Diplôme d'Habilitation à Diriger des Recherches

# Statics and dynamics of systems in magnetic interaction

## Medical applications

Synthesis of research presented
at the Institut Polytechnique of Paris

Jean Boisson

Professor assistant of the Ecole Nationale Supérieure of Techniques Avancées
Institute of Mechanical Science and Industrial Applications

# Curriculum Vitae

## Personal informations

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| Date of birth : | 15/06/1979 at Montpellier |
| Nationality : | Française |
| Current activities : | Professor Assistant at ENSTA-Paris since 2012 |
| | Lecturer at Ecole Polytechnique since 2016 |
| Host laboratory : | Institute of Mechanical Science and Industrial Applications (IMSIA) |
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## Formation

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| 2008 : | PhD from university Paris 6 : *Sur l'interaction eau/anion ; les caractères structurants et déstructurants, la rupture de symétrie du nitrate.*. Supervisor : James T. Hynes. |
| 2004 : | Magisterium of Material Sciences of Ecole Normale Supérieure de Lyon. |
| 2003 : | Agrégation in Physical Sciences (rank 107). |
| 1997 : | Baccalaureate series S, mention fairly well. |

## Professionnal career

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| 2009-2011 : | Post-doctoral fellow at the Service de Physique de l'Etat Condensé, CEA Saclay, France. |
| 2011-2012 : | Post-doctoral fellow at FAST, Orsay, France. |
| Depuis 2012 : | Professor Assistant at ENSTA-Paris, Palaiseau, France. |
| Depuis 2016 : | Lecturer at Ecole Polytechnique, Palaiseau, France. |

## Teaching activities

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| ENSTA $1^{st}$ year : | *Instabilities and complex fluids.* |
| | *Free surface flows* (lab course). |

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| | *Cavitation* (practical work). |
| | *Introduction to magnetohydrodynamics* (course, handout and tutorials). |
| ENSTA $2^{nd}$ year : | *Vibrations* (tutorials). |
| | *Fluid-structure interactions* (tutorials). |
| | *Experimental module* (projects). |
| | *Introduction to instabilities in fluid mechanics.* |
| Ecole Polytechnique $2^{nd}$ year : | *Structures couplées* (Laboratory module). |
| Ecole Polytechnique $3^{rd}$ year : | *Laboratory Project.* |
| Ecole Polytechnique Bachelor $1^{st}$ year : | *Mechanic* (practical work). |

## Responsabilities

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| since 2012 : | Responsible for the nuclear power program at ENSTA-Paris (mutualized with INSTN since 2016). |
| since 2017 : | Head of Experimental Modules (ENSTA $2^{nd}$ year). |
| | Head of Laboratory Modules (École Polytechnique). |
| 2013-2015 : | Seminars. |
| 2013-2017 : | MCQ Mechanics AST |

## Collaborations

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| SPHYNX laboratory, SPEC, **S. Aumaître**, CEA Saclay (since 2012) : | Magnetohydrodynamics, magnetocouette experiment, [Boisson, 2017], [Boisson, PoF, 2012]. |
| Necker children's Hospital APHP, **N. Kadlub**, Paris (since 2015) | Medical engineering, development of the magnetic distractor, [Boisson, 2016], [Rougier, 2020], [Kadlub, 2019], [Debelmas, 2018]. |
| École des Ponts, **G. Cumunel**, Paris (2017-2018) | Magnetic damper and coupling with a primary structure, [Lo Feudo, 2018]. |
| PMMH laboratory, ESPCI, **B. Roman**, Paris (2015- 2017) | Dielectric elastomers, energy harvesting. |
| École Polytechnique, **L. Bodelot**, Paris (2014-2016) | Dynamics of a magnetic flag. |

## International (excluding conference)

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| 20/11/2019 | Invited seminar at KLS Martin (Germany) : *Magnetic distractor and activator, design and cadaveric testing*, negotiation for the transfer of the intellectual property of VIVODOGMA. |

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| Since 2019 | Collaboration with the Morphology Center (MORF), Experimental and Clinical Research Institute (IREC), Université catholique de Louvain, Bruxelles (Belgique) : *Characterization of the mechanical properties of decellularized biological tissues.* |
| During 2020 | Collaboration with J. I. Cardona Estrada, maxillo-facial surgeon, Technological University of Pereira (Colombie) : *Mucoperiosteal magnetic distraction of the jaws for the neoformation of atrophic edentulous alveolar ridges.* |

## Participation in research contracts

**Principal Investigator**

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| Magnetic distractor : | DOGMA (10k€, SORG, 2016)<br>PROTODOGMA (32k€, IDEX Paris-Saclay, 2016)<br>VIVODGOMA (608.8k€, SATT Paris Saclay, 2018)<br>PROTODISMA (70k€, IPParis, 2020)<br>SIMFACE (192.45k€, AID, 2021)<br>Traction Biotissus (5k€, Inter labos IPParis, 2021) |
| Magnetohydrodynamic : | MagnetohydroX (5k€, NEEDS, 2016) |

**Coordinnator**

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| Medical engineering : | 3D-printing of jaws for maxillo-facial applications (23k€, Gueules Cassées, 2018)<br>D-printing of jaws for maxillo-facial applications (10k€, FERCM, 2018)<br>Mechanical properties of decellularized porcine jaws (28k€, Gueules Cassées, 2020) |

**Participant**

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| Dielectric elastomers : | SMarT (40k€, ANR, 2015)<br>STRELAC (50k€, Lasips, 2014) |
| Medical engineering : | Mechanical properties of the Cleft lip skin (28k€, Année recherche, 2020) |
| Magnetic structures : | DYSACCI (140k€, DGA, 2015)<br>AMORMAG (90 k€, DGA, 2014)<br>PhD J. Lee (IDEX, 2013) |

## Supervision and co-supervision

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| **M1 level internship** : | **C. Lesoil** : *Fluttering of an articulated flag*, funding : DYSACCI, 50%, 4 months, 2018.<br>**S. Asiri** : *Propriétés du périoste mandibulaire, influence de la localisation*, funding : VIVODOGMA, 50%, 6 months, 2019. |

**E. Su** : *Design of a magnetic intermaxillar disjonctor, modeling of a palatal suture*, funding : PROTODISMA, 50%, 4 months, 2020.

**M2 level internship** :

**U. Heller** : *Mechanical properties of decellularized porcine jaws*, funding : Gueules Cassées, 50%, 12 months, 2020-2021.
**G. Rougier** : *Mechanical modeling of a mandible during a sagittal osteotomy and 3D-printing reproduction*, funding : Gueules Cassées et FERCM, 33%, 12 months, 2018-2019.
**A. Debelmas** : *Characterization of the mechanical properties of the mandibular periosteum, comparison with calvaria*, funding : Année Recherche, 12 months, 80%, 2016-2017.
**A. Hun** : *Study of the fluttering of a magnetic structure in a hydraulic channel*, funding : AMORMAG, 33%, 6 months, 2016.

**PhD** :

**J. Lee** : *Magnetic structures ; dynamics, inductive coupling and energy harvesting*, funding : IDEX, 33%, 36 months, 2016.

**Post-doctorate** :

**G. Ben-Ghorbal** : *Vibrations damping by coupling magnetic interaction and rolling motion*, funding : DYSACCI, 33%, 2 months, 2018.
**G. Pennisi** : *Vibrations damping by coupling magnetic interaction and rolling motion*, funding : DYSACCI, 33%, 8 months, 2018.
**S. Lofreudo** : *Magnetic vibration dampers and coupling with a primary structure*, funding : DYSACCI, 33%, 12 months, 2017.
**S. Bennacchio** : *Magnetic vibration dampers, design, static and dynamic caracterization*, funding : AMORMAG, 50%, 12 months, 2016.
**L. Legrand** : *Dielectric elastomers, manufacturing and modelling for energy harvesting*, funding : Strelac, 50%, 12 months, 2015.
**M. Duccheschi** : *Modelling of a magnetic flag*, funding : F2M, 20%, 12 months, 2014.

**Maturation Engineer** :

**N. Kogane** : *Development of the magnetic distractor : clinical aspects*, funding : VIVODOGMA, 60%, 12 months, 2018-2019.
**J. Dallard** : *Development of the magnetic distractor : mechanical aspects*, funding : VIVODOGMA, 90%, 25 months, since 10/2018.

## Reviewer activity

Physics of Fluids
Journal of Fluids and Structures
The European Physical Journal Applied Physics
Journal of Sound and Vibration
Medical Engineering and Physics
ANR
Emergence Ville de Paris

# Synthesis of research and teaching activities

## Synthesis of research activities

In this habilitation thesis, I present in three chapters my research work since I joined ENSTA-Paris in July 2012. I therefore do not describe the work developed during my doctorate or during my post-doctoral studies (except my work on in the Magnétocouette experiment that was extended in ENSTA-Paris and which constitutes one of the chapters). This work has nevertheless led to several publications in recent years and I summarize it in the following.

### PhD : Study of the structuring and destructuring character of halides, breaking the symmetry of nitrate.

Structuring ions (resp. destructuring) have the property of increasing (resp. reducing) the viscosity of a solution according to their concentration. During my doctorate, I studied configurations and dynamics of water molecules in the vicinity of the fluoride ion (structuring) and the iodide ion (destructuring) by numerical simulations of molecular dynamics. Regarding the structural effect, I observed the opposite of what the classical definition of structuring / destructuring suggests : fluoride destabilizes the network of hydrogen bonds of water while iodide stabilizes it. Then, I highlighted the differences in the reorientation mechanism of water molecules close to fluoride (diffusive) and iodide (by large amplitude jumps) [Boisson, PCCP, 2011]. I also developed a program making the link between quantum numerical simulations and classical numerical simulations (QM/MM). Finally, I used this tool to highlight the symmetry breaking of nitrate induced by water [Boisson, 2008] as well as the dynamics of water molecules in its vicinity.

### Post-doctorate

#### Inertial waves and modes in a rotating fluid.

2011 - 2012 : Post-Doctorate at FAST laboratory of University Paris-Sud :

Fluids rotating at a rate $\Omega_0$ are the site, for excitation pulsations $\omega < 2\Omega_0$, of inertial waves which when they resonate in a finite box create inertial modes. By applying a slightly modulated rotation in time (libration) to a cube filled with water, I was able to demonstrate that only inertial modes having strictly the same symmetries as those imposed by the libration motion are excitable and that resonance is weak [Boisson, 2013]. I also demonstrated, that in practice, a fluid which one imposes a solid rotation never reaches it. Indeed, the combined action of the tank's rotation and of the rotation of the Earth causes a slight precession of the system which excites a mode of inertia whose structure is a fixed roller, East-West oriented in the reference frame of the laboratory [Boisson, EPL,2012].

## At ENSTA-Paris

### Chapter 1 : Dynamics of magnetic structures

At IMSIA, research is being carried out on the energy harvesting potentiality of classical fluid-solid instability phenomena such as the fluttering of a slender plate in axial flow [1]. The fluttering phenomenon is an instability which occurs once a critical flow speed threshold is exceeded and is manifested by large amplitude oscillations of the structure. The first objective here was to study the coupling between the fluttering instability of a structure and the magnetic induction generally used to convert mechanical energy into electrical energy. This conversion can be used in different ways e.g. oscillations of a magnetized structure near an electromagnetic coil or the oscillations of a conductive plate in a magnetic fluid. During his thesis, Joosung Lee [2] experimentally demonstrated the possibility of harvesting electrical energy by fluttering an articulated flag.

In order to model the fluttering, a good understanding of the magnetically induced bending stiffness of the structure is essential, that is why we were interested in the mechanical properties of slender structures composed of permanent magnets. Especially, we have highlighted two peculiar dynamic properties for structures composed by discrete cylindrical magnets [Boisson, 2015]. One is provoked by the distancial aspect of the magnetic interaction which induces, for example, the removal of degeneracy for 3 cylinders structure clamped in its middle. The other is provoked by the topology of the magnets remanent field [Rouby, 2020] which reduced the structure rigidity induced by the closest neighbours and thereforce modify the stability of rectilinear configuration in favor of circular configuration. We also observed mode veering and crossing for 7 cylinders structures that we were able to isolate with the MAC criterion. In addition, we also studied the influence of an external magnetic field on the rigidity of theses structures [Lee, 2020].

Another aspect of this work is concerned with the damping of vibrations in primary structures and has already led to the development of a magnetic damper, the Magnetic Vibration Absorber (MVA). This device uses the remote magnetic interactions between permanent magnets to generate the restoring force on the moving mass. This mass (a permanent magnet) oscillates between two fixed magnets oriented to apply a repulsion force, and it is submitted to the field of four other magnets which are oriented to apply and attraction force. By correctly adjusting the positions of this set of fixed magnets, the values of linear, cubic and quintic stiffness of the system's equivalent spring can be finely adjusted. Therefore, it is possible to tuned freely the damper frequency to the primary structure one but also to change the damper nature. So, using a single device, one can to go from a tuned mass damper to a non-linear energy sink for which the linear stiffness is zero, or even, to a bistable configuration (a damper with a negative linear stiffness). Generally, these latter configurations are difficult to achieve experimentally, this gives the relevance of the MVA. After the design phase, we have demonstrated the agreement of the MVA static and dynamic experimental behavior with the model [Benacchio, 2016], then we demonstrated its damping capacities on primary structures submitted to linear then non-linear vibrations [Lo Feudo, 2018].

### Prospects

**Vibrations damping by coupling magnetic interaction and rolling motion** One prospect, for which the project is already underway, concerns the production of vibration absorbers using the coupling between magnetic interaction and rolling motion. The idea of this damper is to combine the properties of magnetic attraction between two magnets and the kinematic of an ellipsoid rolling on a plane. For this we have developed a system of two cubic magnets in mutual interaction. One is fixed on one side of a plane while the other is inserted in the center of a cylinder or ellipsoid. The force of attraction between the two magnets causes that the cylinder can oscillate around its equilibrium position for which the two magnets are aligned in the direction where the gap between them the smallest.

In the hypothesis of rolling without sliding, the stiffness of the oscillator is non-linear because of the distance dependance of the magnetic attracting force which decreases in $1/r^4$. The idea is to modify the eccentricity of the ellipsoid in order to adapt the stiffness of the oscillator to the primary structure to be damped. The modeling of the stiffness of the oscillator is based on the work carried out during the postdoctoral fellowships of M. Duccheschi and G. Pennisi. The modeling and preliminary tests by students of the Ecole Polytechnique demonstrate a good match between the model and the experiment.

**Ferrofluids** Another longer term perspective on magnetized structures concerns ferrofluids [3]. These fluids, which I often use in teaching because they allow easy visual experiments [4], re composed of magnetizable particles (usually magnetite $Fe_3O_4$) dissolved with a surfactant in an oleaginous solvent or water [5]. A fluid is then obtained whose properties change when it is subjected to a magnetic field. These fluids, introduced in the second half of the $20^{th}$ century, have applications in various fields such as automotive where they are used in car vibrations absorbers, as ink in printing dollar bills [6] ; or in oncology, where aqueous phase ferrofluids are used to remove tumors by causing hyperthermia of the area when subjected to an oscillating magnetic field [7]. This area is quite promising, provided there are still limits of indication such as, for example, deep tumors for which there is a risk of tumor dissemination (due to the difficulty of injection). To overcome these limits, it could be considered to inject the ferrofluid by venous route, before directing it towards the area of interest. Research in this thematic is inspired by the knowledge acquired in propulsion of micronageurs and in modeling of ferrofluids. In particular, I think that taking into account the geometry of magnetizable particles for the design of "new" micronagers or for the modeling of "new" ferrofluids (ie where the particles would be cylinders), could be the source of progress. in this field by endowing ferrofluids or micronagers with properties that are currently inaccessible.

### Chapter 2 : Magnetohydrodynamics

During my postdoctoral fellowship at SPEC of CEA Saclay, I participated in the Von Karman Sodium experiment (VKS) which is the first to have observed the turbulent dynamo effect, i.e. when a turbulent flow of liquid metal spontaneously generates a magnetic field. In addition to my participation in the measurement campaigns at Cadarache, which made it possible to identify the dynamic regimes of the magnetic field [Berhanu, 2010] and the consequences of the interaction between the dipolar and quadrupolar part of the magnetic field [Gallet, 2012], I contributed to the development of a program which reconstructs the magnetic field in the whole system from few measurement points [Boisson, NJP, 2011]. In addition, I characterized the influence of the structure of the flow on the structure of the observed axisymmetric dipolar magnetic field [Boisson, NJP, 2012].

I developed, in parallel, an experiment involving a flow of a conductive fluid - a liquid metal alloy - electromagnetically forced into a Taylor-Couette geometry of aspect ratio $\frac{h}{\triangle r} = 10$. Here, the inner and outer cylinders are fixed and apply a radial electric current, the forcing is completed by immersing the device in a vertical magnetic field. The Lorentz force, oriented in the azimuthal direction, drives the fluid. I identified, through ultrasound measurements, three different flow regimes : a stationary one, one presenting hydrodynamic traveling waves and one with magnetic traveling waves [Boisson, PoF, 2012].

After my integration of ENSTA-Paris, I completed the experimental study of electromagnetically forced flows by changing the geometric parameters of the experiment to increase the width of the gap $\frac{h}{\triangle r} = 4$. This new configuration allowed us to probe the radial velocity of the secondary flow. The comparison of the measurements from the two experimental device shows that, depending on the geometry of the channel, the inertial terms of the Navier-Stokes equation cannot be neglected. In this case, the average azimuthal velocity depends both on the electric current and on the magnetic field [Boisson, PoF, 2012] unlike similar experiments in the literature for which the Lorentz force equilibrates with the viscous term. In addition, I found the previously observed flow regimes, and highlighted the existence of a magneto-inertial boundary layer which controls the intensity of the average flow as well as the transition between different secondary flows regimes [Boisson, 2017].

### Prospects

**MHD sloshing** Sloshing refers to the movements of a free surface liquid subjected to acceleration in a reservoir [8]. This project consists in experimentally studying the sloshing of a electrically conductive fluid subjected to an external magnetic field. The objective is to determine and understand the influence of the magnetic field on the free surface oscillation : both to dampen surface motions (constant magnetic field) or to excite them (oscillations of the magnetic field or electric current).

In a second time, we will study the use of the sloshing of a conductive fluid to damp the vibrations of primary structures. And finally, we will focus on the sloshing of two immiscible fluids with different conductivity (a liquid metal and an electrolyte) in order to get closer to the conditions of the aluminum production industry for which the electrolytic cells are subject of surface instabilities which are the cause of a high overconsumption of electricity (1-2% of world consumption) [9].

### Chapter 3 : Medical Engineering

Distraction osteogenesis is a surgical procedure, consisting of the progressive lengthening of a bone segment (1 mm/day), which has a widespread use in the craniofacial pratice for the treatment of congenital malformations or acquired large bone defects [10]. This technique requires the implantation of an internal distractor device, of which daily activation is performed using a transmucosal or transcutaneous rod to rotate the distractor endless screw. This activation rod may be responsible for multiple adverse events and discomfort [11]. To overcome these issues, we have demonstrated the feasibility of distant activation with a magnetically activated device for mandibular distraction [12, Boisson, 2016, Boisson, Brevet, 2015]. The first cadaveric tests confirmed the effectiveness of this design [C], therefore, in the framework of the VIVODOGMA project, we are currently developing this device in order to realize clinical trials in 2021.

The collaboration with the Necker children's hospital and the University of Paris 5 initiated thanks to the magnetically activated distractor project, has been enriched by several research projects. The mechanical properties of the osteogenic distraction were investigated, namely the role of the surrounding soft tissues. We demonstrated thanks to a series of tensile tests that the periosteum, a bilayered soft tissue surrounding bone, is primarily responsible for opposing the osteogenic distraction load [Debelmas, 2018]. We also compared the tensile properties of the mandibular and the calvarial periosteum using a model, initially applied on the skin, and based on a structural approach involving the mechanical properties of the corrugation of the collagen [13]. The model succeed to capture the correct mechanical behaviour for the periosteum, but the statistical analysis showed that only certain parameters extracted from the histological data and traction data are comparable. Moreover, we observed a stiffer periosteum in the calvaria than in the mandible. This is questionning the role and origin of this increase of stiffnes in this location [Kadlub, 2019].

Another project consisted in the design of a 3D-printed mandible which reproduces the mechanical properties of mandible of anatomical subjects when they are submitted to a control surgical procedure (sagittal osteotomy). The objective was to determine the material, the method and the manufacturing process that create a high fidelity mandidle which can serve as a simulation model for students and interns in surgery [A].

### Prospects

**Characterization of mechanical properties in surgery** One of the projects consists in developing, in IPParis, a translational research on the mechanics of surgical procedures. Most surgical procedures are empirical, and are justified by know-how and experience.

A mechanical approach to surgical practices - i.e. the determination of the specific load involved during the process and of the biological tissue response to this load - could provide a better knowledge and understanding of the medical consequences of the surgical procedures : trauma, bleeding, pain. Therefore, this can lead to the development of new devices, high fidelity simulation models, and the improvement of techniques. This theme is extremely rich and involves many fields of mechanics that may be of interest to several research teams from IPParis, or even from Paris-Saclay.

For example, the characterization of the periosteum and the role of Sharpey's fibers (which secure the periosteum to the underlying bone), would provide essential data for the osteogenic distraction surgery (eg, extent of periosteal detachment, role of periosteal incision). A project, involving Pierre-Philippe Cortet of FAST, is envisaged in the near future.

Another project, involving F. Szmytka from IMSIA, consists in the developpement pursuit of a high fidelity simulation model for maxillofacial surgery (bone and soft tissues). First, we will carry out a series of mechanical tests in order to identify the mechanical properties of the different tissues composing the face (bones, skin, mucous membranes, fat tissues). In a second step, we will design, in 3D printing, replicas of these different tissues, in order to determine for each one, which type of impression is closest to the biological tissue. Then, a multi-material printing will be used to combine all this mechanical properties in a single object (Stratays Object 260, Pollen PAM Serie P). Finally, the creation of a bank of normal or pathological radiological images, for example, for cases of facial mass fractures, ballistic trauma, facial malformations, will allow the printing of high-fidelity mechanical models and will offer students, interns and surgeons the opportunity to train on demand on these typical cases.

## Synthesis of teaching activities

My teaching experience has greatly increased since my arrival at ENSTA-Paris. Initially relying on my lecturer position during my PhD at the University of Paris 6, I quickly became involved in the experimental teaching of ENSTA-Paris, that whether in practical work, in projects or in laboratory class.

I also carried out tutorials in vibration and fluid-structure instability, which allowed me to consolidate my knowledge in these two disciplines involved in my research themes. I was recruited in 2016 as an incomplete-time lecturer at the École Polytechnique again to carry out experimental teaching by project and practical work. To my point of view, project-based teaching is beneficial to all parties, it allows teachers to explore new research thematic and expand their knowledge while transmitting the concepts of scientific approach to students. For example, the design of the magnetic distractor began thanks to the laboratory research project (PRL) of Hervé Strozyk of the École Polytechnique.

Since 2018, I have been responsible for experimental teaching by project of ENSTA-Paris (MODEX) which involves around thirty speakers and between 80 and 90 students. I try to develop this teaching in particular by proposing new themes (biomechanics, sports physics) and different assessment methods (production of a video instead of the oral defense). Indeed, the multiplication of digital tools for the teaching and culture of this generation of students makes this method of evaluation attractive and increasingly relevant for the rest of their career where this medium should take an important place in the professional world. This fact became even more prominent since the COVID crisis.

Finally, I have been teaching a new course of *Introduction to magnetohydrodynamics* at ENSTA since 2018. This course takes place at the end of the first year and opens up students to new themes and approaches from which they can draw inspiration for the rest of their career. The handout for this course has been available since 2019, and I have set up an evaluation inspired by the aggregation lessons for which students organize et perform one oral teaching session. The year 2020 was also an opportunity to experiment distance learning. For the occasion, I have set up some new practices (video lessons, ”live” session even more focused on the experience) that I think I will try to perpetuate in the rest of my teacher career.

### Prospects

**MEChanical ENgineering for CLInicians track : MECENCLI** Clinical medicine and surgery have been based on empirical foundations for years. More recently, with the arrival of new technologies such as 3D printing, robotics, or ”machine learning”, a need and demand for understanding these new systems has arisen. This understanding requires for clinicians to increase their theoretical bases in mechanics and physics.

It is to fulfil this purpose that the master 2 track : “Mechanical engineering for clinicians ” of Institut Polytechnique de Paris and Université de Paris has been validated in fall 2020 for a beginning in November 2021. This track was initiated thanks to the collaboration between N. Kadlub and myself.

The objective of this training is to provide medical students a relevant knowledge of mechanics and physics so that they can be at the interface of the two disciplines (medical and mechanical). These ”doctor-mechanics” will then be able to incorporate clinical issues into mechanical and physical research, but also apply the recent results of this research to medical practices in order to improve them.

# Publications

### Articles

[Rougier, 2020] G. Rougier, N. Kogane, J. Dallard, F. Mangione, L. Slimani, B. Salmon, N. Thurieau, L. Cherfa, N. Kadlub, J. Boisson and F. Szmytka Ramus Sagitall Osteotomy related biomechanical Properties *Br J Oral Maxillofac Surg.*, S0266-4356(20)30205-9, **2020**

[Kadlub, 2019] N. Kadlub, A. Debelmas, J. Dallard and J. Boisson. Modeling of the human mandibular periosteum material properties and comparison with the calvarial periosteum *Biomech. Model. Mechanobio.* **19**, 461–470, **2020**.

[Lo Feudo, 2018] S. Lo Freudo, C. Touzé, J. Boisson and G. Cumunel. "Nonlinear magnetic vibration absorber for passive control of a multi-storey structure *J. Sound. Vibration*, **438**, 33–53, **2019**.

[Debelmas, 2018] A Debelmas,A Picard, N Kadlub, J. Boisson. Contribution of the periosteum to mandibular distraction *PLOS ONE*, **13 (6)**, e0199116, **2018**.

[Boisson, 2017] J. Boisson, R. Monchaux and S. Aumaitre. Inertial regimes in a curved electromagnetically forced flow *J. Fluid Mechanics*, **813**, 860-881, **2017**.

[Benacchio, 2016] S. Benacchio, A. Malher, J. Boisson and C. Touzé Design of a magnetic vibration absorber with tunable stiffnesses *Nonlinear Dynamics*,**85**,893-911, **2016**.

[Boisson, 2016] J. Boisson, H. Strozyk, P. Diner, A. Picard and N. Kadlub Feasibility of magnetic activation of a maxillofacial distraction osteogenesis, design of a new device *J. CraniomaxillofacSurg.*, **44 (6)**, 684-8, **2016**.

[Boisson, 2015] J. Boisson, C. Rouby, J. Lee and O. doaré Dynamics of a chain of permanent magnets *EPL*, **109 (3)**, 34002, **2015**.

[Miralles, 2014] S. Miralles, J. Herault, S. Fauve, C. Gissinger, F. Pétrélis, F. Daviaud, B. Dubrulle, J. Boisson, M. Bourgoin, G. Verhille, P. Odier, J-F. Pinton and N. Plihon Dynamo efficiency controlled by hydrodynamic bistability newblock *Physical Review E*, **89**, 063023, **2014**.

[Miralles, 2013] S. Miralles, N. Bonnefoy, M. Bourgoin, P. Odier, J-F. Pinton, N. Plihon, G. Verhille, J. Boisson, F. Daviaud, and B. Dubrulle Dynamo threshold detection in the von Karman sodium experiment newblock *Physical Review E*, **88**, 013002, **2013**.

[Boisson, 2013] J. Boisson, C. Lamriben, L. R. M. Maas, P.-P. Cortet, and F. Moisy Inertial waves and modes excited by the libration of a rotating cube newblock *Phys. Fluids*, **24**, 076602, **2012**.

[Boisson, EPL,2012] J. Boisson, F. Moisy, et P.-P. Cortet Earth rotation inhibits fluid solid body rotation newblock *EPL*, **98**, 59002, **2012**.

[Boisson, PoF, 2012] J. Boisson, A. Klochko, F. Daviaud, V. Padilla, and S. Aumaître Travelling waves in a cylindrical magnetohydrodynamically forced flow *Phys. Fluids*, **24**, 044101, **2012**.

[Gallet, 2012] B. Gallet, S. Aumaître, J. Boisson, F. Daviaud, B. Dubrulle, N. Bonnefoy, M. Bourgoin, Ph. Odier, J.-F. Pinton Experimental observation of spatially localized dynamo magnetic fields *Phys. Rev. Lett.* ,**108**, 144501, **2012**

[Boisson, NJP, 2012] J. Boisson, S. Aumaitre, N. Bonnefoy, M. Bourgoin, F. Daviaud, B. Dubrulle, Ph. Odier, J-F. Pinton, N Plihon, and G. Verhille Symmetry and couplings in stationary von Kármán sodium dynamos *New J. Phys.*, **14**, 013044, **2012**

[Boisson, PCCP, 2011] J. Boisson, G. Stinermann, D. Laage, and J.T. Hynes Water reorientation dynamics in the first hydration shells of $F^-$ and $I^-$■ *Phys. Chem. Chem. Phys.* ,**13**, 19895-19901, **2011**

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