of generation is a subtle interaction phenomenon between vortical and internal waves. It results from a (radiative) instability different from well-known shear driven instabilities (Kelvin-Helmholtz instability, viscous boundary layer instability). Several theoretical and experimental results have been obtained in the context of rotating flows [1, 2]. For a boundary layer flow, the existence of the radiative instability has been theoretically predicted in an inviscid framework [3].

In the present work, we analyse the impact of viscosity on the radiative instability for a tanh boundary layer on a vertical wall in a uniformly stratified fluid [see figure ?? (a)]. The base flow is assumed to have a uniform velocity profile $U(z) = U_0 \tanh(z/L)$, a constant buoyancy frequency $N_0 = \sqrt{(g/\rho_0)\partial_y \rho}$ and a kinematic viscosity ν so that it depends on the two parameters

$$Re = \frac{U_0 L}{\nu}, \quad F = \frac{U_0}{N_0 L}, \tag{1}$$

The stability diagram that we obtain in the (Re, F) plane is shown in figure ??(b). It shows that the radiative instability is the first to appear as Re increases. The critical Reynolds number for the radiative instability is about 2000 for a Froude number of order 1 while it is 3550 for the viscous boundary layer instability (Tollmien-Schlichting waves). Moreover, the radiative instability is found to dominate over the viscous boundary layer instability in a Froude number intervalle which increases with the Reynolds number. An illustration of the perturbation mode associated with the radiative instability is shown in figure ??(c). Contrarily to the viscous modes, the most unstable modes of the radiative instability are 3D with a short transverse wavelength.

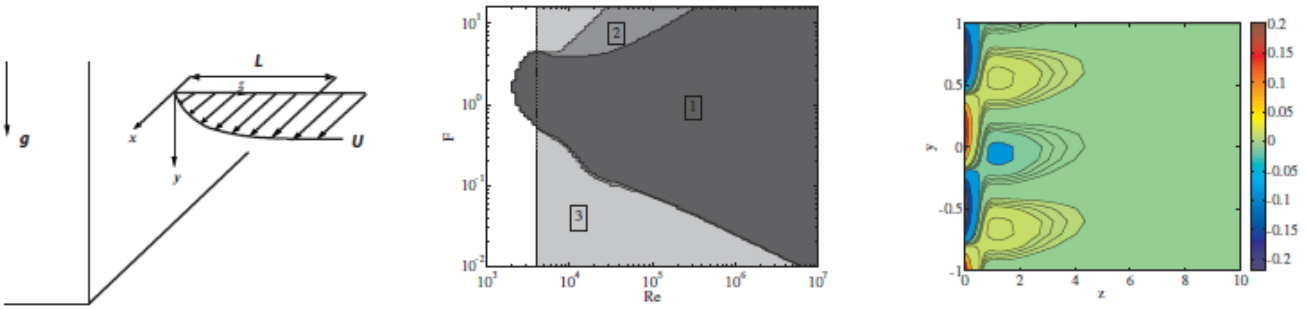

Figure 1. (a): Sketch of the flow configuration; (b): Stability diagram. Grey regions correspond to instable regions. The radiative instability is present in regions 1 and 2; it is dominant over the viscous instability in region 1 only. In region 3, only the viscous instability is active. (c): Density contours of a radiative instability mode in the (y, z) plane. Here: $Re = 10^5$, $F = 1$; the characteristics of the mode are $k_z L = 0.88, k_y L = 5.14, \omega L/U_0 = 0.73 + 0.017i$.

Preliminary results of Direct Numerical Simulations of the instability will also be shown.

References

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Aerodynamic and acoustic analysis of the tip-leakage flow on a single aifoil, from experiment to large-eddy simulation

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LMFA, Ecole Centrale de Lyon / Université Lyon 1 / CNRS UMR 5509

Tip-clearance flow is a major concern in the field of turbomachinery studies, as it is involved in the generation of aerodynamic losses and noise. In this study, the behavior of the tip-leakage vortex is investigated experimentally and numerically. The configuration is constituted of an isolated NACA5510 airfoil enclosed between two horizontal end plates, with a clearance at the lower end. PIV measurements are carried out at different axial positions. The numerical study uses large-eddy simulation (LES) around the clearance region, and Reynolds-averaged Navier-Stokes (RANS) in the external region, on a 150 million points multi-block structured grid. The LES results are extracted and interpolated on the PIV grid, and the same post-processing is employed, in order to allow a direct comparison between the two approaches.
The results are first analyzed on a cross-stream plane, 2mm downstream of the trailing edge. A very good agreement is found between the experiment and the simulation. The tip-leakage vortex is intense, with mean cross-stream velocities of the order of the free-stream flow. Vortex identification functions (Γ_1 and Γ_2) are used to evaluate the position and the width of the vortex. Again, a very good agreement is observed between experimental and numerical results. A counter-rotating vortex is detected in the PIV results, but it is less visible in the LES. Furthermore, the comparison of the velocity fluctuations reveals that the simulated vortex is slightly more diffused than in the experiment. Finally, the far-field acoustic spectrum is extracted from the simulation using an acoustic analogy, and compares very favorably with the experiment. The signature of the tip-leakage noise is dominant in the frequency range [0.7kHz ; 7kHz].

This work has been carried-out in the frame of the Sino-French project AXIOOM (funding: NSFC and ANR). Bo Li is funded by CSC.

An extension of slender-body theory for moderate aspect ratio bodies

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For large Reynolds number flows, slender-body theory (SBT) has been originally proposed by Munk [1] and later developed by Lighthill [2]. It is a classical and popular model used to calculate the hydrodynamic forces produced by an elongated body moving in a uniform flow. However, this model is restricted to bodies with slender enough geometries, i.e. the aspect ratio should be asymptotically small. Here, we propose an extension of slender-body theory [3] to include bodies of moderate aspect ratios. The principle of this inviscid analysis is to seek a solution of the fluid-structure interaction problem, where the velocity potential is decomposed into even powers of aspect ratio. At first order, this model is equivalent to the classical slender-body theory of Lighthill. But the advantage of the present extension is that it can be carried out up to any order of the aspect ratio.

To assess the validity of this approach, we compare the results of the proposed theoretical model to numerical simulations performed with a panel method [4]. We consider a rectangular flexible plate of aspect ratio 0.3, which is clamped at its leading edge, free at its trailing edge, and subject to a uniform, incompressible, inviscid, and axial flow. The motion of the plate is prescribed to be the first eigenmode of a clamped-free beam with reduced frequency $k = 0.5$.

In Figure 1, the real and imaginary parts of the pressure jump across the plate are plotted as a function of the chord coordinate ($-0.5 < x < 0.5$). Comparison with the numerical solution shows that, indeed, the proposed extension of SBT gives more accurate results than classical slender-body theory, particularly near the trailing edge. Further tests (not shown here) have demonstrated that the extension of SBT has a significative gain in accuracy over a large range of frequencies and aspect ratios.

We expect the present method to be useful to calculate accurately hydrodynamic forces produced by deformable bodies of moderate aspect ratios, with applications to different fluid-structure interaction problems, such as swimming [2] and flag flutter [5].

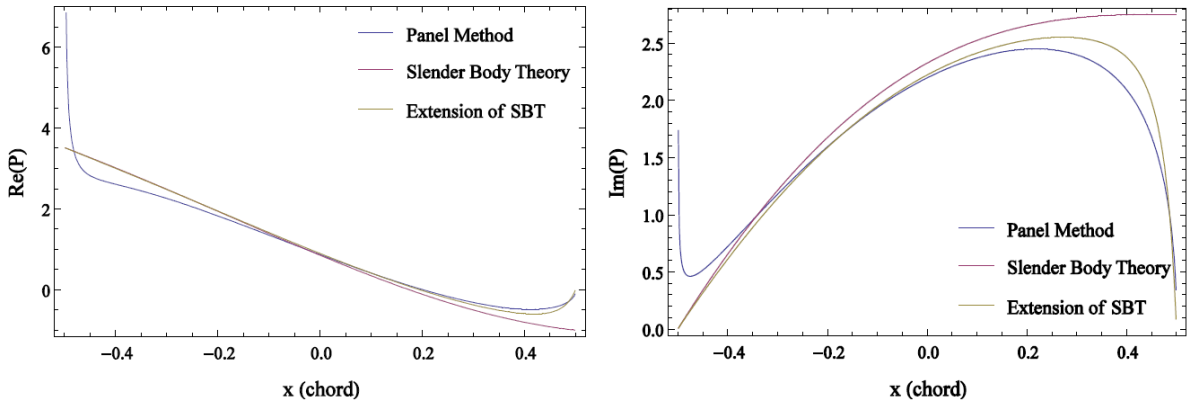

Figure 1. Real and imaginary part of pressure difference across a flapping plate.

References

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[Solid Mechanics and Materials]

Experimental investigation and modeling of mechanical behaviors of advanced ceramic composites at high temperature

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Our research team is committed to investigating the basic mechanical problems of utilizing advanced ceramic matrix composites into aerospace applications. The advanced ceramic matrix composites include ceramic matrix composites consisting three dimensional braided textile preform, fiber reinforced aerogel matrix composites and stitched sandwich thermal protection composites. The experimental and modeling systems for investigating the mechanical behaviors of structural ceramic matrix composites have been established. In the past five years, some novel and interesting results about the material properties and damage mechanisms have been discovered and published.

Experimental system has been established with reference to the existed testing standards. For three dimensional braided CMCs, monotonic tension, fatigue and creep tests at up to 1300oC could be conducted on one set of experimental equipment. In these tests, the gage section is heated in furnace and the grip section is cooled outside the furnace. Approximate fifty tests have been conducted to obtain the mechanical properties including tension, fatigue, creep and dwell fatigue at 1100oC and 1300oC. Not only the mechanical properties but also damage evolutions in the tests have been recorded for further analysis. The failure mechanisms have been examined by SEM and the effects of fiber strength degradation and unbridged matrix crack propagation due to oxidation have been quantitatively investigated.

A series of mechanical properties experimental characterization methods for lightweight load-bearing thermal protection materials have been developed according to the international testing standards. For ceramic fiber reinforced aerogel matrix composites, compression, bending, creep and stress relax tests have been conducted at high temperature up to 900oC. Fusing and Clustering of aerogel particles at high temperature have an important effect in mechanical properties. In addition, mechanical behaviors and failure mechanisms under tension, compression, shear and bending loads have been investigated. For stitched sandwich thermal protection composites, relevant testing method establishment and failure analysis with μ-CT scan technique are already in progress.

To understand the influence of constituent and preform geometry, modeling the composites at meso-scale have been developed to simulate the material properties. The yarn-matrix unit cell and binary sandwich model are developed for three dimensional braided CMCs and stitched sandwich thermal protection composites, respectively. The modulus, strength and stress-strain behavior were predicted and correlated well to the experimental data. More insight of the damage evolution could be obtained through the non-linear simulation. Efforts in constitutive theories and modeling technologies can help us in the knowledge of damage and failure problems.

Wave-based numerical homogenization method to study periodic structures

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Periodic engineering structures are widely applied in various engineering domains, typical examples include multi-storey buildings, multi-span bridges, multi-blade turbines, chemical pipelines, stiffened plates and layered composite structures in aerospace and ship structures.
In this work, the broadband wave propagation feature in periodic perforated plate is investigated by both the numerical and experimental approaches. The study begins with the modelling using numerical method - Condensed Wave Finite Element method (CWFEM). Based on the periodic structure theory, a single unit cell is modelled by the FEM, where the modal reduction is included compared to the classical WFEM. Using the wave dispersion relation identified by CWFEM, wave-based homogenization methods are proposed to define the equivalent parameters of the homogenized model. The experimental validation of the computed wave propagation characteristics is provided. The accuracy of the homogenized model is illustrated by the comparison with the full model in FEM, where good correlation is observed between the two models in terms of modal analysis.

Keywords: wave propagation, homogenization approach, Condensed Wave Finite Element Method.

Microstructure-sensitive modeling of scatter in HCF crack formation

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Crack formation, up to 85% of the total HCF life, is remarkably sensitive to the variability of the local microstructures. We present a computational strategy to modeling the microstructural influence to the fatigue scatter. First, a metrical Voronoi tessellation algorithm is used to construct multi-cell models to approximate polycrystalline microstructures. Partly to completely constrained period boundary conditions can simulate the state of microstructures located from surface to interior. Second, crystal plasticity based on internal variable is introduced to describe the crystallographic deformation. Finally, a shear strain-like fatigue indicator parameter (FIP) is formulated as the driving force for crack formation. With numerical simulations on a large number of microstructures, extreme value probability distribution on FIP can be obtained. The proposed cumulative distributions of FIP under different strain amplitudes and boundary conditions can be determined to link the different mechanisms of scatter in crack formation of HCF.

Sound insulation performance of plate with interconnected piezoelectric networks

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Piezoelectric materials, since they were discovered, have been much developed for vibration controlling due to their electromechanical coupling characteristics. However less research concerned the noise controlling or reduction by using properties of piezoelectric materials. Our research on the plate with piezoelectric materials, short for PEM plate below, reveals a phenomenon interested to sound insulation. The PEM plate studied is obtained by distributing piezoelectric patches on the surface of a host plate uniformly and then interconnecting all the piezoelectric patches with circuit networks. Coincident frequency, sound transmission loss and wave constant of the PEM plate are dealt with here. Firstly, the coincident frequency of the structure is analyzed; then the sound transmission loss of the undamped PEM plate and the damped PEM plate are researched respectively. It is found that by optimizing electric parameters, the PEM plate can considerably reduce sound transmission in the zone of coincident effect. In order to understand the mechanism of the PEM plate in controlling sound transmission, the wave constant of the PEM plate and the relation between it and the coincident frequency are studied. The result shows that the PEM plate could make vanish the low ebb of the sound transmission loss curve with a different way compared with general structures. The effect of sound isolation of the PEM plate comes from the existence of two different flexural waves with different speeds transmitted in it.

15h40-16h00	**Cafe Break salle 224**	
	Session: Fluid Mechanics salle 235/233	**Session: Solid Mechanics and Materials salle 220**
16h00-16h25	3D visualization and tomographic particle image velocimetry measurement for vortex breakdown of delta wing: **Gao Qi (BUAA)**	Micro and nano-structures for acoustic band gaps engineering in micro-electro-acoustic devices: **YU Du (ECLi)**
16h25-16h50	Active experimental characterization of the instability modes of turbomachinery (Calypso Project): **Lu ZHANG and J. Scott (ECL)**	Product Innovation Management Based on New Technology and Material: **Zhang Rong (BUAA)**
16h50-17h15	Modelling of Nonlinear Impedance of Micro-Resonators: **Li Xiaodong (BUAA)**	Relationship between the rubbing surface and the squeal occurrence: Investigation of third-body effect: **N. Singla (ECLi)**
17h15-17h40	Numerical turbulence: **L. Shao (ECL)**	Optimization of the dynamic behavior of vehicle structures by means of passive interface controls: **Xingrong HUANG (ECL)**
19h30-21h30	**"GALA" Diner Restaurant les Arcenaulx**	

[Session: Fluid Mechanics]

3D Face Recognition with Asymptotic Cones based Principal Curvatures

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Jean-Marie Morvan, Yunhong Wang, Liming Chen
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The classical curvatures of smooth surfaces (Gaussian, mean and principal curvatures) have been widely used in 3D face recognition (FR). However, facial surfaces resulting from 3D sensors are discrete meshes. Here we present a general framework and define three principal curvatures on discrete surfaces for the purpose of 3D FR.

These principal curvatures are derived from the construction of asymptotic cones associated to any Borel subset of the discrete surface. They describe the local geometry of the underlying mesh. First two of them correspond to the classical principal curvatures in the smooth case. We isolate the third principal curvature that carries out meaningful geometric shape information. The three principal curvatures in different Borel subsets scales give multi-scale local facial surface descriptors. We combine the proposed principal curvatures with the Local Normal Pattern-based facial descriptor and Sparse Representation-based Classifier for recognition.

The identification and verification experiments were using 4007 face images of 466 subjects from FRGC v2.0 database. We tested the algorithm's recognition performance with three principal curvatures respectively and then fused them to form the new local feature. We got the identification rate as 93.16% using three principal curvatures and the verification rate as 96.57% at False accept rate is 0.01. The experimental results show that the third principal curvature offers complementary geometrical information of face.

In the future work, we plan to use the eigenvector from the matrix of asymptotic cones for better describing the face surface and enhance the recognition performance.

Active experimental characterization of the instability modes of turbomachinery (Calypso Project)

Lu ZHANG, LMFA ECL
Julian SCOTT, LMFA ECL
Xiaofeng SUN, SJP BUAA

Flow instability in turbomachinery is caused by spontaneous growth of small perturbations of the nominal flow in compression system, which can lead to degradation in performance, large-amplitude oscillations, and even structural damages. There are two main types of instability: surge and rotating stall. In practice, surge is extremely harmful and has to be avoided at all costs.

Instabilities of linear origin (growth of small disturbances) correspond to normal modes of the flow whose growth/decay rate passes through zero at the stability threshold. The aim of Calypso project is to develop experimental techniques based on active, impulsive forcing (e.g. compressed air impulses) to characterize the precursors of instability, similar in principle to tapping an elastic structure to identify the normal mode frequencies and spatial structure (a technique widely used by structural engineers). This should provide us an improved understanding of the onset of instability and direct input to theoretical models. An experimental tool will also be designed to serve real-time diagnostics and controls in turbomachinery.

Calypso is a Sino-French cooperative project with two test benches: one at LMFA, the other at SJP in Beijing. The results will be compared with theoretical models developed at LMFA, SJP and elsewhere.

Modelling of Nonlinear Impedance of Micro-Resonators

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Acoustic liners are widely installed in the nacelle of commercial aero-engine nowadays due to its sound absorption capability, which can be characterized by a complex value, acoustic impedance, a combination of both resistance and reactance. The value of acoustic impedance contains the factor of liner geometry and incoming flow pattern, the speed of grazing flow and incident sound pressure level, etc. which result in the difficulty of impedance modelling. An acoustic liner with good sound absorption performance relies on the impedance model. Based on theoretical study and extensive experimental data, semi-empirical impedance model could be applied in real liner design nowadays. But on the other hand, empirical parameters used in the model could weaken its reliability and could not fully reveal the underlying physics mechanism. Moreover, the extremely small scale of micro resonator opening hinders the further experimental investigation of information from flow field and acoustic field, which affects the theoretical improvement of nonlinear impedance modelling of micro-resonators.

With the acknowledgement of rapid development of computer technology and numerical methodology, a combined numerical and theoretical study is conducted, trying to take a deep observation of nonlinear absorption characteristics of microslit resonator under high incident acoustic intensity. Direct Numerical Simulation (DNS) is employed and implemented with high order Computational Aero-Acoustic (CAA) method in order to reproduce complex flow phenomena around the opening of microslit resonator with detailed flow field information under different frequencies and different incident Sound Pressure Levels (SPLs). Through the analysis of flow field data, an exponential relationship between normal velocity at the opening and the reactance is established, which is able to further improve the nonlinear resistance model introduced by high SPL that proposed by Ingard and Ising in 1960s. This new nonlinear resistance model eliminates the reliance on input data comparing with previous model, and shows good agreement with reference results. Furthermore, a complete nonlinear impedance model for multi slits or orifices is formed through the corporation with the linear impedance model by Maa and the grazing flow effects of Guess's impedance model. Validation results against experimental data show that the proposed the model could give a pretty good prediction of nonlinear impedance of micro-resonators with multi slits or orifices under high SPL and in the presence of grazing flow.

Numerical turbulence

L. Shao

[Session: Solid Mechanics and Materials]

Micro and nano-structures for acoustic band gaps engineering in micro-electro-acoustic devices

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Micromachined phononic crystals with operation frequency in the hundreds of MHz to GHz range have attracted significant interest for applications ranging from radio-frequency signal processing, sensing and actuation. The interest in these materials stems from their useful wave guiding and transmission properties. Phononic crystals for surface acoustic waves and lamb waves are typically created from drilling holes and deposition of pillars in/on a solid substrate and in/on a free standing membranes. They exhibits a well known series of band-pass and band-stop frequencies, originating from Bragg interference of scattered waves and hybridization of local resonances, that have attracted significant attention for use as filters, absorbers, wave-guiding using linear defects, and trapping acoustic energy in high-Q resonators using isolated defect. This study is focused on experimental observation of surface acoustic wave transmission thought 1D and 2D PnCs based on Ni pillars deposited between two identical wide-bandwidth interdigital transducers (IDTs). Both slanted and chirped configurations are used.
Phononic crystals composed of Ni pillars arranged in different lattice symmetries on a piezoelectric substrate have been investigated. Different methods of characterization, including relative transmission and phase difference, indicated clearly the location of band-gaps and the peaks of local resonances. Fairly good experimental confirmation of SAW propagation characteristics was achieved through direct scattering matrix measurements of fabricated test dispersive delay lines with observed phononic crystal arrays. For further investigation, In term of devices other structures like nano-wires, colloidal nano-particles, even other materials like elastomer also can be applied in PnCs. Numerous applications are targeted ranging from designing innovative platform for micro-fluidic sensing and actuation, physical sensors based on localized resonant mode, etc.

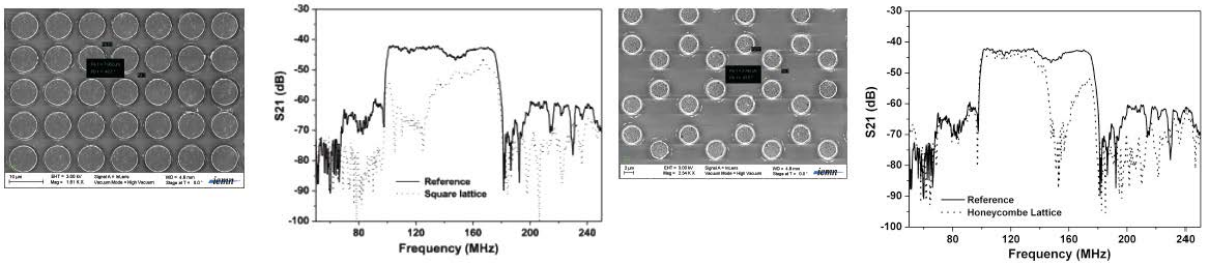

Figure: Measured electrical transmission S12 as a function of frequency for a pair of slanted interdigital transducers (IDTs) operating in a delay line configuration.

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Product Innovation Management Based on New Technology and Material

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Abstract: We are in a period that management field has been influenced by design thinking, interactive thinking and internet thinking. It makes managers more aware of a good product, which can not only bring a new user experience, but also change people's lifestyle. However, new technology and new material are the base of such products. Therefore, managers should apply new technology and new material properly into product. In addition, it is necessary to do some research on new technology and new material for some demand. This paper, setting an example of the projects in our lab and Apple products, mainly explains the function of managers in the process of product innovation, and the way managers lead the development direction of new technology and new material.

Keyword: management; New technology & New material; Product innovation; New lifestyle

Relationship between the rubbing surface and the squeal occurrence: Investigation of third-body effect

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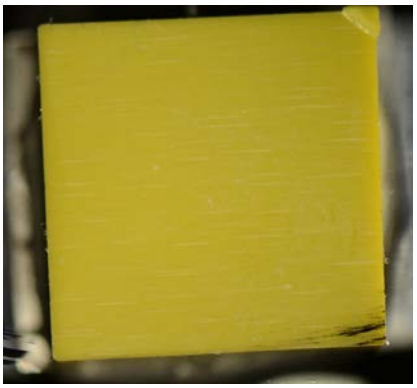
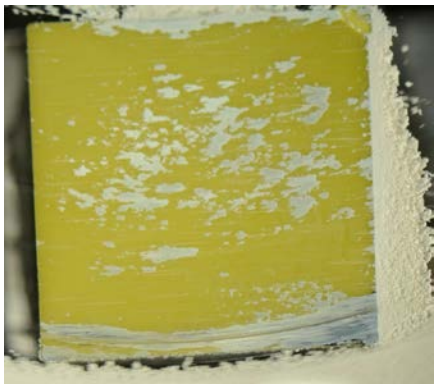
Brake squeal involves unstable vibrations due to coupling mode between the parts in contact which can lead to large amplitude vibrations. Since squeal is a friction-induced instability, it is affected by many different factors on both the micro and macro scales. The phenomena at small scales, both in length (microscopic contact effects) and in time (high-frequency vibrations) and at large scales (wear, tribological and dynamical behaviors of the tribological triplet, ie the whole brake system) affect. Thus, squeal is an interdisciplinary issue, and a correct approach to the problem should include jointly a tribological and dynamic analysis.
The objective of the work is to understand how the interfaces link with squeal generating mechanism and characteristics of wear. An elementary experiment was performed under low load and low speed, using a simplified tribosystem "CrisMat" designed for analysis of material and surface effect on squeal. Furthermore, the pad materials (nylon, HDPE pad) provide useful conditions for minimum squeal and minimum wear when rubbing on a glass disc, allowing contact video observation during sliding. An artificial third body has been used and introduced to feed the tribological contact. It is concluded that with the flat surfaces, there is no noise in the absence of the artificial third body and as some artificial third body adds, the noise comes into the existence.
Key-Words: Brake Squeal, Friction induced Vibrations, Artificial third body.

(a)





(b)

Figure. Contact video observation during sliding through the glass disc: case of HDPE pad (a) without and (b) with artificial third body.

Optimization of the dynamic behavior of vehicle structures by means of passive interface controls

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As passive control, padding rubber layers on the most heavily deformed zones of the system can improve the dynamic behavior and the acoustic comfort of a vehicle system. In this paper, we proposes an extensive hybrid modal synthesis method to study coupled fluid-structure system by retaining few degrees of freedom.
Modal criteria corresponding to noise transmission paths between substructures in the system are then derived to characterize the dynamic phenomenon from a modal view. These criteria are then substituted by Kriging interpolation models to avoid prohibitive simulation effort
during the optimization of the complex system. Once the mathematical models of investigated modal criteria are established and the multi-objective functions for rubber characteristics are defined, an approximate optimal solution leading to superior dynamic performance is obtained based on a genetic algorithm. Analytical results and numerical experiments conducted also justify the efficiency of the proposed strategy.

Friday 22 Mai 2015

	Session 2: Control/Intelligent Systems salle 235 /233	**Session: Energy/Physics /Electronics/Photonics salle 220**
09h00-09h25	Electromechanical coupling of periodical piezoelectric composite in wave domain: **Yu Fan (ECL,BUAA)**	Rhodopsin-based photovoltaic materials and nanosystems. **Yan Xiang (BUAA)**
09h25-09h50	Segmentation of tesselated model and its applications in CNC machining: **Xv Shixin (BUAA)**	Fluid simulations of edge plasma turbulence in tokamaks for magnetic fusion: **Serre Eric (ECM)**
09h25-10h15	Multi-scale homogenization of 1D periodic structures **Xiangkun Sun (ECL)**	Solar spectral selective coatings and electrochromic devices for solar energy and energy efficiency windows in green buildings: **Diao Xungang (BUAA)**
10h15-10h40	An Efficient Multimodal 2D-3D Feature-based Approach to Automatic Facial Expression Recognition: **Huibin Li (ECL)**	Functionalization of magnetic nanoparticles with ferrocene for electrochemical enzymatic biosensing: **Feixiong Chen (ECL)**
10h40-11h00	**Cafe Break salle 224**	

[Session 2: Control/Intelligent Systems]

Electromechanical coupling of periodical piezoelectric composite in wave domain

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2 - SJP, Beihang University

Distributed piezoelectric strategy is widely used for controlling the energy flow in the host structure, especially in medium /high frequencies and multi-mode vibration control cases. If identical impedance is used for all piezoelectric patches which are periodically distributed, the strategy will be easier to implement. The success of the control is directly related to the strength of the electromechanical coupling in the piezoelectric composite when waves are travelling. In terms of structural modes, the coupling factor can be estimated by the open-circuit (OC) and short-circuit (SC) natural frequencies. However in terms of wave, few criteria are available.
In this work, two wave-based criteria are proposed to evaluate the coupling factor of the piezoelectric composite. The coupling factor of a whole periodic piezoelectric waveguide can be calculated by just considering one unit cell. To do this, enhanced Wave and Finite Element Method (WFEM) is employed to obtain the dispersion relations and the shapes of the waves. Then the criteria can be calculated. Criterion one uses the dispersion curves of the OC and SC statuses. Criterion two is defined on the fraction of energy calculated from the SC wave-shape only.
An example is given, where a beam-like piezoelectric waveguide is considered. Though calculated from different processes, the two criteria agree with each other well. The agreement is then formally demonstrated. In the application, it is also illustrated that how the geometric parameters can affect the coupling factors.

Segmentation of Tessellated Model and its Application in CNC Machining

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Tessellated model, as a discrete data model, has been gained increasing interest in 3D shape representation in recent years for reverse engineering, 3D printing (additive manufacturing), simulation, etc. since it has simple format, good interoperability, and yet capable to represent complex shapes. One testimony for this is that the newly-issued standard — ISO 10303-242:2014 (Application protocol: Managed model based 3D engineering) introduced tessellated shape representation, which will promote applications and data exchange of tessellated model. This 3D representation allows display efficiently a 3D shape by using a simplified representation (e.g. triangulated faces), and also allows to have topological information (e.g. face is a collection of triangles). Segmentation is an important technique to partition a tessellated model usually given as an unordered and unstructured triangle mesh into connected subsets of triangles, called regions, such that each region has common properties, such as local shape types (flat, convex, concave, saddle), underlying surface classes (plane, quadric surface, free form surface, etc.). For example, connected triangles forming a concave shape locally can be grouped into a concave region according to the curvature values of the mesh vertices.
In order to segment a tessellated model reliably, a systematic approaches are proposed. First, for a given triangle mesh, pre-process it to become a manifold polyhedral B-rep model, then identify its border edges and corners by dividing its vertices into three types —vertex on a border edge, vertex on a corner and vertex on a face, via a normal voting tensor method. After this operation, the mesh is partitioned into raw regions demarcated by border edges. Second, within one raw region, the angle deficit of each vertex is computed; also the global curvature of each vertex is computed by spherical image method. The angle deficit and the curvature combined can determine the shape type near the vertex neighborhood—whether it is flat, convex, concave, or saddle. In order to decrease the influence of the calculation error, a fuzzy system is adopted for assisting the vertex classification. Third, vertex clustering is performed based on the shape type of a vertex. Vertices having same shape type are clustered together. Then connected regions are generated from these clustered vertices via two successive operations: region growing to get initial segmentation, and region refining aiming to reduce over-segmented regions and to smooth region borders. Thus a raw region is further partitioned into several flat/convex/concave/saddle regions. So far, the segmentation of the tessellated model is done. And finally, to manufacture the workpiece by CNC milling in conformity to the given tessellated model, for each region, optimal milling directions, tool path types, and cutter location points can be determined, as well as the optimum type and size of the tool's bottom can be decided. Optimal directions are created upon minimum curvature directions at every cutter contact point and the region's shape type. Based on machining practices, if the region shape is convex, then the appropriate tool path is spiral; if the shape is concave, then the path is zigzag or circle; if the shape is flat/saddle, then the path is parallel. Minimum curvature of a region also decides the tool's radius. As for the tool's bottom type, for example, if the region's shape is flat/convex, then a flat-end tool is recommended; if the shape is concave, then a ball-end tool is favorable. Our tests proved the above approaches are feasible.

Key words: tessellated model; region segmentation; 3D shape information process; CNC

Multi-scale homogenization of 1D periodic structures

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2- ICJ, Ecole Centrale de Lyon

Periodic structures are widely applied in various engineering domains, such as the sandwich panel, the train rail etc. Many methods are available to study the periodic structure, among which Finite Element Method (FEM) is the most famous. Numerical method can deal with complex structures. However, the computational cost can be high and parameterization or scaling of the model requires repeated computations. As for the analytical methods, although often limited to simple structures, it provides a full insight into the behavior of modeled periodic structures with obtained solutions parameterized and fully scalable. This work focus on the homogenization method for the periodic structures which allows to obtain analytical solutions of the model.
In this work, we consider the homogenization of the standard wave equation in 1D case. The results can be related to the longitudinal, torsional and shear wave motions. In the studied multi-scale homogenization theory, multiple spatial scales are introduced. One fast spatial scale describes the rapid fluctuations of material properties, while one slow spatial scale accounts for the long-term behavior of the homogenized structure. According to the classical homogenization theory, the homogenized material properties can be obtained by taking the mean value of the composition, which is not accurate enough even in the first pass band. However, in the studied method, the higher order asymptotic homogenization method is used to obtain a new equivalent homogenized wave equation, which involves a higher order term representing the microstructural heterogeneity. In this way, the new analytical solution can give a more accurate theoretical description of these phenomena.
A longitudinal wave propagating in periodic structure example is given. The result based on multi-scale homogenization is also compared with the one obtained by the classical homogenization method, while the multi-scale homogenization method proves his accuracy advantage compared to the classical one.

An Efficient Multimodal 2D-3D Feature-based Approach to Automatic Facial Expression Recognition

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We present a fully automatic facial expression recognition approach and demonstrate its performance on the BU-3DFE and Bosphorus data. Our approach combines multimodal (2D and 3D) and double-order (first and second) local descriptors in order to achieve efficiency and robustness.
First, a set of fiducial facial landmarks of a 2D face along with its 3D model are automatically localized using a novel approach based on the Incremental Parallel Cascade of Linear Regression (iPar-CLR). Then, a novel histogram of second order image gradients (HSOG) based local image descriptor in conjunction with the scale-invariant feature transform (SIFT) are used to describe the local texture around each 2D landmark. Similarly, the local shape around each 3D landmark is described by two novel local shape descriptors constructed using the histogram of normalized surface normals, i.e., mesh gradients (meshHOG) and the histogram of normalized surface curvatures, i.e., mesh shape index (meshHOS). Finally, the support vector machine (SVM) based recognition results of all 2D and 3D descriptors are fused at both the feature-level and score-level to achieve higher accuracy.
Comprehensive experimental results demonstrate that there exist impressive complementary characteristics between both same order and different order 2D-3D multimodal descriptors. We use the BU-3DFE benchmark to compare our results to the state-of-art approaches. Our multimodal feature-based approach outperforms all others by achieving 86.32% average recognition rate. Moreover, a good generalization ability is shown by achieving 84.72% accuracy on the Bosphorus data.

[Session: Energy/Physics/Electronics/Photonics]

Rhodospin-based photovoltaic materials and nanosystems

Yan XIANG

Fluid simulations of edge plasma turbulence in tokamaks for magnetic fusion.

Serre Eric
M2P2, Marseille

The perspective of ITER, currently being built in Cadarache (south France), and within a shorter time frame, the setting up of an ITER-like full tungsten divertor in the Tore Supra tokamak at the CEA-Cadarache (WEST project, http://west.cea.fr/en/index.php), convey strong signals to intensify our effort on the numerical modelling of magnetized fusion plasmas. In tokamak reactors, the control of heat and particle fluxes on the divertor targets and the quality of plasma confinement in the reactor are two of the most crucial issues regarding on the performances. These call in particular for an improvement to predict turbulent transport, which leads to an important modelling effort. Due to the wide different scales involved, such simulations remain very challenging and require high performance computing (HPC). Benefiting from the standing increase of the available computing power, we currently develop in collaboration with IRFM-CEA Cadarache two efficient numerical codes SOLEDGE2D and TOKAM3X able to describe self-consistently turbulent transport in realistic tokamak geometry. During this talk, we will show how these codes can help to address key physcis issues for fusion performances and also provide results in support to tokamaks experiments.

Solar spectral selective coatings and electrochromic devices for solar energy and energy efficiency windows in green buildings

Xungang Diao

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The earth receives 1.74×10^{17} W of solar energy at the upper atmosphere and about 70% of the total radiation comes onto the surface of the earth by energy fractions to 44% visible light, 3% ultraviolet, and the remainder infrared with wavelength ranging at 200-400 nm, 400-760 nm and 760-2500 nm respectively. Objects at temperature below 500 °C lose their energy by infrared radiation with wavelength ranging at about 3000-25000 nm. This energy spectral distribution makes it possible that solar spectral selective films/coatings can be applied for energy efficiency windows in green buildings.

Solar spectral selective films/coatings are classified into transparent films for energy efficiency windows of green buildings and transportations and absorbing coatings for solar thermal collectors. Solar spectral selective transparent films include 1) low emissivity transparent conductive thin films with typical examples of indium tin oxide (ITO), aluminum doped zinc oxide (ZAO) and single/double/triple silver layer based low emissivity multilayers; 2) electrochromic multilayer smart windows with typical materials of WO_3 and NiO_x together with some Li^+ or H^+ ion conductors; 3) thermochromic films typically VO_2 doped by tungsten. These solar spectral selective transparent films are all applied for high energy efficiency windows to control solar and thermal radiation in or out of buildings. Solar spectral selective absorbing coatings are optically designed and optimized metal/ceramic gradient mixed multilayers. Materials are different for low, medium and high temperature applications. Special solar spectral selective absorbing coatings have been developed for building integrated solar thermal collections.

Electrochromic devices have been regarded as the next promising generation high performance energy efficiency windows for green buildings and transportation tools such as trains, automobiles and airplanes. Comparing to the market-existing low emissivity glass coatings, electrochromic smart windows show great advantages by supplying more efficient solar energy light and room temperature infrared light modulation through the windows and therefore supplying more comfortable environment in the room or space. We use magnetron sputtering to fabricate all solid state thin film multilayered electrochromic devices which have potential applications on high energy efficiency smart windows and satellite surface thermal controllers respectively. A typical five multilayered transparent electrochromic device Glass/ITO/WO_3/$LiTaO_3$/NiO_x/ITO and a flexible reflective device PI/Al/WO_3/$LiTaO_3$/NiO_x/ AZO have been monolithically fabricated layer by layer with a home-made multi-target magnetron sputtering machine. The maximum transparency and reflectance difference in the visible light spectrum region between coloration and bleaching states reaches as high as 80%. The response time for both coloration and bleaching is as fast as within less than 20 seconds.

Functionalization of magnetic nanoparticles with ferrocene for electrochemical enzymatic biosensing

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Context: A high-performance and reliable biosensor must have the following characteristics: high sensitivity and selectivity, response time and detection limit as low as possible. Among all the existing devices, electrochemical biosensors are constituted of conductive or semi-conductive electrodes whose electrical properties are locally modified when target biomolecules are immobilized at their surface. The performances of an electrochemical biosensor depend mainly on the amount of immobilized probe biomolecules (sensing element) onto the surface of the transducer. Indeed, the increase of quantity of immobilized sensing material enhances biosensor sensitivity and improves the detection limit (increases the range of targets that may be detected). In this purpose, it is necessary to replace 2D-immobilization by a three-dimensional (3D) 'in-volume' immobilization of sensing biomolecules onto transducer surface. Moreover, the immobilization of biomolecules close to the transducer must be quickly and selectively achieved. In this context, the high surface to volume ratio developed by nanomaterials could be a mean to immobilize a high number of molecular probes and in the same time to keep a good accessibility. In particular, magnetic nanoparticles can be magnetically moved to capture more efficiently molecules in a solution. In this context, we propose to develop new electrochemical enzymatic biosensors using dual-functionalized (enzymes and redox probes) magnetic nanoparticles. These magnetic nanoparticles will help to regenerate the catalytic sites of enzymes and to improve the electron transfer between enzymes and electrode surface. Moreover, the magnetic manipulation of nanoparticles will allow the detection onto non-functionalized electrodes and the regeneration of electrode surface.

Preliminary results: First, we focused on the functionalization of magnetic nanoparticles with ferrocene, an electroactive molecule. We started from carboxylate-modified iron oxide nanoparticles. Then, ethylenediamine (EDA) was grafted thanks to NHS-ester chemistry. With this method, we can obtain a double-functionalization of nanoparticles with both carboxylate and amine groups. The percentage of amino groups was estimated to 25% using colorimetric titration. Finally ferrocene carboxylic acid was grafted onto these amine groups using a similar process. Electrochemical measurements proved that ferrocene grafting onto nanoparticles was successful. The remaining free carboxylate groups will be used to immobilize enzymes.

	Pedagogy salle 235/233	**Session: Energy/Physics/Electronics/ Photonics salle 220**	**Session: Chemical engineering/Biophysics salle 225**
11h00-11h25	**Project Activity and Professional Development at ECPk** Jean-Marc CAMELIN (ECP), YIN Chuantao (ECPk), TANG Hongzhe (ECPk), ZHANG Wei (ECPk), FANG Le (ECPk), NIU Wei (ECPk), SONG Meng (ECPk), YU Lei (ECPk), Véronique LE COURTOIS (ECLi-ECPK), XU Ping (ECPk), YU Liming (ECPk), Anne SPASOJEVIC-de BIRÉ (ECP-ECPk)*	The Espace Photonique: a platform for the fabrication of complex optical interference filters: **Michel LEQUIME and Julien LUMEAU (ECM)**	Total Syntheses of Quadrane sesquiterpenes: **Y. Ren (ECM)**
11h25-11h50	Pedagogical Change in Thermodynamics : **Pascal DENIS (ECM) – YUAN Weixing (BUAA)**	Dark fermentative hydrogen production in an anaerobic packed bed biofilm reactor: **A. Soric (ECM)**	Innovative Heteropolyacid (HPA) Catalysts for Biomass Valorization in Liquid phase Reactions: **Xiaofeng Yi (ECLi)**
11h50-12h15	**Anne Spasovic (ECP) and Veronique Le Courtois (ECLi)**	Capping and decapping GaAs nanowires with As for preventing oxidation and for epitaxial shell growth: **X. Guan (ECL)**	Multiplex detection of anti-heat shock protein autoantibodies in breast cancer sera: **Yi Shi (ECL)**
12h15-12h40		Online multiclass learning with "bandit" feedback under a Passive-Aggressive approach : **Hongliang ZHONG (ECM)**	Hydrodynamic Study of the MicroGasic Process. Application: Conversion of Syngas to Ultraclean Hydrocarbon Fuels. **Haiqin Quan (ECLi)**
12h40-14h00	Lunch - Crous		
14h00-16h00	**LABORATORY VISITES**		

[Pedagody]

Project Activity and Professional Development at ECPk

Jean-Marc CAMELIN (ECP), YIN Chuantao (ECPk), TANG Hongzhe (ECPk), ZHANG Wei (ECPk), FANG Le (ECPk), NIU Wei (ECPk), SONG Meng (ECPk), YU Lei (ECPk), Véronique LE COURTOIS (ECLi-ECPK), XU Ping (ECPk), YU Liming (ECPk), Anne SPASOJEVIC-de BIRÉ (ECP-ECPk)*

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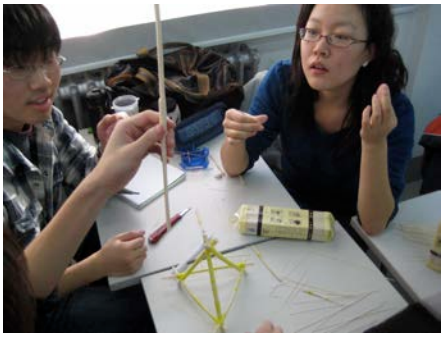
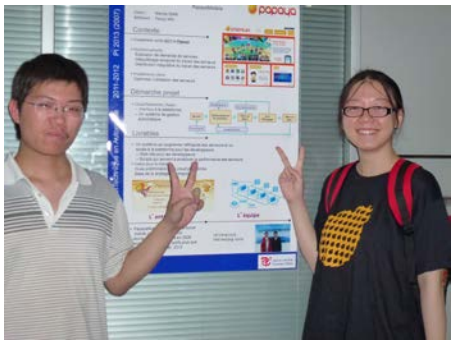
The project activity and professional development (3PI *Pratiques Professionelles et Projets d'Ingénieurs*) have been created since October 2008, for the first engineer year of the first cohort. The general aims are the following:
- To help the student to build one's academic and career plan and to present oneself professionally (graduating for each year)
- To follow the Bachelor project and the Innovative and Cooperative Project (PIC)
- To follow the three internships of the engineering cycle.

The organization, the activities will be presented. A comparison will be done with similar activities in ECP and ECLille. The particularity of ECPk will be emphasized.





Bachelor project defense, "Thales group",

Pedagogical Change in Thermodynamics

Pascal DENIS (ECM) – YUAN Weixing (BUAA)

Pedagogy must change at Centrale Beijing, for different reasons : financial & economical aspects, avaibility of french teatchers, student course weeks and hours of learning, language barrier, cultural differences, and so on … All these reasons could be changed into opportunities to think on a new model, keeping the « Centrale Teatching Way of Life » and solving external specific constraints.

After 7 years of teatching « Engineering Thermodynamics » at Centrale Beijing, we have been trying to propose a solution to the most important constraint, using new pedagocical methodology, with the help of e-technology (e-book, computer/tablet, network, vodeoconferencing, etc …).

On the basis of a PBL approach (Problem Based Learning), we have built a model along 12/16 weeks, with specific meeting and identified « *tempo* ». Problem choice, student group's cohesion, documents and supports, adequate means have been analysed and proposed. Remarks, critics and evolutions made at Centrale Marseille helped us to build the model (students interview, feedback, intern thinking group). This is what we would present during the workshop

[Session: Energy/Physics/Electronics/Photonics]

The Espace Photonique: a platform for the fabrication of complex optical interference filters

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The Espace Photonique is a 250 m^2 cleanroom facility that has recently been constructed in order to provide the thin film research team of the Institut FRESNEL with a new state-of-the-art platform for the fabrication of complex optical interference filters. Within this facility are installed 5 deposition machines, all associated with an in-situ optical monitoring system. They include e-beam evaporation systems, with or without ion/plasma assistance, an assisted ion beam sputtering system and a Plasma Assisted Reactive Magnetron Sputtering (PARMS, Leybold Optics Helios) machine. Several characterization systems (Spectro-photometer, Fourier-Transform Infrared Spectrometer, Optical profilometer…) allow complete characterization of the fabricated filters.

In this presentation, we review some of the recent results that were obtained by the thin film research team of the Institut FRESNEL. We first present some results related to the fabrication of complex optical filters for space applications. These squared profiles, broadband rejection, bandpass filters were deposited by PARMS technique. Both faces of the substrates were coated with multilayer stacks, with total number of layers exceeding 100 for each face and a total thickness up to 25 microns. Thanks to the process and optical monitoring stabilities, the deviation between the experimental and theoretical transmission curves of these filters does not exceed a few percent over a broad spectral range. Uniformity within 0.5% over a 100 mm diameter is demonstrated.

We also present the principle of pixelated filters for multispectral imaging. These matrices of macro-filters are composed with 2×2 micro-pixels with 30×30 μm^2 lateral size. Each of these pixels is a narrow-bandpass filter centered in visible range and with broad spectral rejection. The techniques involved in the fabrication of these filters are presented: design, photo-lithography, low temperature thin film deposition process, characterization procedure. The first prototype of this new generation of filters is presented.

Finally, we describe some results of other research topics of interest, including ultra-flat mirrors, ultra-uniform filters, volumetric diffractive optical elements…

Dark fermentative hydrogen production in an anaerobic packed bed biofilm reactor

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Keywords: bioreactor engineering; *Clostridium acetobutylicum*; *Desulfovibrio vulgaris*; biofuel

Anaerobic digestion (or dark hydrogen fermentation) is an attractive pathway to produce H_2. Dark fermentation systems are relatively simple to construct, their functioning does not consume much energy and fermenting bacteria can utilize different and complex forms of organic substrate. As a result the technical feasibility of H_2 production from wastewater has been largely investigated in anaerobic packed bed reactors (APBR) using mixed bacterial cultures (Barca *et al.*, 2015). However, many studies have shown low H_2 yields and instable H_2 production, as the result of the variability of microbial dynamics and metabolic pathways. Therefore, the most important challenge for future research is to improve reactor design and operation in order to obtain stable and efficient H_2 production.

Recent studies have shown that sub-dominant bacteria (such as *Escherichia coli*, *Ralstonia eutropha*, *Desulfovibrio vulgaris*) can have a significant effect on H_2 production performances of dominant species (*Clostridii*) (Ranava *et al.*, 2015). With these results, this study aimed at evaluating the H_2 production performances of two continuous up-flow APBRs (2 L of total volume each) inoculated with a co-culture of *Clostridium acetobutylicum* and *Desulfovibrio vulgaris*. After inoculation, the reactors were continuously fed with an anaerobic medium containing glucose as the main carbon source (1 g/L of glucose), and operated at mesophilic temperature conditions (37 °C).

The novelty and importance of the work presented here are highlighted by the two following points: (i) investigation of the effect of various operating parameters, including void hydraulic retention time (HRTv) and pH, on H_2 production performances in continuous experiments, and (ii) an in-depth study on the influence of these parameters on microbial dynamics and metabolic pathways.

The results indicated that a steady state was reached after 3 days of operation. H_2 production rates increased linearly with the decrease of the HRTv from 4 to 2 h. This effect is explained by the increase of carbon availability in the reactor. Therefore, the H_2 content of biogas produced (%) and H_2 yields (mol H_2/mol glucose) remained stable despite the change in HRTv, thus indicating that the decrease in HRTv did not affect the global metabolism. At the end, HPLC analyses of the effluents showed that the main metabolic pathways involved in hydrogen production were acetate and butyrate pathways.

References

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D. Ranava, S. Benomar, ML Cardenas, E. Trably, Y. Rafrari, A. Ducret, J. Hamelin, E. Lojou, J-P. Steyer, M-T. Giudici-Orticoni, Nutritional stress induces exchange of cell material and energetic coupling between bacterial species, Nature Commun., 2015, 6:6283, doi: 10.1038/ncomms7283

Online multiclass learning with “bandit” feedback under a passive Aggressive approcah

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There are several classification algorithms that address the bandit setting. The Banditron, based on the Perceptron algorithm, is the most "classical" one, having a number of mistakes asymptotically bounded. For the case where the data is linearly separable, the number of mistakes is bounded in $(O(\sqrt{T})$ in T rounds.
Another bandit algorithm, named "Cofidit". In the cofidit approach, the bound of the regret (sum of mistakes with respect to the optimal classifier) is improved from of $O(T^{2/3})$ to $O\sqrt{T}\log T$. At last the Policy Gradient , stemming from the Reinforcement Learning framework, also provides an efficient methodology to deal with this problem.
This paper presents a new approach to online multi-class learning with bandit feedback. This algorithm, named PAB (Passive Aggressive in Bandit) is a variant of Online Passive-Aggressive Algorithm proposed by Crammer, the latter being an effective framework for performing max-margin online learning. We analyze some of its operating principles, and show it to provide a good and scalable solution to the bandit classification problem, particularly in the case of a real-world dataset where it outperforms the best existing algorithms.

Capping and decapping GaAs nanowires with As for preventing oxidation and for epitaxial shell growth

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Semiconductor nanowire-based materials are building blocks for future electronic and photonic devices. Due to their nanometric diameter and the efficient elastic relaxation at the lateral surface, nanowires (NWs) can accommodate more strain, and thus minimize lattice-matching constraints, inevitable in conventional thin film growth.[1] In order to improve the physical properties of such nanowires and to develop electronic devices, core shell structure has been intentionally constructed.[2, 3] However preparing core/shell nanowires with good quality is quite challenging for the necessity of the perfect control of the core/shell interface.[4] As known, oxidation is one of the most common processes which change the properties of the surface, in turn, affect the performance of materials. In consideration of the small dimension and the extreme large specific surface area, semiconductor NWs core materials have a higher tendency to be oxidized in the air, especially when an epitaxial shell made of heterogeneous materials is been pursued which is obligated to be grown with a different reactor. However, the passivation preventing NWs from the oxidation is less studied.

In this work, self-catalyzed GaAs NWs were grown by molecular beam epitaxy (MBE) on silicon substrate. The morphology of NWs is uniform, about 50 nm in diameter and 1 μm in length, while the surface density is as high as 7 NW/μm^2. To obtain a better understanding of the growth mechanism, the effect of different experimental parameters were investigated, including the effect of the substrate orientation (001), (111) and (110), the pre-deposition temperature of the catalyst, the gallium and arsenic flux and the temperature and time of the growth. Aiming to regrow an epitaxial shell around the as-prepared GaAs NWs in another reactor after an air exposure, chemical surface information on NWs was gathered by performing TEM and XPS measurements. A typical GaAs NW has quite smooth lateral facets with a thin amorphous layer outside which is composed of gallium and arsenic oxides, attributed to the oxidation in air. Such oxidation might affect the subsequent fabrication of the core-shell structure by introducing structural defects at the interface. Thus we propose a reversible arsenic-capping method without introducing any other impurities at the interface in order to exclude such difficulties. By using this method, the growth of shell materials is still under studied and will be reported later.

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[Session: Chemical engineering/Biophysics]

Total syntheses of quadrane sesquiterpenes

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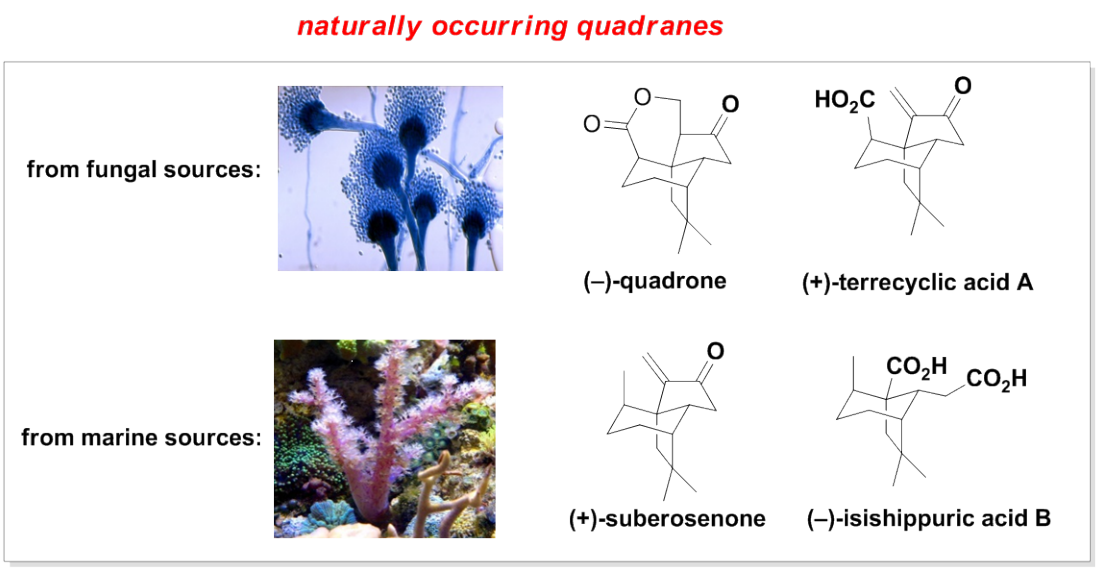
The quadranes from a restricted family of naturally occurring sesquiterpenes belonging to the larger group of polyquinanes, featuring a diquinane core fused with a bicyclo[3.2.1]octane system.[1] They were discovered in 1978 with the isolation of (–)-quadrone, which because of its challenging structure and highly potent biological activity has attracted considerable attention. Since 2000, new members of this family of natural products with enhanced biological activities have been isolated from marine sources and have triggered renewed interest in these natural sesquiterpenes.
In this communication our own synthetic approach is presented. It is based on a multi-catalytic domino reaction for the enantioselective construction of the key functionalized bicyclo[3.2.1]octane ring system.[2] Significantly, the first enantioselective total syntheses of quadrane sesquiterpenes could be achieved using this approach.[3]



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Rodriguez, *Chem. Rev.* **2013**, *113*, 525−595.
[3] Unpublished results

Multiplex detection of anti-heat shock protein autoantibodies in breast cancer sera

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Objet: Heat shock proteins (hsps) are over-expressed in many human cancers leading to the stimulation of the immune system with production of autoantibodies against hsps. These autoantibodies are good biomarkers of tumor cell proliferation, differentiation, invasion and metastasis. However their individual frequency is very low and varies from 5 to 30%. Combining the detection of a panel of biomarkers greatly increases the reliability of the test. Protein microarrays have demonstrated to be cost-effective and powerful tool for screening biomarkers from tiny samples. However, efficient multiplex analysis remains challenging due to biomarkers variability and tumors heterogeneity. A lot of parameters have to be optimized for obtaining sensitive detection. We have previously developed and characterized six surface chemistries allowing covalent or non covalent immobilization of proteins. In this study we have implemented protein microarrays for the profiling of anti-hsp autoantibodies in breast cancer sera.
Methods: Firstly, 7 hsps were immobilized at various concentrations on chemically functionalized glass slides. Their biological activity was evaluated and best conditions were selected. Secondly, glass slides functionalized with selected chemistries were used to screen 50 breast cancer sera and 26 healthy donor sera.
Results: The efficiency of each hsp/anti-hsp recognition varied with the immobilization conditions of hsp. Considering best results for each hsp/anti-hsp couple, 2 surfaces (COOH and chitosan surfaces) were selected for sera screening. The detection of a single anti-hsp allowed identifying only few breast cancer sera. However, the multiplex detection of the 7 anti-hsps under best conditions increased the sensitivity of breast cancer identification from 26% to 60%.
Conclusions: Our customized antigen microarray provides a powerful tool for rapid screening and profiling of cancer biomarkers in breast cancer.