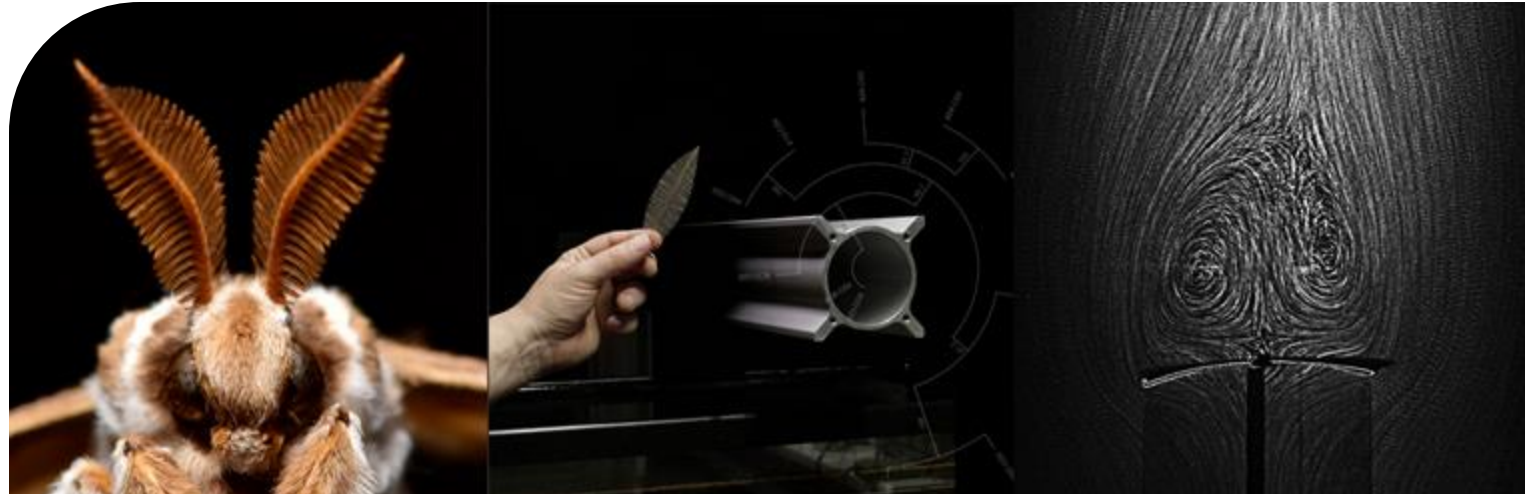
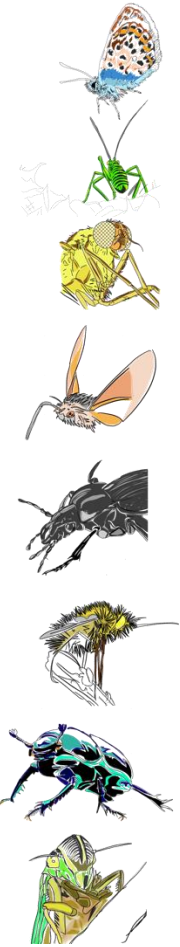
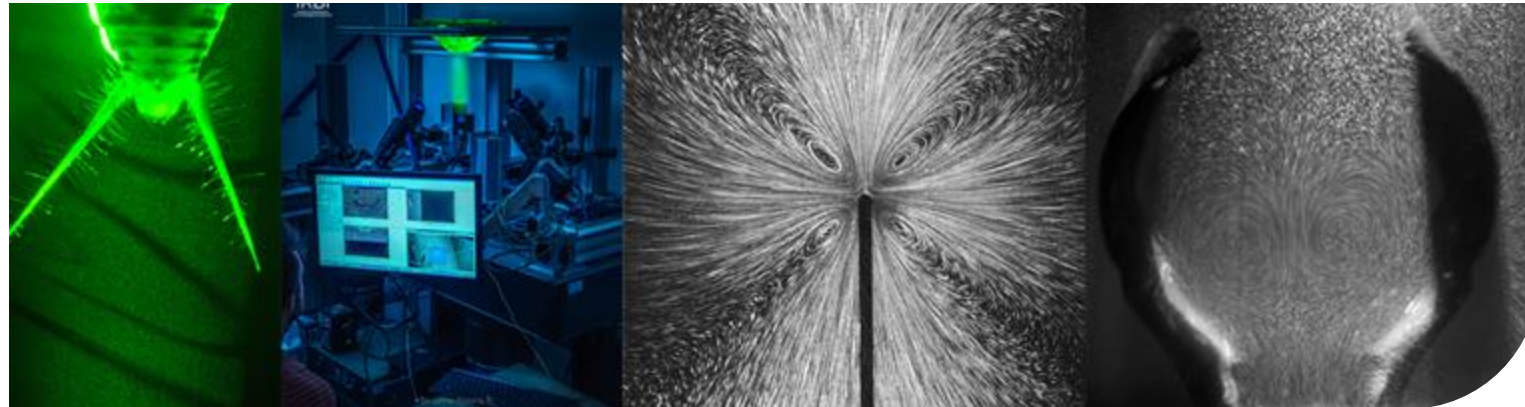


Des insectes inspirants



Thomas STEINMANN – IR CNRS
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thomas.steinmann@univ-tours.fr



Atelier Insectes et Innovations : Biomimétisme et Electronique en Région Centre

<http://irbi.univ-tours.fr>

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IRBI

Institut de Recherche
sur la Biologie de l'Insecte



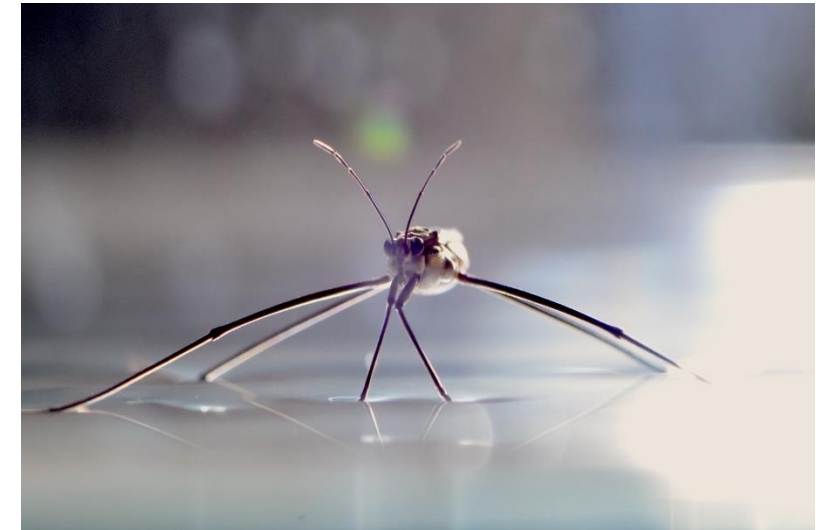
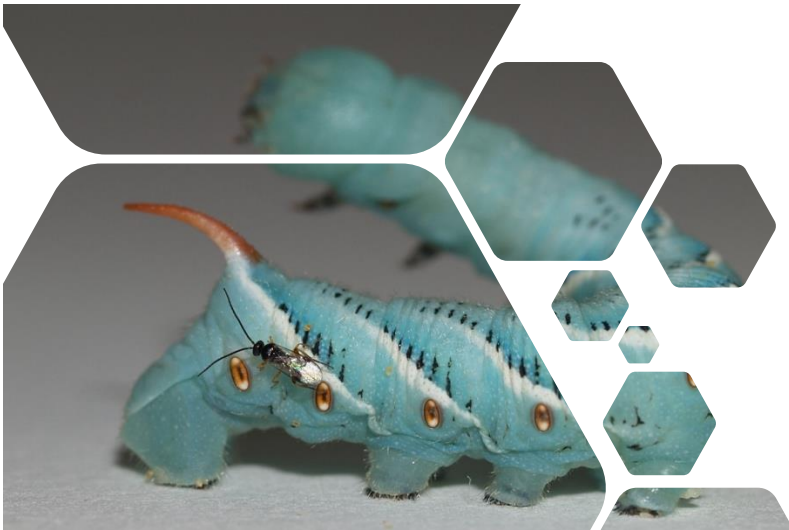
université
de TOURS



IMIP Biodiversity and Interactions between
Micro-organisms / Insects / Plants

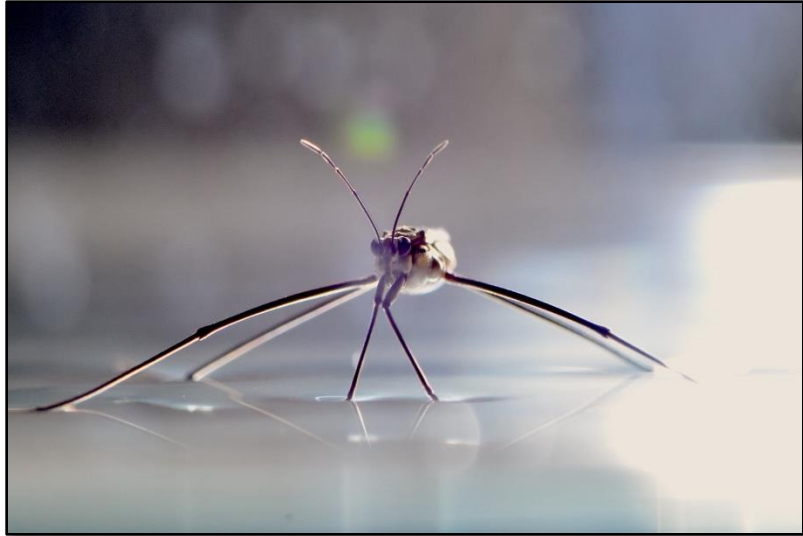
ESORE Social Evolution and Responses to the
Environment

INOV Interactions Organisms-enVironment:
mechanisms and responses to global changes



Biomimétique / Mécanique de la vie des insectes

INOV Interactions Organisms-enVironment:
mechanisms and responses to global changes



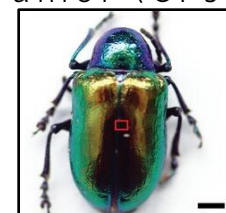
Miguel Pineirua
MCF Univ Tours



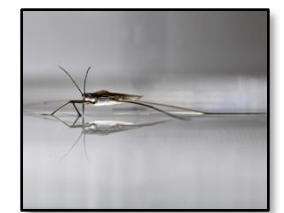
Jérôme Casas
Prof Univ Tours



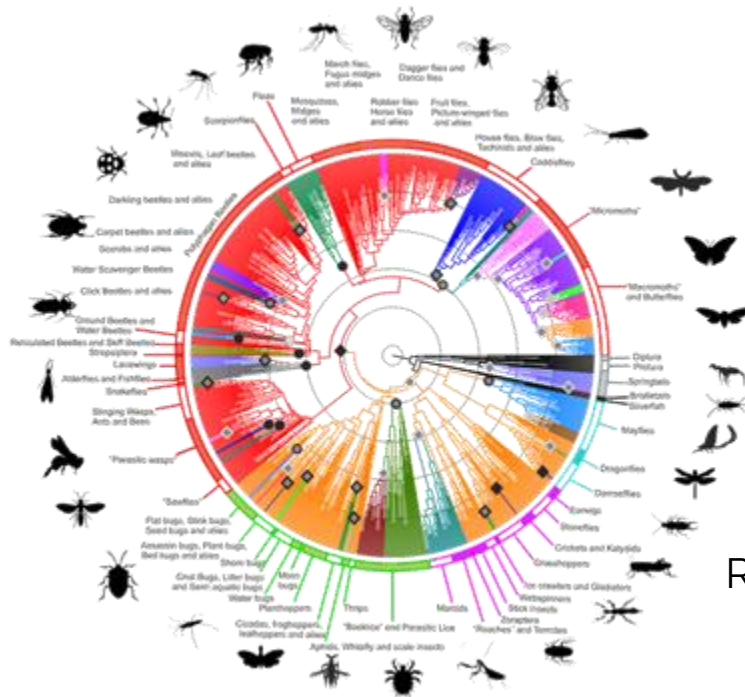
Vinod Kumar Saranathan
CNRS Chaire de Professeur
Junior (CPJ)



Thomas Steinmann
IR CNRS



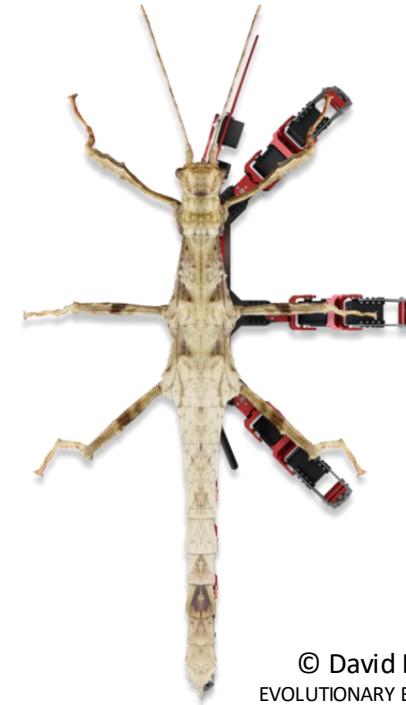
Les insectes sont très nombreux



Raynford et al 2014

Aujourd'hui, **1,3 million d'espèces d'insectes** ont été décrites, ce qui représente **les deux tiers des organismes vivants connus.**

Un outillage locomoteur et sensoriel miniature incroyable

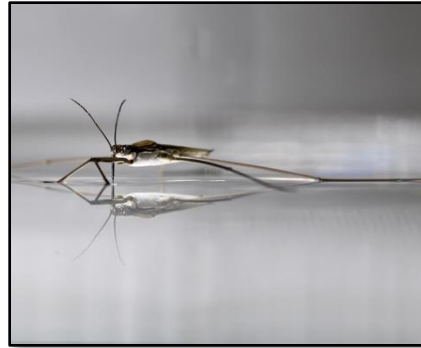


© David LaBonte
EVOLUTIONARY BIOMECHANICS
LABORATORY

Systeme micro mécanique autonome et résistant

Se déplacer

Vol, Locomotion en milieux granulaires ou sur l'eau



Ressentir l'environnement

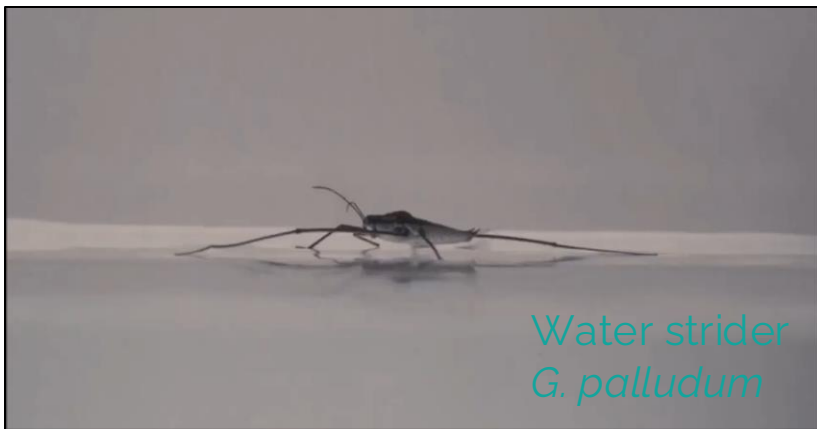
Recherche de nourriture, Reproduction, Anticiper la prédation

Se protéger, surface fonctionnelle

Résister au froid, à la chaleur, Eviter la noyade, se cacher, se reproduire

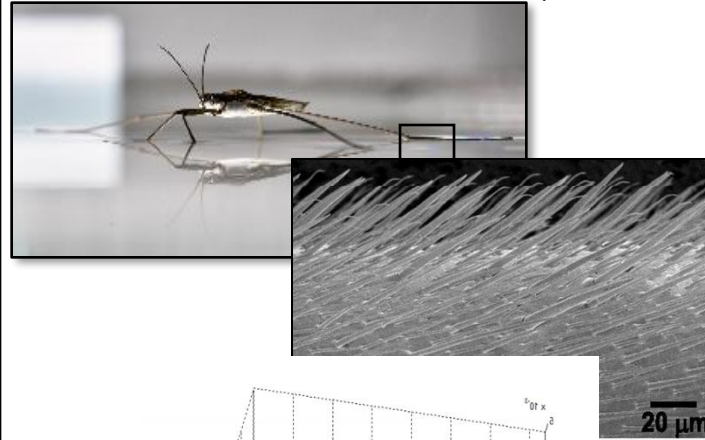


Les gerris

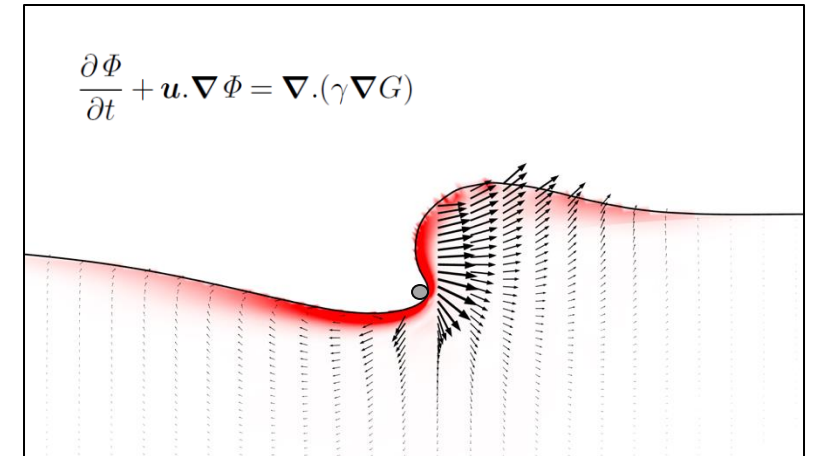
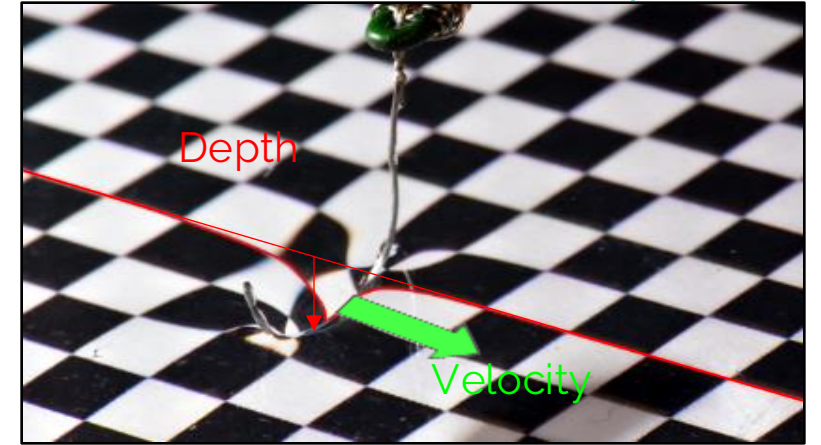


Patte hydrophobe

Surface composée de micro poils et de sillons nanométriques



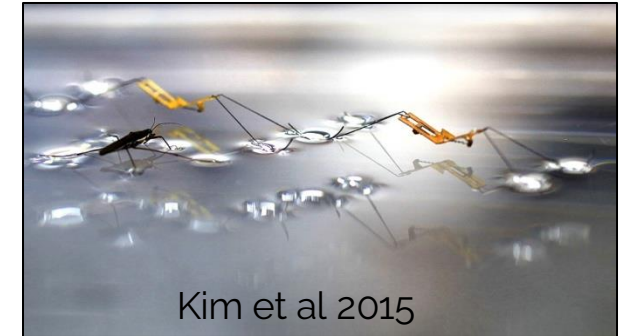
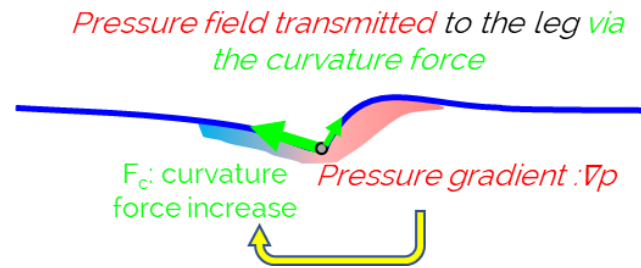
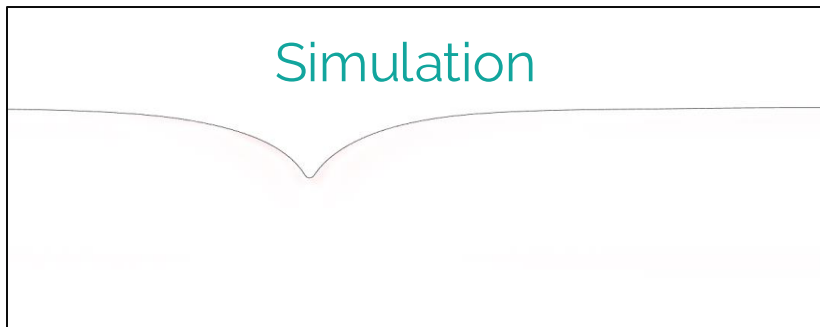
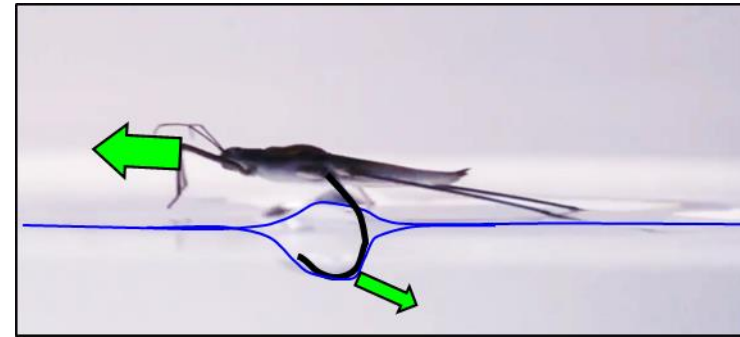
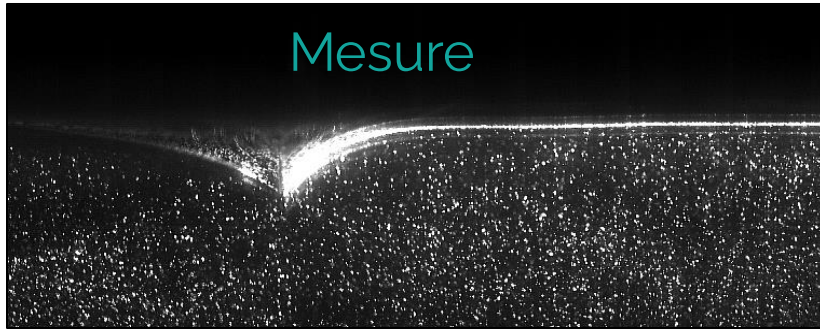
Patte artificielle, expériences et simulations numériques



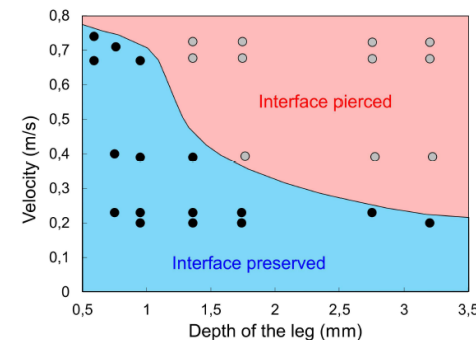
Etudier le mécanisme de propulsion

Modèle de transmission de force

Optimisation des robots semi aquatiques



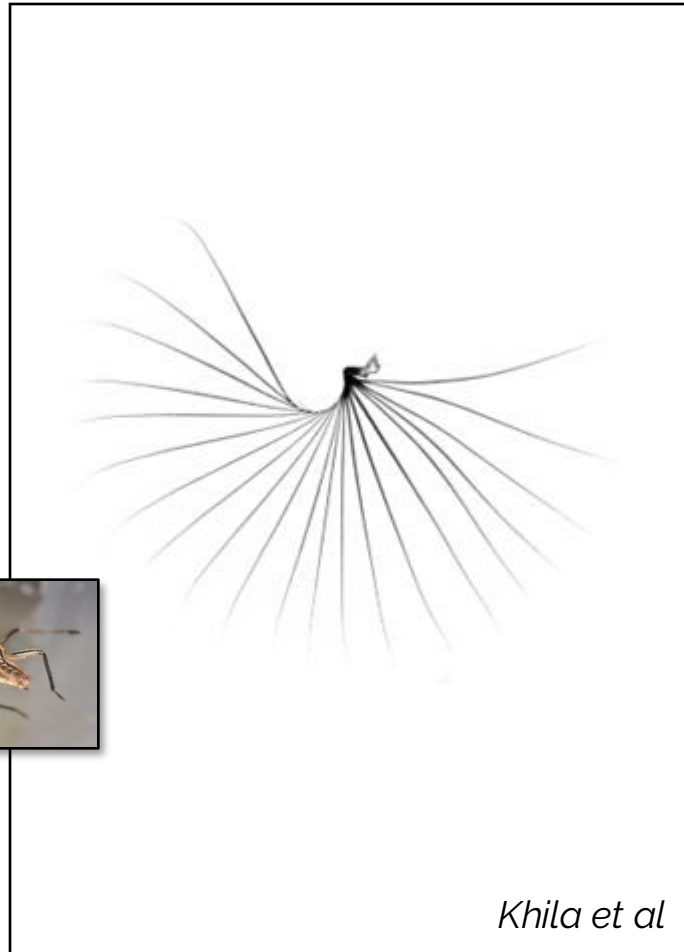
Steinmann T et al (2018) - Journal of Fluid Mechanics
 Steinmann T et al (2020) - Experiments in Fluids
 Steinmann T et al (2021) - Journal of Fluid Mechanics



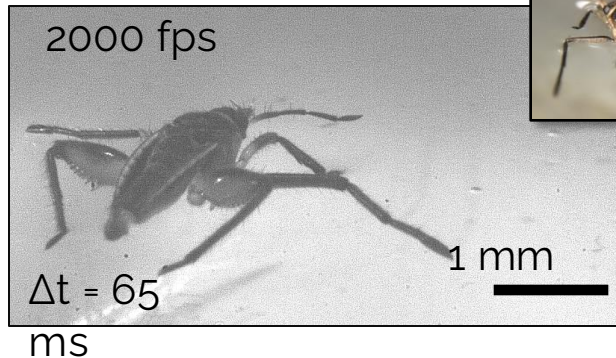
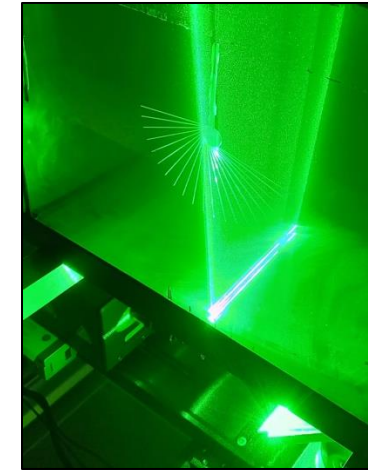
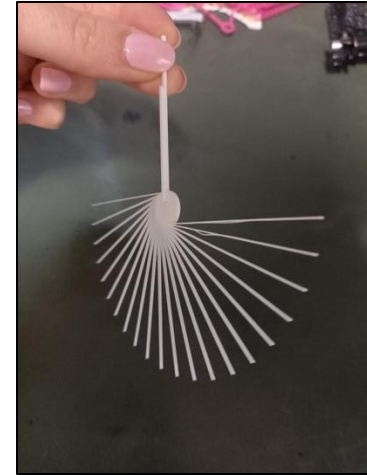
Eaux vives / torrents



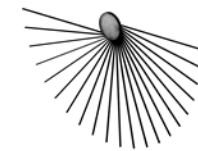
Eventail/rame repliable



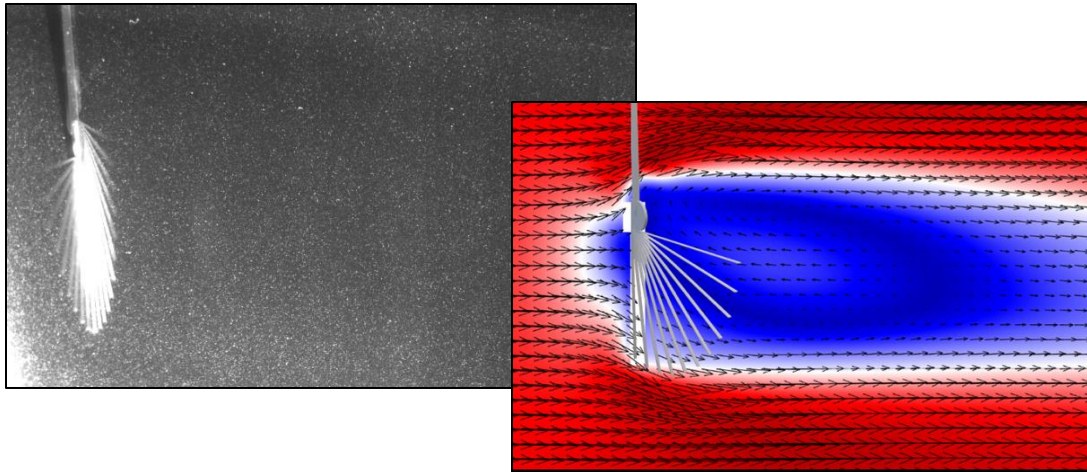
Impression 3D, Mesures & Simulations



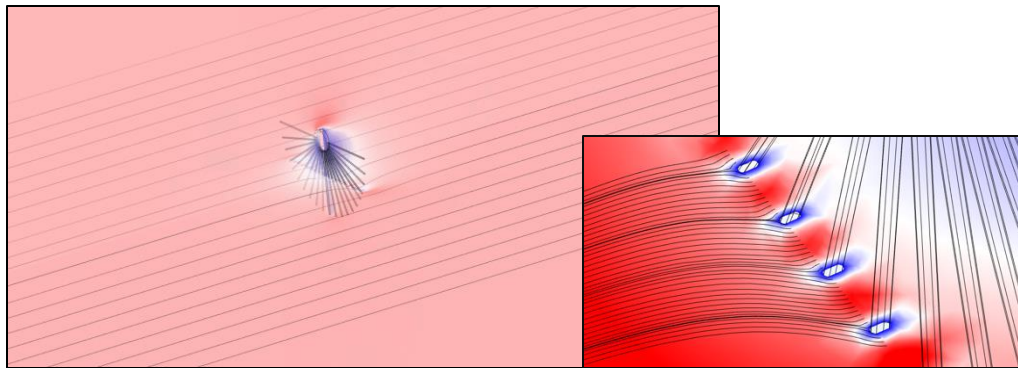
$$\rho \frac{\partial \mathbf{u}}{\partial t} + \rho \mathbf{u} \nabla \mathbf{u} = \nabla \cdot [-p\mathbf{I} + \mu(\nabla \mathbf{u} + \nabla \mathbf{u}^T)] + \rho \mathbf{g}$$



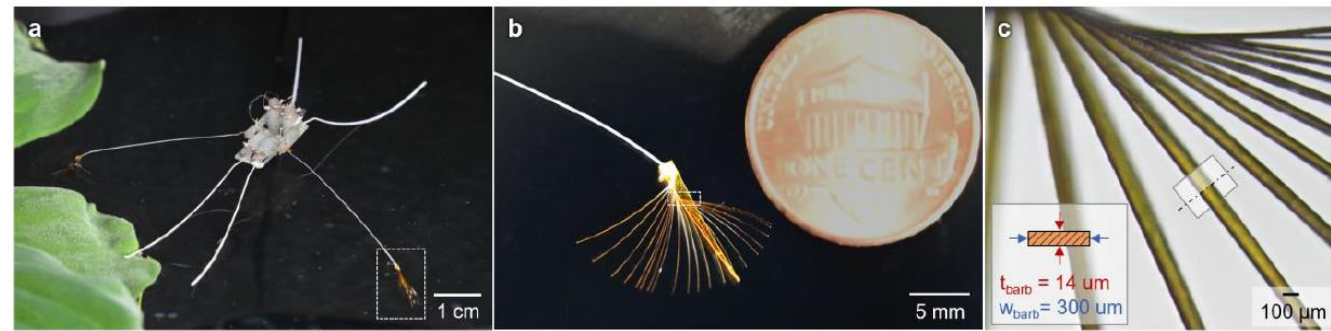
Caractériser et optimiser la porosité et la force de l'éventail



Rame pliable & poreuse ultra légère



Steinmann T et al (2025) - Submitted



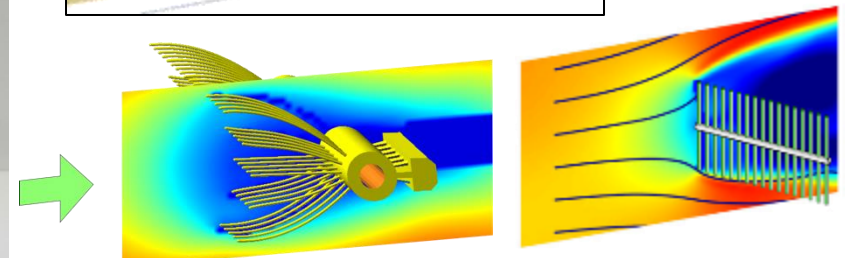
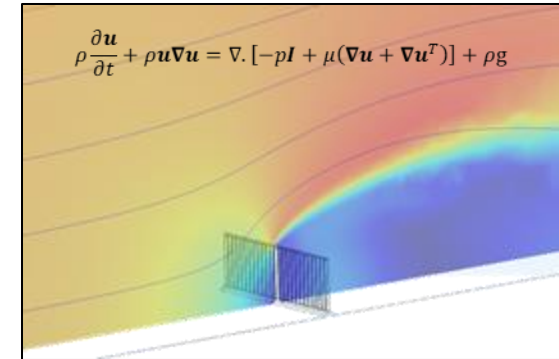
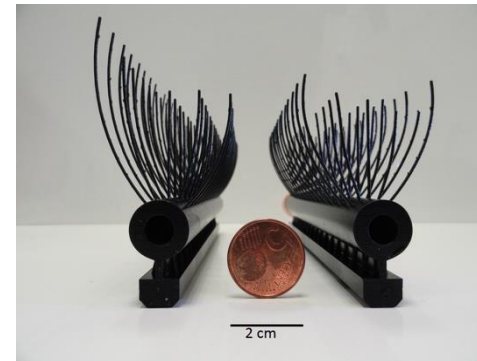
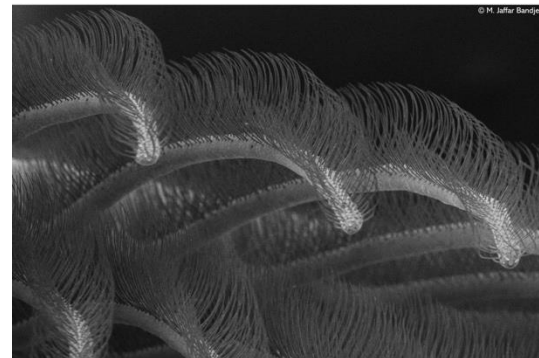
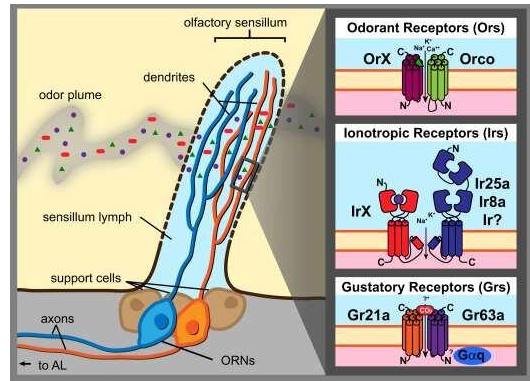
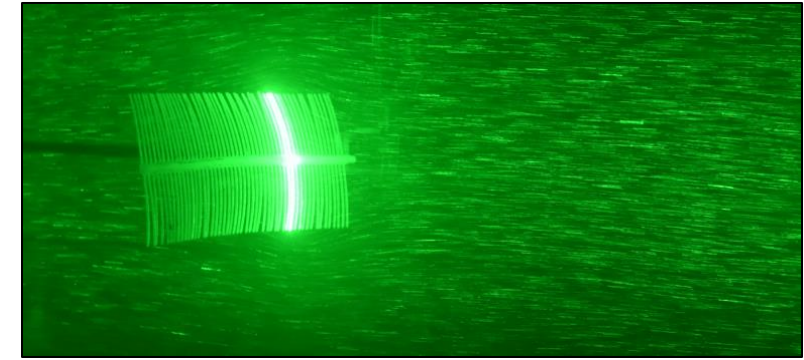
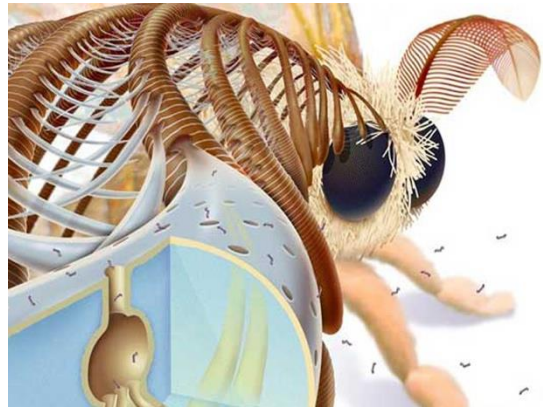
Ortega Jimenez et al (2024) - BiorXiv

S'inspirer des insectes pour améliorer les détecteurs d'explosifs

Antennes pectinées

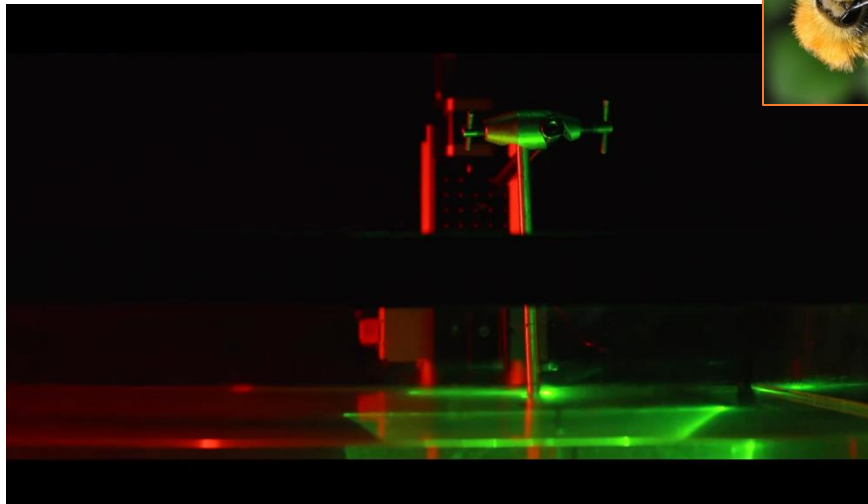
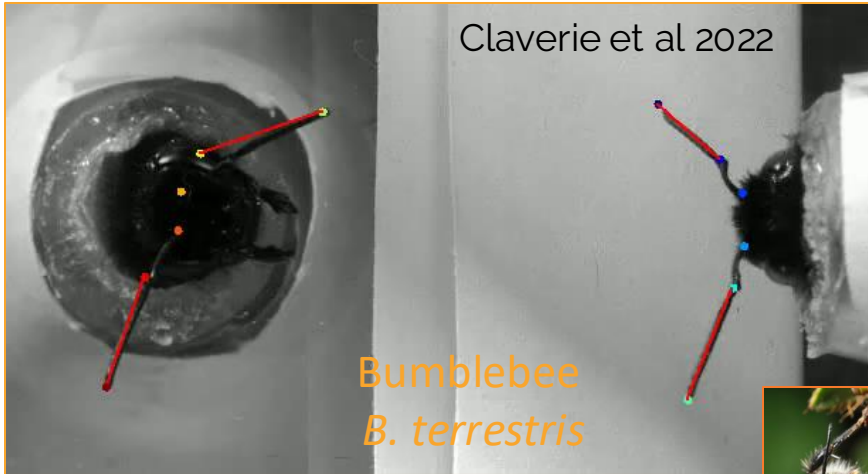
Impressions 3D

Mesures et simulations



Jaffar-Bandjee, Engels, Steinmann, Krijnen & Casas, ProceedingsB, 20
 Jaffar-Bandjee, Steinmann, Krijnen & Casas, Interface, 2020
 Jaffar-Bandjee, Steinmann, Krijnen & Casas, PNAS, 2020

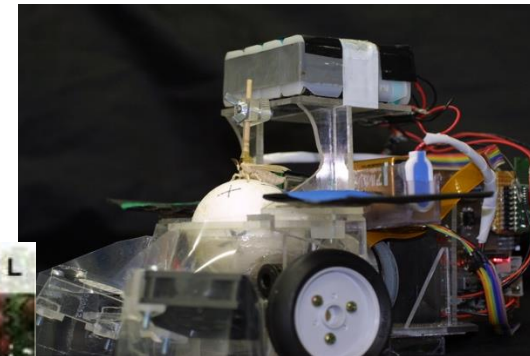
Olfaction active par mouvements des antennes



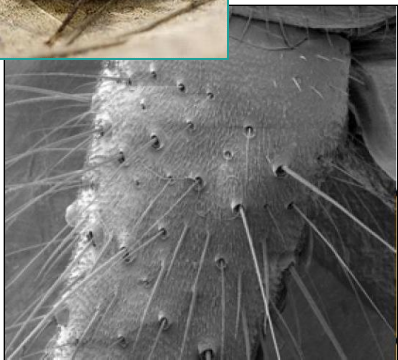
PheroInnov :

Détection bio-inspirée d'odeurs infinitésimales par les insectes: Innover en agroécologie et dans la lutte anti-terroriste.

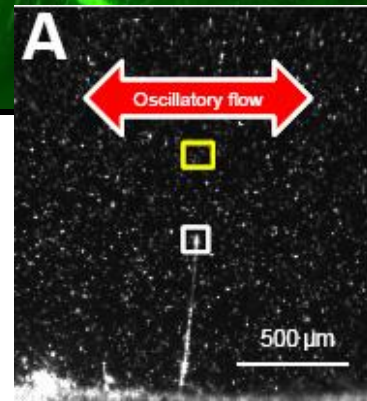
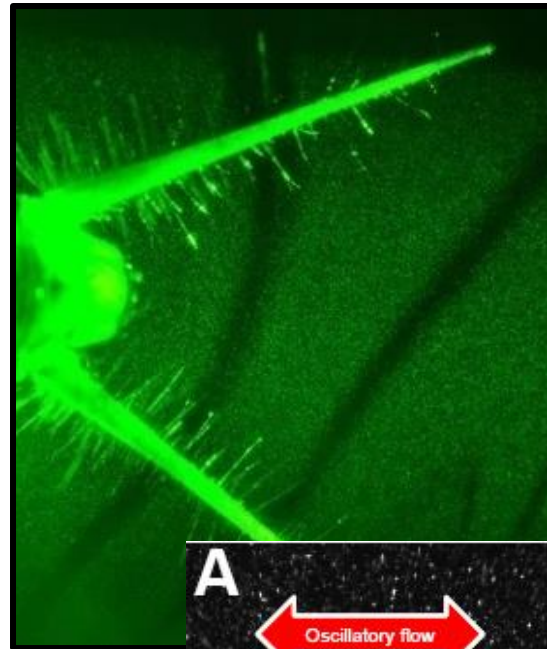
Projet Recherche à Risque RI2 :
Prof. Jérôme Casas



Le senseur le plus performant du monde animal

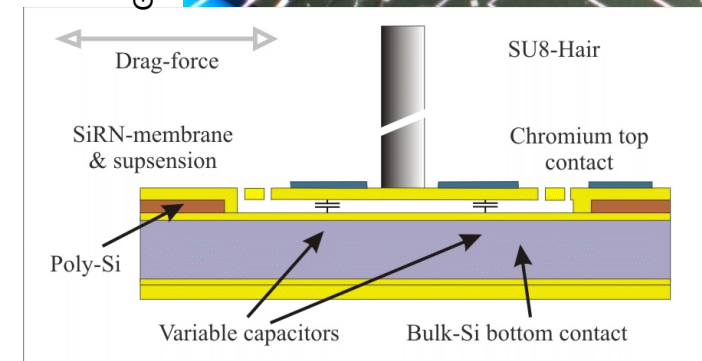
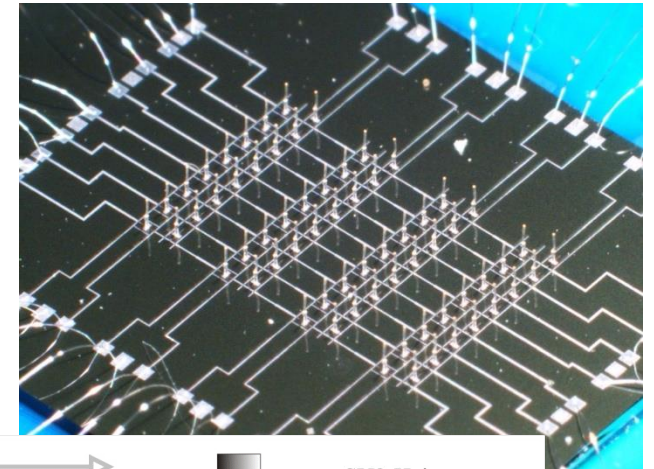


Caractérisation de la performance



Réseaux de poils biomimétiques ultraperformants

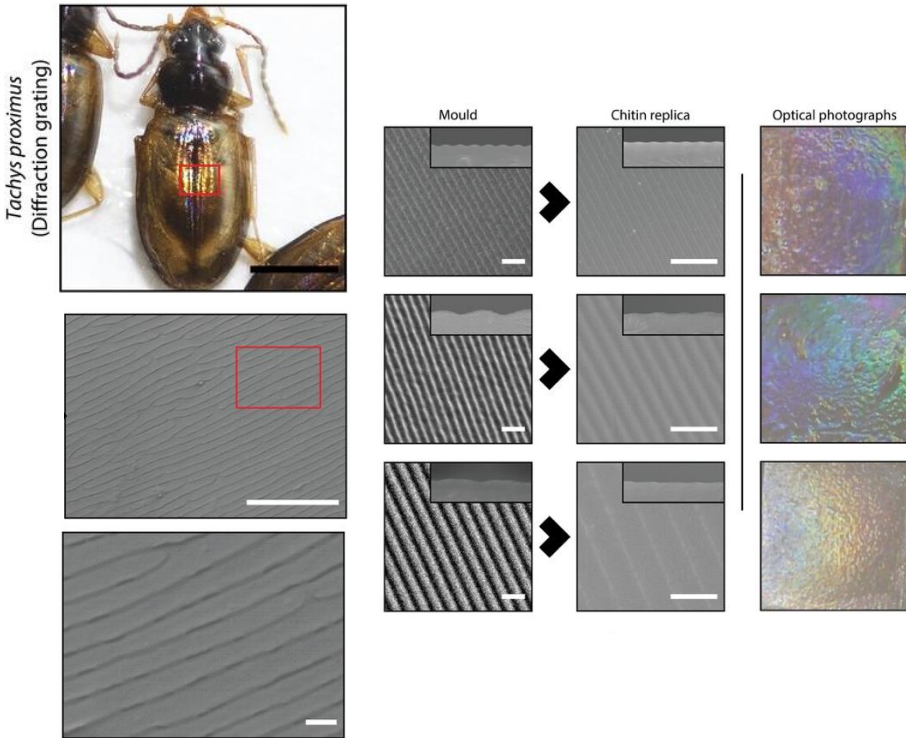
G. Krijnen, MESA+, Twente University



Casas & Steinmann 2014 *Proceedings B*
 Krijnen, Droogendijk, Steinmann et al. 2014 *Handbook of Biomimetics and Bioinspiration*
 Droogendijk, Casas, Steinmann, & Krijnen 2015 *Bioinspiration and Biomimetics*
 Steinmann & Casas 2017 *Interface*
 Krijnen, Steinmann et al 2019 *Architected Materials in Nature and Engineering*

Dr. Vinod Kumar Saranathan
 CNRS Chaire de Professeur Junior (CPJ)

**Evolution and Development of Biophotonic Nanostructures:
 Biomimetics and Bioinspiration of Nature's Multi-functional Nanostructures:**

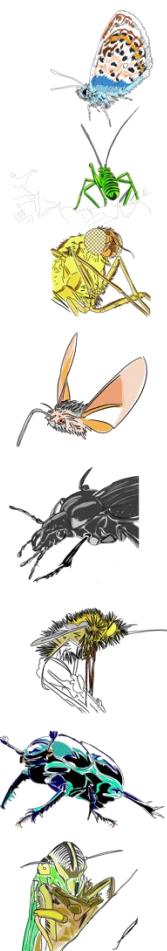


3D Objects With a Chitinous Iridescent Coating

Des insectes inspirants



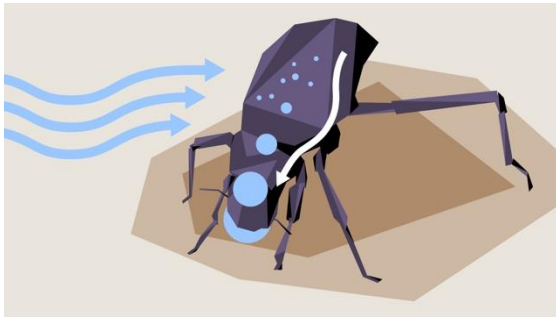
Merci pour votre attention !



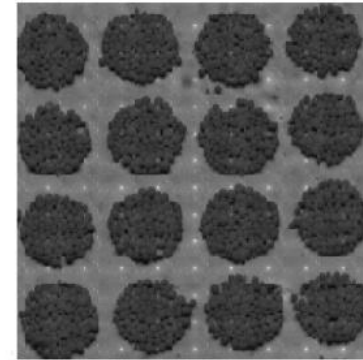
➤ Résister à la sécheresse

Plasmachemical patterned superhydrophobic/superhydrophilic surfaces

Water capture by desert beetle



R. P. Garrod et al 2007

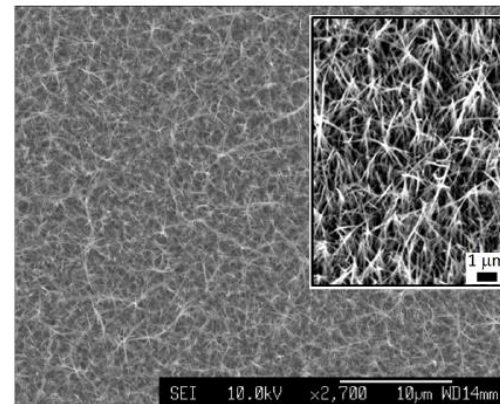
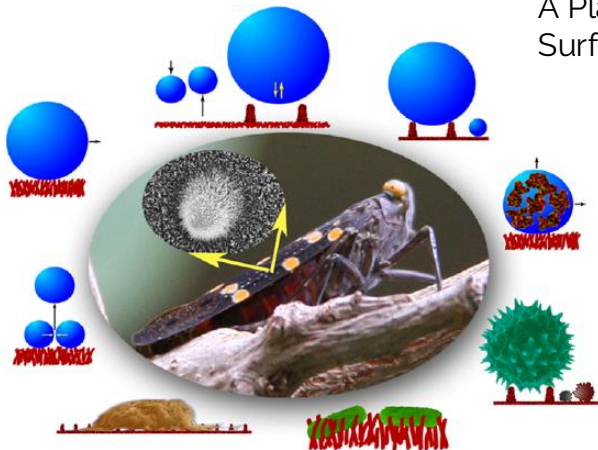


1 mm

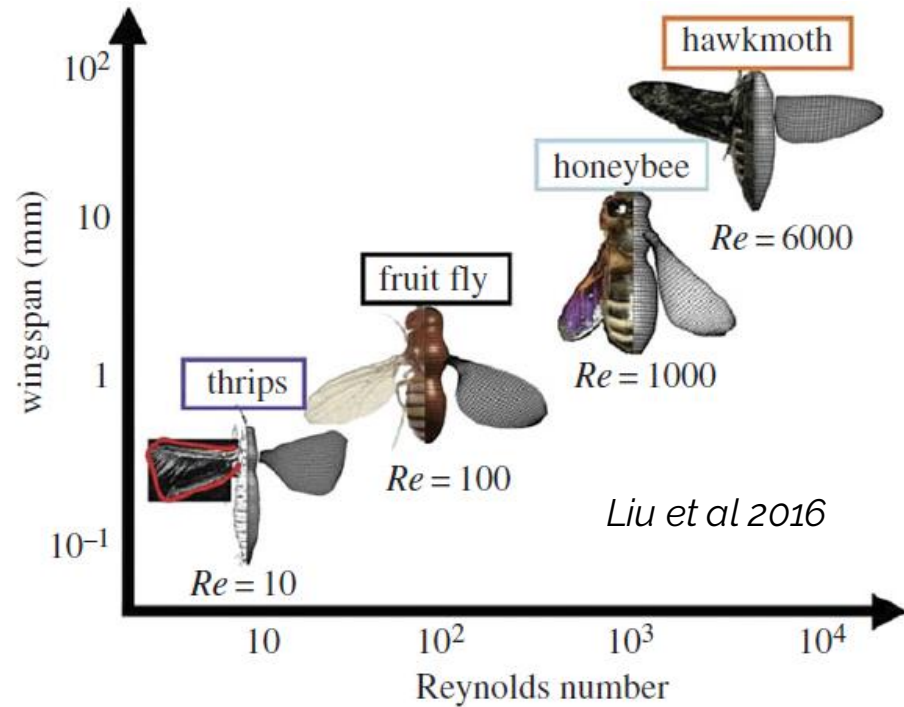
➤ Garantir la propreté des surfaces

Watson et al 2017

A Planthopper Wing Membrane Incorporating a Low-Adhesion, Nonwetting, Superhydrophobic, Bactericidal, and Biocompatible Surface



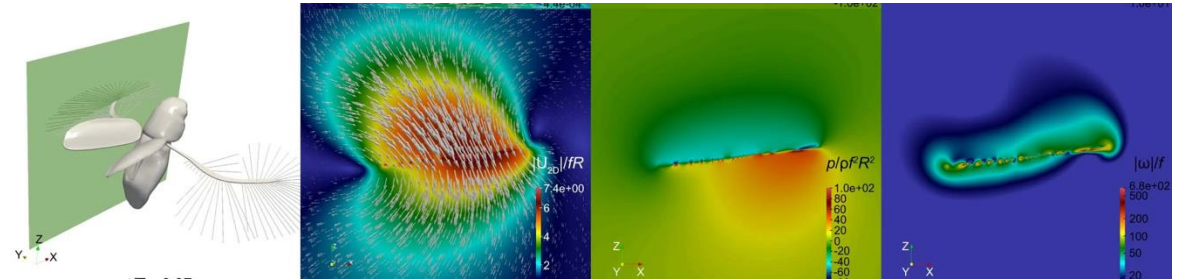
➤ Micro-drones inspirés des insectes



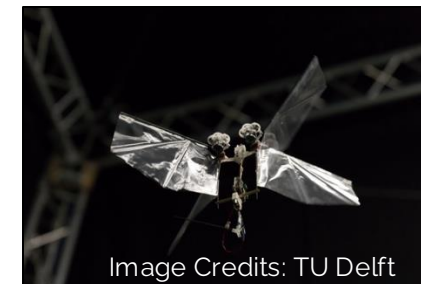
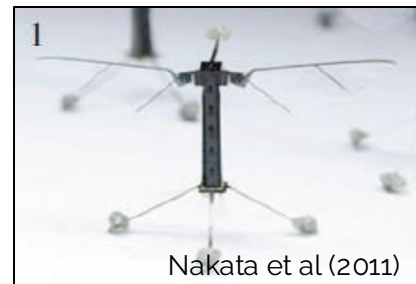
➤ Etudier



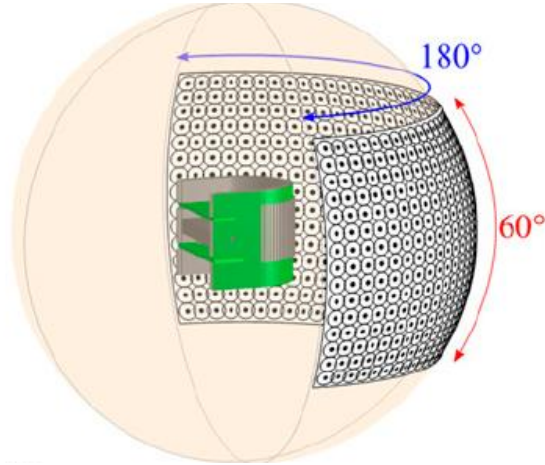
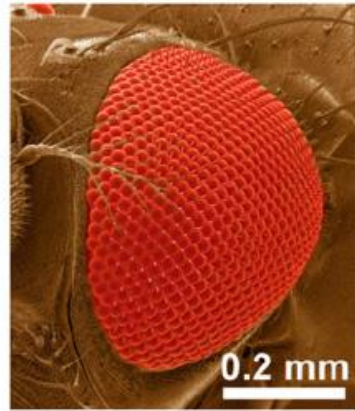
➤ Modéliser, comprendre les mécanismes



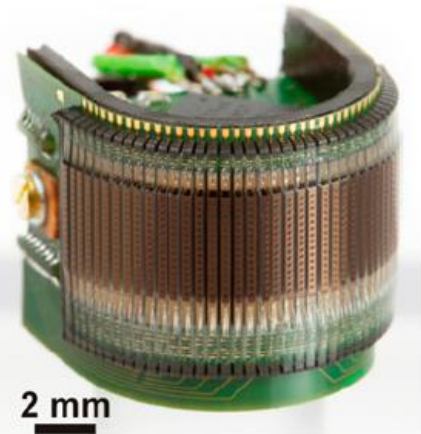
➤ Mimer



➤ Traitement local et décentralisé de l'information



Bio inspired compound eye
From fly to robot and vice versa

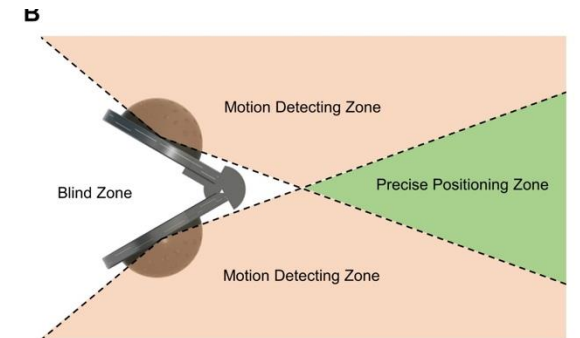
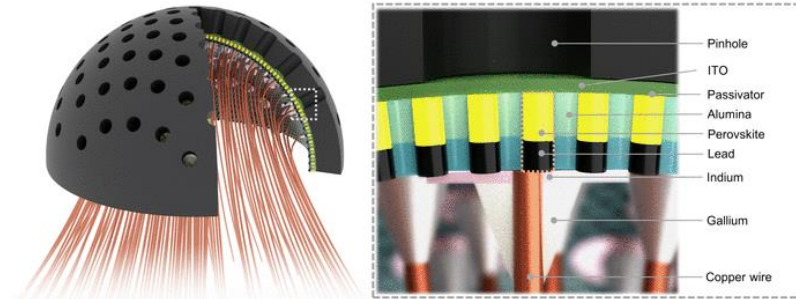
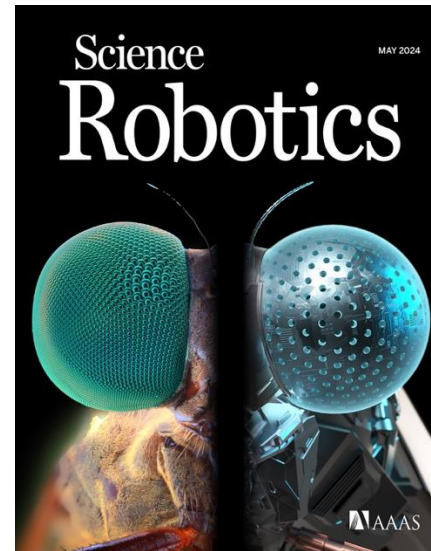


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DES SCIENCES ETIENNE
DU MOUVEMENT JULES
// // // // // MAREY



Francescini, Violet

Œil composé biomimétique



An ultrawide field-of-view pinhole compound eye using hemispherical nanowire array for robot vision
Zhou et al 2024