Conference Program

Schedule	Thursday, May 30	Friday, May 31	Saturday, June 1
8:30-9:00	Registration & Open Ceremony		
9:00-10:00	**Drop-based Microfluidics**	**Precise, intelligent, mobile and secure POC diagnostics: how can tech help?**	**Particle deposition in Microfluidics and Microfluidic photonic materials**
10:00-11:00	Coffee Break	Coffee Break	Coffee Break
11:00-12:00	**Fundamental fluid dynamics challenges in piezoacoustic inkjet printing**	**Acoustofluidics: ultrasound handling of particles and fluids in Microfluidics**	**Toroids, instabilities and a bit of Microfluidics**
12:00-13:30	Free Discussion time (2, 7, 10)	Free Discussion time (9, 13, 15)	Free Discussion time (3, 4, 6)
13:30-15:00	Lunch	Lunch	**ROUND TABLE** & Closing Ceremony
15:00-16:00	**Driving particles and fluids using chemical fluxes**	**Microfluidic approaches for particle separation from suspensions**	
16:00-17:00	Free Discussion time (8, 11, 12, 16)	Free Discussion time (1, 5, 14, 17)	
17:00-18:00	**ROUND TABLE**	**ROUND TABLE**	
18:00-19:00	Free Discussion time	Free Discussion time	
19:00-21:00	Welcome Reception		
21:00-22:00		Conference	
22:00-23:00		Dinner	

Talk 1

Drop-based Microfluidics

David Weitz
Experimental Soft Condensed Matter Group
Harvard University, USA

This talk will discuss the use of microfluidic devices to precisely control the flow and mixing of fluids to make drops and will explore a variety of uses of these drops. They can be used to create new materials that are difficult to synthesize with any other method. These materials exhibit fascinating physical properties and have great potential for practical uses. I will also show how the exquisite control afforded by microfluidic devices provides enabling technology to use droplets as microreactors to perform reactions at remarkably high rates using very small quantities of fluids. I will discuss both the science and the technology of the use of microfluidic devices.

Talk2

Fundamental fluid dynamics challenges in piezoacoustic inkjet printing.

Detlef Lohse
Physic of Fluids Group
University of Twente, The Netherlands

Piezo-acoustic inkjet printing has become a mature technique for high performance printing. Nevertheless, there are still various scientific challenges. In this talk I will cover some of them:
(i) Coupling between the fluid dynamics and the acoustics, in particular when a disturbing bubble has been entrained in the ink channel.
(ii) Optical and acoustical monitoring of the bubble.
(iii) Mechanisms of the bubble entrainment.
(iv) Droplet formation and pinch-off of droplets.
(v) Droplet impact on substrates.

Talk 3

Driving particles and fluids using chemical fluxes.

Todd Squires
Chemical Engineering
UC Santa Barbara, USA.

Suspensions of micron-scale particles and drops are ubiquitous in complex fluid formulations — foods, consumer products, pharmaceuticals, paints, coatings, and other materials and precursors. A number of equilibrium interactions have long been exploited to stabilize these suspensions and tune the properties of the materials. Here, we describe a set of non-equilibrium, chemical phenomena that allow particle migration to be directed and controlled over significantly longer ranges than is possible with equilibrium interactions. Examples will build upon somewhat classic pictures of diffusiophoresis or solvophoresis, wherein fluxes of various chemical species quite generically drive fluid flows and particle migration. We will lay out a conceptual, intuitive framework to understand, design, and manipulate these chemical fluxes — and illustrate with systems that drive particles into or out of dead-end pores; where particles might 'find' targets hidden within a maze, and where structures may collect specific suspended particles from millimeters away.
We will additionally describe new techniques we have developed to sculpt chemical micro-environments in space and time, and interferometric methods to visualize these concentration fields as they evolve. We will illustrate with direct, dynamic measurements of physical and reactive absorption of vapor-phase solutes into ionic liquids, reagent depletion during interfacial polymerization reactions, and diffusion of associative solutes through hydrogels.

Talk 4

Precise, intelligent, mobile and secure POC diagnostics: how can tech help?

Dr. Emmanuel Delamarche
IBM Research - Zurich, Switzerland

Diagnostics are ubiquitous in healthcare because they support prevention, diagnosis and treatment of diseases. Specifically, point-of-care diagnostics are particularly attractive for identifying diseases near patients, quickly, and in many settings and scenarios. One of our contribution to the field of microfluidics is the development of capillary-driven microfluidic chips for highly miniaturized immunoassays. In this presentation, I will review how to program capillary flow and encode specific functions to form microfluidic elements that can easily be assembled into self-powered devices for immunoassays, reaching unprecedented levels of precision for manipulating samples and reagents. This technology can also be augmented using peripherals and smartphones for flow control and monitoring with sub-nanoliter precision. Finally, counterfeiting of point-of-care diagnostics is an issue, with sometimes dramatic consequences. Using capillary phenomena, we devised a method for producing in chips a complex signal with a "time domain" for authentication of devices. All together, capillary-driven elements can bring extremely high control for manipulating sub-microliter volumes of samples and picogram quantities of reagents and may therefore extend the performances of microfluidic devices for point-of-care diagnostics to a next level of precision.

Talk 5

Acoustofluidics: ultrasound handling of particles and fluids in microfluidics.
Henrik Bruus
Department of Physics
Technical University of Denmark, Denmark

For the past 15 years, ultrasound-based microscale acoustofluidic devices running at low MHz frequencies have successfully and in increasing numbers been used in the fields of physics, biology, environmental and forensic sciences, and clinical diagnostics. Examples include cell synchronization, enrichment of prostate cancer cells in blood, high-throughput cytometry and multiple-cell handling, single-cell patterning and manipulation, size-independent sorting of cells, and rapid sepsis diagnostics by detection of bacteria in blood. Acoustic forces have also been used for noncontact microfluidic trapping and particle enrichment, massively parallel force microscopy on biomolecules, and acoustic tweezing. This development has been accompanied by advances in the understanding of the basic physics of acoustofluidics in particular related to the acoustic radiation force acting on suspended particles, the acoustic streaming of the carrier fluid, and the acoustic body force acting on inhomogeneous solutions. In the talk, an overview is presented of the state-of-art within acoustofluidics, covering some of the recent developments within basic physics theory, experimental methods, and commercial applications.

Talk 6
Microfluidic approaches for particle separation from suspensions
Howard A. Stone
Complex Fluid Group
Princeton University, USA

Many material systems require handling suspensions where a particulate phase is suspended in a continuous liquid phase. In some situations it is of interest to concentrate the particles or to separate the particles from the solution. Here we describe microfluidic, and related milli-fluidic, approaches for these processes. In particular, we demonstrate (i) how the motion of bubbles through a channel filled with a bidisperse suspension can produce a speed-based separation of the particles by size, (ii) the use of chemical gradients, e.g. a gradient of CO_2, for driving the motion of particles relative to a flowing aqueous phase liquid, via the mechanism of diffusiophoresis, and, if there is time, (iii) microfluidic photopolymerization of chemically functionalized fibers and particles, which enables non-specific interactions between the different objects. These approaches utilize the ideas of physicochemical hydrodynamics to achieve various forms of particle manipulations in fluids.

Talk 7

Particle deposition in microchannels and microfluidic photonic materials

Patrick Tabeling
Director
Institut Pierre Gilles de Gennes fro Microfluidics, France

Two topics:

- 1 - Why do particles, suspended in a fluid and travelling in a channel, deposit onto walls? The question has far-reaching implications in different domains (filtering, syringeability, fouling,.). Close to a channel wall, particles are subject to a variety of effects, which control their trajectories: hydrodynamic forces, diffusion, van der Waals adhesion forces, and electrostatic forces. By coupling microfluidic experiments, theory, and numerics, we succeed in establishing a general description of the phenomenon. The present work allows understanding of empirical observations and provides a new paradigm enabling to engineer devices in a way that reduce or enhance particle deposition.
- 2 - Is it possible to manipulate particles with microfluidics so as to make new self-assembled materials ? This question will be addressed and I will show that, with microfluidics, it is possible to fabricate well controlled solid foams having interesting optical properties, in particular developing complete photonic band gaps.

Talk 8

Toroids, instabilities and a bit of microfluidics

Alberto Fernandez-Nieves
School of Physics, Georgia Tech, USA
Department of Condensed Matter Physics, University of Barcelona, Spain
ICREA - Institució Catalana de Recerca i Estudis Avançats, Barcelona, Spain

In this talk I will briefly discuss our recent work with toroidal droplets: How to make them, how they evolve, what does charge do, and how to stabilize them. Along the way, I will mention some of our prior work with microfluidics, jets and drops. We will thus cover Rayleigh-Plateau break-up, the shrinking instability of toroidal droplets, whereby the toroidal "hole" shrinks in time, the effects of charge and how they enrichen the observed behavior, and how to prevent all these different instabilities using yield stress materials in what can be seen as a way to 3D print.

Short talks

1) Escape from the chip: flowing and clogging in confined suspensions.

Alvaro Marin, Physics of Fluids, University of Twente.

People leaving a room in panic, sand in an hourglass, particles in a fluid through a porous medium or blood flowing through a narrowed vessel are all examples of "things" of different nature being forced through constrictions. In all these cases it is important to make sure that the system keeps continuously flowing, sometimes even lives are at risk. Even though the case of silos and dry particles driven by gravity towards a funnel has been well-studied for years, the case of suspensions passing through a constriction is not well understood yet. Most cases studied so far have been focused on particles with high adhesivity to the channel walls. In this short tall, I will show that if such adhesivity is turned off, suspensions surprisingly follow the same statistics as dry granular matter when passing through constrictions.

If the constriction is removed in this conditions, particles should flow without trouble. However, their dynamics are far from trivial even in diluted conditions. At critical interparticle distances, particles tend to interlace their trajectories, only bonded by hydrodynamic interactions. While classical studies on non-Brownian self-diffusivity report average particle displacements of fractions of the particle diameter, the trajectories observed in our system show displacements of several particle diameters. I will show you how the experimental results compare with particle dynamics simulations to elucidate the nature of the hydrodynamic interactions entering into play. The reported phenomenon could be applied to promote advective mixing in micro-channels or particle/droplet self-assembly.

2) Raydrop: an universal droplet generator based on a non embedded “co-flow-focusing”.

Adrien Dewandre, Javier Rivero-Rodriguez, Youen Vitry, Benjamin Sobac and <u>Benoit Scheid,</u> Université libre de Bruxelles, BELGIUM.

We present a new microfluidic device for the high-throughput production of monodisperse droplets. Most commercial microfluidics droplet generators rely on the planar flow-focusing configuration implemented in polymer or glass chips. However, this planar configuration suffers from many limitations, mostly due to the contact between the walls of the microchannels and the two phases at the junction, making laborious and often ephemeral wettability treatments of these walls necessary.

Here we present a new configuration based on the alignment of two capillaries immersed in a pressurized chamber containing the continuous phase. The dispersed phase exits one of the capillaries through a 3D-printed nozzle, placed in front of the outer capillary for collecting the droplets. This non-embedded and co-flowing implementation of a three-dimensional flow-focusing is referred to as the Raydrop technology. Experimental results demonstrate the universality of the Raydrop in terms of the variety of fluids that can be emulsified (water, oil, organic solvent, polymer, air, …), as well as the range of droplet size that can be obtained, without the need of surfactant neither coating. Additionally, numerical computations are shown to correctly predict the droplet size in the dripping regime, when varying the geometrical and flow parameters. The mono-dispersity ensured by the dripping regime, the robustness of the fabrication technique, the optimization capabilities of the numerical scheme and the universality of the configuration confer to the Raydrop technology a very high potential in the race towards high-throughput droplet generation processes.

3) Nanofluid down an incline: nonlinear description of ion-induced solid flow.

Rodolfo Cuerno

Departamento de Matemáticas, UC3M, Madrid, Spain.

We will describe the derivation of a nonlinear evolution equation that describes space-time self-organization at the free surface of a solid target undergoing irradiation by an energetic ion beam. Under this type of driving, for many materials the outermost surface layer of the target responds as a highly viscous fluid, displaying formation of nanoscale ripples in macroscopic time scales. In spite of the irrelevance of gravity at these small distances, the weakly nonlinear limit of the equation resembles the well known description of a macroscopic incompressible viscous thin film flowing down an incline, which is a paradigmatic instance of free surface flow systems for which the morphological instability responsible for pattern formation is controlled by inertial effects. The predictive power of the evolution equation for ion-beam surface nanopatterning underscores nonlinear effects that might have been expected to be of a secondary importance in such a nanoscopic-scale, Stokes-flow system. The content of this talk is joint work with Mario Castro (Universidad Pontificia Comillas) and Javier Muñoz-García (UC3M).

4) Gaussian statistics as an emergent symmetry of the stochastic Burgers equation

Enrique Rodríguez Fernández

Departamento de Matemáticas, UC3M, Madrid, Spain.

Symmetries play a conspicuous role in the large-scale behavior of critical systems. In equilibrium they allow us to classify asymptotics into different universality classes, and out of equilibrium, they sometimes emerge as collective properties which are not explicit in the “bare” interactions. Here we elucidate the emergence of an up-down symmetry in the asymptotic behavior of the stochastic scalar Burgers equation, manifested by the occurrence of Gaussian fluctuations even within the time regime controlled by nonlinearities. This robustness of Gaussian behavior contradicts naive expectations due to the detailed relation—including the lack of up-down symmetry—between the Burgers equation and the Kardar-Parisi-Zhang equation, which paradigmatically displays non-Gaussian fluctuations described by Tracy-Widom distributions. We reach our conclusions via a dynamic renormalization group study of the field statistics, confirmed by direct evaluation of the field probability distribution function from numerical simulations of the dynamical equation.

5) Three ways to unpin a buoyant bubble stuck in a capillary

L. Keiser, G. Lerisson, H. Elettro, P.-G. Ledda and F. Gallaire, LFMI, EPFL, Lausanne, Switzerland.

Following Bretherton's analysis, a long rising bubble will get stuck if the radius of the tube is less than a fraction of the capillary length. We explore three ways to unpin such a bubble: (i) first by reducing its volume, (ii) by tilting the tube and (iii) by rotating the tube around its axis.

6) Recent Advances in Liquids: Identification of "Static" Shear Elasticity

Laurence Noirez,

Laboratoire Léon Brillouin, Paris-Saclay Univ., CEA-Saclay, 91191 Gif-sur-Yvette, France.

Since Robert Brown (1827), molecules were supposed to move freely in the liquid or molten state. However, we will show that at sub-millimeter scale and particular liquid/surface boundary conditions, liquids can work mechanically like an elastomer [1] and optically as a harmonic oscillator [2]. This "elastomeric" behaviour is directly evidenced via the stress response to a mechanical field while an "elastically induced" optical birefringence is visible in response to a low frequency mechanical excitation. These newly revealed properties indicate that the liquid state is a low threshold elastic medium; i.e. molecules are long range dynamically correlated. It sheds a new light for a comprehensive approach of flow properties like flow birefringence, optical banded textures, flow instabilities, shear induced stratification, and make possible the identification of shear induced cooling (Fig.1)[3] or the occurrence of localized temperatures upon applying a mechanical shear strain. These advances are of high

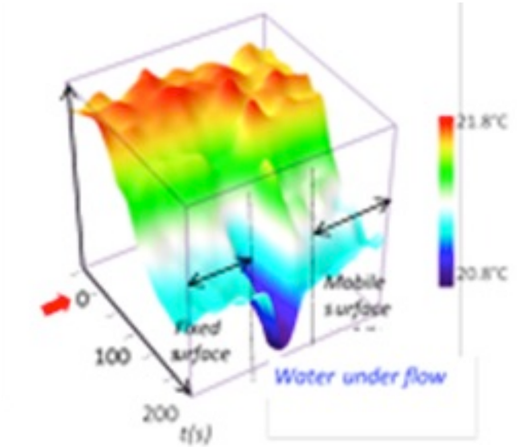


Fig.1: Thermal mapping of the microflow of thin layer of liquid water (from rest to 200s). Time zero is indicated with a red arrow (J. Chem. Phys. Lett. 2013 [3])

interest in the frame of theoretical developments based on solid-like approaches revisiting the Frenkel assumptions [4,5].

[1] L. Noirez, P. Baroni, J. of Phys.: Cond. Matter 24 (2012) 372101.
[2] P. Kahl, P. Baroni, L. Noirez, App. Phys. Lett. 107 (2015) 0844101.
[3] P. Baroni, L. Noirez, P. Bouchet, J. Chem. Phys. Lett. 2013.
[4] F. Volino, Ann. Phys. Ann Phys Fr 22 (1-2) https://doi.org/10.1051/anphys:199701003
[5] K. Trachenko, VV Brazhkin (Rep. Prog. Phys. 79 (2016) 01650.

7) Snap evaporation of droplets on smooth topographies

Marc Pradas

School of Mathematics & Statistics, Open University of London, UK.

The evaporation of droplets on solid surfaces is important for a broad range of applications, including ink-jet printing and surface cooling. Despite its apparent simplicity, the precise configuration of an evaporating droplet on a solid surface has proven notoriously difficult to predict and control. This is because droplet evaporation typically proceeds as a `stick-slip' sequence (a combination of pinning and de-pinning events) caused by microscopic structure of the solid surface. Here we show how smooth, pinning-free, solid surfaces of non-planar topography give rise to a different process called snap evaporation. During snap evaporation the morphology of an evaporating droplet follows a reproducible sequence of steps, where the liquid-gas interface is quasi-statically reduced by mass diffusion until it undergoes an out-of-equilibrium snap. Experimentally, we demonstrate this process using a water droplet evaporating on a wavy ultra-smooth lubricant-infused surface. Mathematically, we use full hydrodynamics lattice-Boltzmann simulations, and a model based on bifurcation theory that reveals the points where snap events are triggered, which obey a strict hierarchy dictated by the underlying surface topography.

8) Controlling the emptying of horizontal capillaries at the microscale

Carlos Rascón

Departamento de Matemáticas, UC3M, Madrid, Spain.

We present a precise mathematical criterion to determine whether the liquid in a horizontal capillary stays in it or flows out of it. Examples are shown for which, quite counter-intuitively, emptying occurs at any scale. Suggestions for the use of this phenomenon to construct microfluidics devices are also given.

9) Growing Nanofluidic Systems: Angiogenesis in Three Dimensions

Rui Travasso[1], Maurício Moreira Soares[1], Rita Coimbra[2], Luís Rebelo[3], João Carvalho[1]

[1] Centro de Física da Universidade de Coimbra (CFisUC), Department of Physics, University

of Coimbra, R. Larga, 3004-516 Coimbra, Portugal

[2] Institute for Research in Biomedicine (iBiMED), Department of Medical Sciences, University of Aveiro, Aveiro, Portugal

[3] Department of Physics, Faculty of Sciences, University of Lisbon, Lisbon, Portugal

Angiogenesis - the growth of new blood vessels from a pre-existing vasculature - is key in both physiological processes and on several pathological scenarios such as cancer progression or diabetic retinopathy. The growing new vessel sprouts form a nanofluidic network that is required for irrigating the live tissue. For this new vascular network to be functional, each growing sprout should merge either with an existing functional mature vessel or with another growing sprout. This process is called anastomosis. We present a systematic 2D and 3D computational study of vessel growth in a tissue to address the capability of angiogenic factor gradients to drive anastomosis formation. We demonstrate that the production of angiogenic factors by tissue cells is able to promote not only vessel growth, but also vessel anastomoses events in both 2D and 3D. The simulations also verify that the morphology of these networks has an increased resilience toward variations in the endothelial cell's proliferation and chemotactic response. In this way, the spatial distribution of tissue cells and the concentration of the growth factors they produce are the major factors in determining the final morphology of the network.

10) The controlled generation of compound droplets with diameters below 10 microns and the mass generation of monodisperse microbubbles in real industrial applications avoiding microfluidics

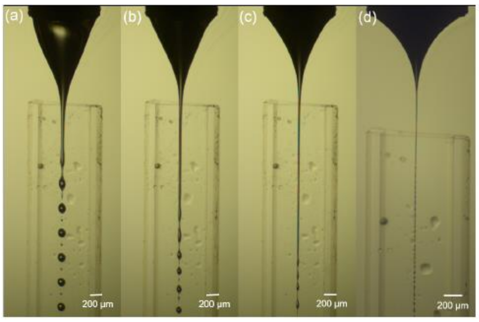
JM Gordillo

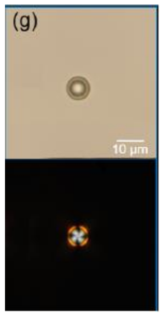
Departamento de Ingeniería Aeroespacial y Mecánica de Fluidos, Universidad de Sevilla, Spain.

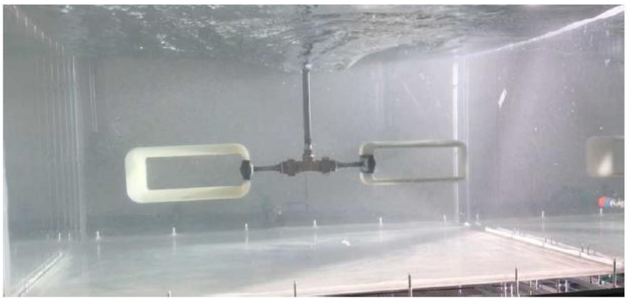
The short presentation will be divided in two parts: first, we present a method to produce liquid crystal shells whose radii and thicknesses can be easily decreased below 10 microns. The technique is based on the generation of a highly stretched thin coaxial jet of two immiscible fluids that flow inside a third bulk co-flowing fluid. The capillary breakup of such coaxial jet produces, in a single step, liquid crystal shells or compound droplets at rates that can be easily modulated to values of the order of 10 KHz. We report here that the production frequency and the inner and outer diameters of the compound droplet follow well defined scaling laws, enabling us to generate

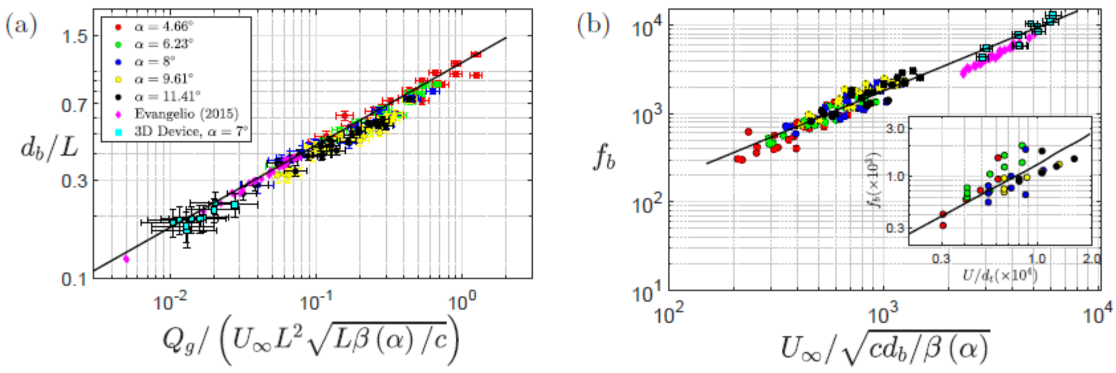
monodisperse double emulsions with the smallest diameters reported up to date, a result which could also find applications in drug delivery.

Secondly, I will report the production of monodisperse microbubbles by taking advantage of the large values of both the pressure gradients and of the local velocities existing at the leading edge of airfoils in relative motion with a liquid. It is shown here that the scaling laws for the bubbling frequencies and the bubble diameters are identical to those found in microfluidics. Therefore, the metre-sized geometry presented here is a feasible candidate to circumvent the inherent problems of using micron-sized geometries in real applications – namely, wettability, the low productivity and the clogging of the microchannels by particles or other impurities.









11) Wall-less fluid transport, pumping and mixing using liquid ‘anti-tubes’

Thomas M. Hermans

University of Strasbourg, CNRS, ISIS UMR 7006, F-67000 Strasbourg, France. hermans@unistra.fr,

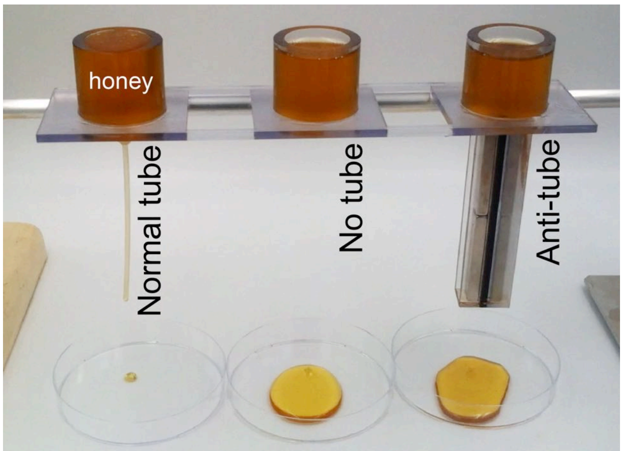
www.hermanslab.com

Fluidic circuits are hampered by solid wall interactions, leading to excessive pressure drop for small channels, solute adhesion, and fouling. We demonstrate a new approach, where wall-less liquid tubes are stabilized by cheap NdFeB magnetic field sources. The flowing liquid is fully enclosed within a surrounding magnetic liquid leading to self-healing, uncloggable, and frictionless microfluidic channels. Common fluidic operations such as valving, mixing, and peristaltic pumping can be achieved by moving permanent magnets without physical contact with the tubes. Applications are foreseen in low shear pumping of delicate biologicals, and low pressure-drop nanofluidics.

o T.M.Hermans, P.Dunne, J.M.D. Coey, B.Doudin, *Device and method for circulating liquids*, **2017**, EP17305070.9

o P.Dunne, T.Adachi, A.Sorrenti, J.M.D.Coey, B.Doudin, T.M.Hermans, *Liquid flow and control without solid walls*, **2018**, https://doi.org/10.26434/chemrxiv.7207001.v1

o Fluids and devices available from https://www.qfluidics.com/



12) Modeling multiphase flow in micromodels: Comparison between 2D and 3D approaches

Luis Cueto-Felgueroso

E.T.S.I. Caminos, Canales y Puertos. Universidad Politécnica de Madrid

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The combination of high-resolution visualization techniques and pore-scale flow modeling is a powerful tool to understand multiphase flow mechanisms in porous media. In the context of a recent benchmark study on pore-scale models for multiphase flow in micromodels, we compare the flow processes and displacement patterns predicted by three different modeling approaches of increasing complexity. The problem under study is the viscously unfavorable fluid–fluid displacement in a microfluidic flow cell patterned with vertical posts. By varying flow rates and wetting conditions, the experimental results explore a rich phase diagram of displacement patterns and processes.

We consider three approaches to simulate this flow problem: a purely 2D phase-field formulation, where flow is assumed to be uniform in the gap; a quasi-3D formulation that partially captures the 3D viscous and capillary coupling between fluids in the cell gap, in the context of a 2D, gap-averaged Darcy formulation; and, finally a fully-3D Cahn-Hilliard-Stokes formulation that is conceived as a high-fidelity flow model for this problem. We discuss the range of applicability of each modeling approach, depending on the capillary number and wetting conditions, and discuss the open challenges in modeling unstable imbibition processes in porous media.

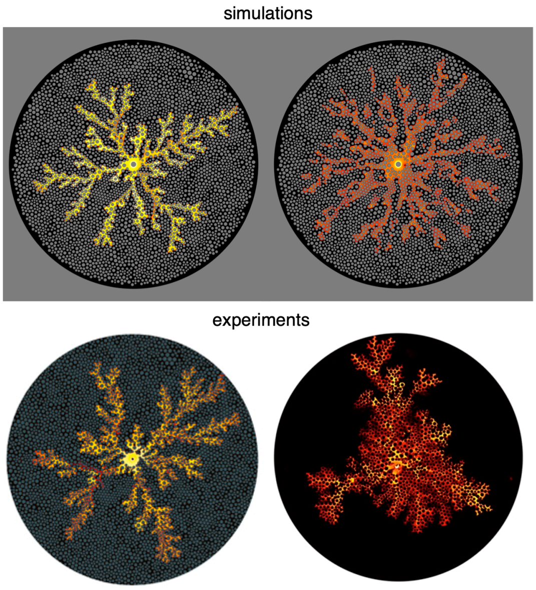

Figure: Simulations and experiments of immiscible displacements in a micromodel.

13) Microfluidics as a Tool for Development "Organ-on-a-chip"

Rosa Monge, PhD. BEONCHIP S.L.

The main problem that researchers face is the lack of concordance between what happens in a laboratory and what actually happens in the clinic. For example, many drugs work in the experimental phase in-vitro in a laboratory, but fail when carrying out the first tests in animals or patients. This is because the stimuli and interactions to which a cell or tissue is subjected are completely different when they are in a plastic disc (as would happen in the laboratory), with respect to when they are in a living being. The possibility of emulating this series of interactions, stimuli and environmental conditions in a microfluidic device is what is called the "biomimetic environment".

In this way, in recent years, efforts were focused on the development of microfluidic devices in which to recreate a biomimetic environment in the most reliable way possible. The ultimate goal is to offer tools capable of testing drugs in an in-vitro laboratory test in conditions closer to those present in-vivo. In this way, both animal tests and costs, both temporary and economic, can be reduced for satisfactory clinical use. This is the "Organ-on-a-chip" technology.

BEOnChip is a microtechnology company born with the intention of offering new tools in the field of cell culture, so that researchers can take their studies one step further.

We will present the solutions that BEONCHIP can offer in the field of Organ-on-a- chip and in microfluidics together with successful examples in different applications like brain, skin or bone models.

14) Dial-a-plume: Localised Photo-Bio-Convection On Demand

Jorge Arrieta[1], Ramón Saleta-Piersanti[1], Marco Polin[2], Idan Tuval[1]

[1] Instituto Mediterráneo de Estudios Avanzados, IMEDEA, UIB-CSIC, Esporles, Spain

[2] Physics Department and Centre for Mechanochemical Cell Biology, University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL, United Kingdom.

Microorganismal motility is often characterised by complex responses to environmental physico- chemical stimuli. Although the biological basis of these responses is often not well understood, their exploitation already promises novel avenues to directly control the motion of living active matter at both the individual and collective level. Here we leverage the phototactic ability of the model microalga *Chlamydomonas reinhardtii* to precisely control the timing and position of localised cell photo-accumulation, leading to the controlled development of isolated bioconvective plumes. This novel form of photo-bio-convection allows a precise, fast and reconfigurable control of the spatio-temporal dynamics of the instability and the ensuing global recirculation, which can be activated and stopped in real time. A simple continuum model accounts for the phototactic response of the suspension and demonstrates how the spatio-temporal dynamics of the illumination field can be used as a simple external switch to produce efficient bio-mixing.

15) Optical capillary-based microfluidic devices for analysis

Luis Fermín Capitán-Vallvey[1] and Alberto J. Palma[2] [1]ECSens, Dept. Analytical Chemistry

[2]ECSens, CITIC-UGR, Dept. Electronics and Computer Technology University of Granada, Granada, Spain.

The development of new outside-the-lab analytical methods and their corresponding technologies to gather in situ and real time chemical information using low-cost, compact devices is one of the most challenging issues facing the analytical sciences.

One type of analytical system that has the potential to provide fast, laboratory-quality results is the lab-on-a-chip device. As an alternative to glass or polymer microfluidic chips, capillary-based analytical devices use paper, thread or cloth as the support. The design of capillary-based devices plays an important role in the performance of the device. It must include a sampling area, an analytical operations area for preconcentration, derivatization, metering, mixing, separation, filtration and the like, and a detection area, with colorimetric and electrochemical measurement techniques being the most common.

The widespread use of imaging devices for the colour measurement of capillary-based devices based on the change, appearance or disappearance of colour or any property measured through a colour change, such as luminescence, has paved the way for the development of innovative, complete analytical systems for outside-the-lab applications.

16) The long crossover of capillary imbibition

Ignacio Pagonabarraga. CECAM (Centre Européen de Calcul Atomique et Moléculaire), EPFL, Lausanne (Suiza)

Capillary imbibition is the spontaneous wetting of a porous material by a liquid. It constitutes one of the paradigmatic examples of capillary dynamics because of its conceptual relevance and wide variety of implications. Although traditionally imbibition has been assumed to be a diffusive growth process that develops after a short transient, it overestimates the wetting speed observed experimentally. I will analyze the relevance that the slow decay of

the hydrodynamic resistance offered by the wetting front and the kinetic energy of the liquid, which

persists long after the liquid's initial acceleration, has on the slowly-slowing-down dynamics of the liquid front.

17) Self-powered Disposable Microfluidics by the Integration of Modular Micropumps with Multilayer-plastic Microfluidic Cartridges

Yara Álvarez Braña. School of Pharmacy. University of the Basque Country

The development of lab-on-a-chip devices able to perform rapid analysis of liquid samples has witnessed a significant revolution during the last decades thanks to the improvement of the manufacture techniques and the implementation of autonomous pumping components for the generation and control of flow inside the microfluidic channels. A universal microsystem architecture for point-of-care analysis should be autonomous and cost effective, allowing for the integration of sensing capabilities and providing controlled flow conditions, which enable short-time analysis. Therefore, the combination of modular polymeric micropumps with multilayer plastic microfluidic cartridges appears as a highly versatile and universal strategy for the development of self-powered microfluidic devices. This was demonstrated by the development of autonomous microfluidic devices, which are designed for a number of commonly used microfluidic operations, using 2D and 3D microfluidic networks such as mixing, aliquoting and sequential flow. Finally, we also evaluated the performance of these modular devices, as a proof of principle, for the autonomous extraction of plasma, as a sample preparation protocol, which is a necessary method needed prior analyte detection from blood.

18*) How to transform a Microfluidics technology in a company?

Oliver Balcells, CEO & Co-Founder

Rheodx

Rheo Diagnostics is developing a medical device for hematological diseases. We will explain the main challenges to build a company based in a disruptive technology and how to get funding.