



BOHEME-METAVEH joint workshop

November 2-3, 2023
Imperial College London, London, UK



Contents

About	4
BOHEME	4
METAVEH	4
Organizers	5
Timetable	6
Thursday, 2 of November	6
Friday, 3 of November	7
List of Participants	8
Useful Information	9
How to get to Imperial?	9
Partner Institutions and Sponsors	12
Sponsors	12

About

Our aim is to have a joint workshop between two related FET Open grants about mechanical metamaterials. It will bring together researchers from across Europe and discuss the latest results obtained.

BOHEME

Coordinator: **Università di Trento (IT)**; Politecnico di Torino (IT); Imperial College London (UK); CNRS (FR); Polish Academy of Science (PL); Università di Torino (IT); Multiwave Technologies AG (CH); EMPA (CH); ETH Zürich (CH); Phononics Vibes (IT).

The project 'BOHEME - Bio-Inspired Hierarchical MetaMaterials' is funded by the European Commission under the FET-Open scheme, grant n.863179.

The project started on 1st January 2020 and its duration is 48 months.

BOHEME's ambitious goal is to design and realize a new class of bioinspired mechanical metamaterials for novel applicative tools in diverse technological fields. Metamaterials exhibit exotic vibrational properties currently unavailable in Nature, and numerous important applications are emerging. However, universally valid design criteria are currently lacking, and their effectiveness is presently restricted to limited frequency ranges. BOHEME starts from an innovative assumption, increasingly supported by experimental evidence, that the working principle behind metamaterials is already exploited in Nature, and that through evolution, this has given rise to optimized designs for impact damping. The "fundamental science" part of the project aims to explore biological structural materials for evidence of this, to investigate novel optimized bioinspired designs (e.g. porous hierarchical structures spanning various length scales) using state-of-the-art analytical and numerical approaches, to design and manufacture vibrationally effective structures, and to experimentally verify their performance over wide frequency ranges. Through this disruptive approach, BOHEME will provide a pipeline to the technological development of a new class of bioinspired metamaterials in innovative applicative sectors over various wavelength scales, from nondestructive testing, to noise reduction, to low-frequency vibration control (including seismic), to coastal protection or energy harvesting from ocean waves. Industrial partners will provide know-how for proof of principle experiments and possible prototypes. The project is ambitious and inherently multidisciplinary, involving research in biology, mathematics, physics, materials science, structural and ocean engineering, drawing from scientific excellence of the partners. It involves theoretical, numerical and experimental aspects, and is a high-impact endeavour, from which basic science, EU industry and society can benefit.

Further information be found here <https://r1.unitn.it/boheme/en/>.

METAVEH

Coordinator: **Zurich University of Applied Science (CH)**; Imperial College London (UK); Multiwave Technologies AG (CH); Politecnico di Milano (IT); ST Microelectronics.

METAVEH - Metamaterial Enabled Vibration Energy Harvesting - is funded by the European Commission under the FET-Open scheme, grant n.952039.

This project aims at realising innovative Lead-free electromechanical energy harvesting systems based on metamaterial wave focussing capacity; these will be easily transported, and installed, to power, in a clean and low-cost manner, autonomous wireless sensing devices thereby eliminating batteries and human intervention.

We bring together six partners with complementary expertise in mechanical metamaterial devices, piezoelectric and functional media, engineering focussed on sensors, data management all with the common goal of creating autonomous clean wireless sensors.

Vibration energy harvesting exploits ambient noise spectra to convert mechanical vibration into energy to power MEMS sensor and actuators in a large number of applications. MetaVEH will completely revisit the current complete harvesting system to make it drastically more efficient, sustainable, more portable and more integrated in a data-driven society.

Further information be found here <https://www.metaveh.com/>.

Organizers

Benjamin Vial Richard Wiltshaw Richard Craster Andrea Colombi Nicola Pugno

Timetable

Thursday, 2 of November

8:30–9:15	Arrival and coffee	
9:15–9:30	Welcome remarks from the BOHEME and METAVER coordinators	
9:30–10:00	Daniel Torrent University Jaume I	Bound states in the continuum in acoustic and elastic waveguides
10:00–10:30	Nicola Pugno Università di Trento	The BOHEME project
10:30–11:00	Federico Maspero Politecnico di Milano	Metastructures and functional materials for MEMS
11:00–11:15	Coffee break	
11:15–11:45	Marco Miniaci IEMN	Mode localisation in elastic media
11:45–12:15	Rafaele Ardito Politecnico di Milano	Metamaterials and MEMs for lead-free energy harvesting
12:15–12:45	Matteo Lorenzo Università di Torino	Attenuating surface gravity waves by an array of submerged resonators: an experimental study
12:45–13:45	Lunch	
13:45–14:15	Fabio Nistri Politecnico di Torino	Applications of acoustic metamaterials using space filling curves
14:15–14:45	Paolo Beoletto Politecnico di Torino	Smart elastic meta-sensors
14:45–15:15	Jacopo Maria De Ponti Politecnico di Milano	Graded metamaterials for wave trapping, mode conversion and tailored edge states
15:15–15:45	Benjamin Vial Imperial College London	Electromechanical modelling and optimisation of piezoelectric energy harvesters by modal expansion
15:45–16:00	Coffee break	
16:00–16:30	Aida Hejazi ETH Zürich	Elastic wave control in reticulated plates utilising Schwarz primitive cells
16:30–17:00	Richard Wiltshaw Imperial College London	Analytical solutions for Bloch waves in resonant phononic crystals
17:00–17:30	Bryn Davies Imperial College London	Graded quasiperiodic metamaterials perform fractal rainbow trapping
19:00	Dinner	

Friday, 3 of November

9:00–9:30	Arrival and coffee	
9:30–10:00	Federico Bosia - Antonio Gliozzi Politecnico di Torino	Photo-responsive periodic structures for tunable wave filtering and topological energy focusing
10:00–10:30	Pawel Kudela Polish academy of Sciences	Time domain spectral element method for large scale problems of nonlinear guided wave propagation in metamaterial-enhanced structures
10:30–11:00	Greg Chaplain University of Exeter	Zero Group Velocity Modes for Enhanced Energy Harvesting: Beyond Nearest Neighbours
11:00–11:15	Coffee break	
11:15–11:45	Luca D'Alessandro Phononic Vibes	Mechanical metamaterials industrial applications actual and outlook
11:45–12:15	Henrik Thomsen ETH Zürich	Immersive boundary experimentation in Elastic waveguides
12:15–12:45	Andrea Colombi Zürich University of Applied Sciences	Harnessing non-linearities in elastic metamaterials
12:45–13:45	Lunch	
13:45	End of workshop	

List of Participants

Raffaele Ardito	Politecnico di Milano
Federico Bosia	Politecnico di Torino
Greg Chaplain	University of Exeter
Andrea Colombi	Zurich University of Applied Sciences
Richard Craster	Imperial College London
Luca D'Alessandro	Phononic Vibes
Bryn Davies	Imperial College London
Jacopo Maria De ponti	Politecnico di Milano
Evripides Georgiades	Imperial College London
Antonio Gliozzi	Politecnico di Torino
Sébastien Guenneau	Imperial College London
Aida Hejazi	ETH Zurich
Erik Orvehed Hiltunen	Yale University
Pawel Kudela	Polish academy of Sciences
Svetlana Kuznetsova	IEMN
Marc Marti	Imperial College London
Federico Maspero	Politecnico di Milano
Onorato Miguel	Universita di Torino
Matteo Lorenzo	Universita di Torino
Marco Miniaci	IEMN
Fabio Nistri	Politecnico di Torino
Beoletto Paolo	Politecnico di Torino
Nicola Pugno	Universita di Trento
Henry Putley	Imperial College London
Daniel Torrent	University Jaume I
Marie Touboul	Imperial College London
Benjamin Vial	Imperial College London
Richard Wiltshaw	Imperial College London
Henrik Thomsen	ETH Zürich

Useful Information

Talks will be held at the **58 Prince's Gate**. Overlooking the leafy Prince's Gardens, this is an elegant Edwardian townhouse venue located opposite the College's main entrance on Exhibition Road, South Kensington, SW7 2PG. **Coffee breaks and lunches** will be offered in the venue.

Wi-Fi will be available during the conference. Imperial College London also provides access to an eduroam network.

The **conference dinner** will be held at the Ognisko Restaurant, 55 Exhibition Road, SW7 2PN, very close to the workshop venue.

How to get to Imperial?

The nearest Underground station is South Kensington, on the District, Circle and Piccadilly lines.

- Plan your route with the Transport for London journey planner.

From London City Airport Take the DLR to Canning Town, then by Underground, Jubilee line to Green Park and the Piccadilly line to South Kensington (journey time 40 minutes) .

From Heathrow airport

Heathrow Express, 15 mins to Paddington mainline station, then the Underground, Circle line to South Kensington.

Or take the Underground, Piccadilly Line to South Kensington station (50 minutes travelling time).

From Gatwick airport

Gatwick Express, 30 mins to Victoria mainline station, then by Underground, District or Circle lines to South Kensington.

Or take a national rail train to Victoria station (journey time 40 minutes) and then by Underground, Circle or District Line; westbound to South Kensington.

From Stansted airport

Stansted Express, 50 mins to Liverpool Street main line station, and then by Underground, Circle line to South Kensington.

Heathrow, Gatwick and Stansted airports are some distance from London and a taxi is not recommended for the whole journey. However, if you have to travel by taxi, establish the cost before you get in.

By sea

Take a British Rail train from the port of entry to London (Harwich to London journey time 1hr

30 mins; Dover to London journey time up to 2hrs) and then travel by Underground to South Kensington Station.

On foot

From South Kensington Station, the campus is only a ten minute walk. Either follow the subway signposted to the museums or walk north up Exhibition Road. The College is next to the Science Museum.

By bus

South Kensington Campus is easily accessible by bus. A number of routes pass within easy walking distance of the campus.

- Transport for London bus route maps

By car

Car parking at South Kensington Campus is severely restricted and you are advised NOT to bring a car unless permission has been given. The car park is open to the public from 18.00 to Midnight on weekdays and from 08.00 to Midnight on weekends. Please note that overnight parking is not permitted. Parking in the streets surrounding the College is at pay and display or parking meters for limited periods only.

The postcode to use for satellite navigation to the South Kensington car park is SW7 2BX . Entry is via Exhibition Road.



Partner Institutions and Sponsors

BOHEME - Bio-Inspired Hierarchical MetaMaterials - is funded by the European Commission under the FET-Open scheme, grant n.863179.

METAVEH - Metamaterial Enabled Vibration Energy Harvesting - is funded by the European Commission under the FET-Open scheme, grant n.952039.

Sponsors



