MarchCOMeeting'15

Complex matter physics:

Active materials, dynamics and patterns

Havana, Cuba, June 24 - 26, 2015

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Complex Matter Physics: it's activity what matters

Why MarchCOMeeting, *June edition*, for God's sake?

Why MarchCOMeeting, June edition, for God's sake?

Well, it's very simple. Our (quite successful) previous meeting, celebrated in March, 2012 was nicknamed MarchCOMeeting '12. We really love this provocative name, and would never dare to change it, even though we are celebrating its second edition on June, 2015. The date has to do with the fact that we were able to connect our meeting with the International Conference "Materials Science in the Age of Sustainability" (Havana, June 29th – July 1st 2015), that functions as an "organizational umbrella" to our little workshop. Needless to say, our participants are encouraged to attend.

MarchCOMeeting '15 is focused on Active Matter: "intelligent particles", nano- and micro-particles, bacteria, ants, sheep, grains of different kinds… but with ample spirit to include subjects related to Soft or Complex Matter or Systems in general–-one of the keys of the success of our previous edition. In any case, as expected in a country where high temperatures are common, thermal activation has already blurred our original aim a bit, and research from fields that are not directly classified as "textbook" Active Matter are finding out their way into our Workshop. We are sure that enthusiasm and true scientific spirit will erase any bumps in the road: after all, it's activity that matters.

This is a meeting with very little financial support. In fact, it is largely being celebrated thanks to the participants, who have been brave enough to challenge the Cuban summer and the mysteries of hotel booking webpages to share science with the small, but *active*, Cuban scientific community. This will surely benefit the youngest generation of Cuban scientists, especially the graduate and undergraduate students that will participate in the meeting.

So welcome to our little workshop in this rapidly evolving land of sticky hot weather, unintelligible architecture and resilient people: see it for yourself, and enjoy taking part in all the activity.

Ernesto Altshuler
Jon Otto Fossum

Proceedings from the Workshop

The organizers will publish proceedings from the contributions, talks and posters, presented in this workshop. We therefore ask presenters to submit within one month after the end of the workshop an extended abstract, 2-4 pages (maximum 4 pages), including authors, affiliations, contact email, text, figures and references. The extended abstracts will be included in a book that will be published in print, in a limited number, and also online, with the following title:

"Proceedings from the MarchCOMeeting'15: Complex Matter Physics: Active Matter, dynamics and patterns, Havana, Cuba, June 24-26, 2015, eds. Jon Otto Fossum and Ernesto Altshuler."

The proceedings will receive an official ISBN number and your extended abstract can be referred to as a publication.

We will ask some of the workshop participants to act as referees for the extended abstracts.

After printing, each workshop participant and the library at their institutions will receive a hardcopy of the proceedings. Copies will also be sent to our sponsors and other institutions.

Deadline for submission of extended abstracts to the editors is set to Oct 31, 2015.

March*COM*eeting'12:

The Organizing Committee

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Carlos González-Raña
Department of General Physics, Physics Faculty, University of Havana, Cuba

GENERAL PROGRAM

Time	Wednesday 24 (The active day)		Thursday 25 (The biological day)		Friday 26 (The granular day)		Time
	Chair	**Speaker**	**Chair**	**Speaker**	**Chair**	**Speaker**	
9:00 – 9:30	2nd moment registration		Walking tour by the University of Havana, (& Group snapshot) Guide: R. O. Caballero		A. J. Batista-Leyva	R. Cruz	9:00 – 9:30
9:30-10:00	Establishing the power laws J. O. Fossum/ E. Altshuler					F. Pacheco	9:30-10:00
10:00 – 10:30	E. Altshuler	M. Turner				O. Sotolongo	10:00 – 10:30
10:30 – 11:00		**Coffee fracture**					10:30 – 11:00
11:00 – 11:30		D. Maza	O. Sotolongo	S. Douady	A.J. Batista-Leyva	O. Ramos	11:00 – 11:30
11:30 – 11:45		A.Reyes		A. J. M. Cornelissen		Lherminier	11:30 – 11:45
11:45 – 12:00		F.Tejera				H. Torres	11:45 – 12:00
12:00 – 12:15		E. Moreno		Aug.González		L. Alonso	12:00 – 12:15
12:15 – 12:30						Al.González	12:15 – 12:30
12:30 – 14:30	**Avalunch**						12:30 – 14:30
14:30 – 15:00	O. Ramos	E. Luijten	A. Rivera	R. Cao Jr.	J.O. Fossum	Poster session including fluid instabilities	14:30 – 15:00
15:00 – 15:15		R. O. Caballero		J. Alvarez S.			15:00 – 1515
15:15 – 15:30							15:15 – 15:30
15:30 – 16:00		**Coffee fracture**					15:30 – 16:00
16:00 – 16:30		D. Bonn	E. Altshuler	R. Cao			16:00 – 16:30
16:30 – 16:45		J. O. Fossum		R. Mulet			16:30 – 16:45
16:45 – 17:00							16:45 – 17:00
17:00 – 17:15		A.Mikkelsen		*THINK VIBROTS*	J. O. Fossum	T. Pöschel	17:00 – 17:15
17:15 – 17:30		E. C. Santos					17:15 – 17:30
17:30 – 17:45		L. Valdés		Introduction/ Ch. Scholz/ Undergrads/ Discussion		D. van der Meer	17:30 – 17:45
17:45 – 18:00	Group Snapshot						17:45 – 18:00
18:00 – 18:30						Best poster award & power law cutoff	18:00 – 18:30
18:30 – 19:30							18:30 –19:30
19:30 – 21:30	E. Altshuler	*Welcome dinner*	E. Altshuler	*"Shot noise" ceremony (if rain allows it)*	E. Altshuler /J.O. Fossum	*Rhum table (& finger food) with fluctuations*	19:30 – 21:30
Drinkscussion sessions ↓							
21.30 -	J.O. Fossum	Patchy self-assembled random walk for drops behind bars	J.O. Fossum	Self-assembly applied to edible soft and complex matter	J.O. Fossum	Cooperative phenomena matter: Examples	21.30 -

DETAILED PROGRAM

Wednesday 24 (The active day)				
Time	**Place**	**Chair**	**Speaker**	**Title**
9:00 – 9:30	Hotel Nacional	2nd moment registration		
9:30-10:00		Establishing the power laws J. O. Fossum/E. Altshuler		
10:00 – 10:30		E. Altshuler	M. Turner	Connecting the physics of swarming animals and active matter
10:30 – 11:00			**Coffee fracture**	
11:00 – 11:30			D. Maza	About the definition of "clogging transition" in bottlenecks
11:30 – 11:45			A.Reyes	Uninformed sacrifice: ants do not act collectively against danger
11:45 – 12:00			F.Tejera	Transmission of danger information in ants
12:00 – 12:15			E. Moreno	Directed molecular evolution to create a new anti-tumor antibody
12:15 – 12:30				
12:30 – 14:30		**Avalunch**		
14:30 – 15:00	Hotel Nacional	O. Ramos	E. Luijten	Dynamic collective behavior and phase separation of active colloids
15:00 – 15:15			R. O. Caballero	Living on the edge: transfer and traffic of *E.coli* in confined environments
15:15 – 15:30				
15:30 – 16:00			**Coffee fracture**	
16:00 – 16:30			D. Bonn	In vitro measurements of proton transport and directed vesicle motion in cell-like environments
16:30 – 17:00			J.O. Fossum	Active structuring of colloidal particles on drops by electric fields including electroformation of Janus and patchy colloidal shells
17:00 – 17:15			A.Mikkelsen	Mechanics and rheology of Pickering films
17:15 – 17:30			E. C. Santos	Hydration, cation-exchange process and storage ability of clays particles
17:30 – 17:45			L. Valdés	Ciprofloxacin intercalation into a synthetic clay (NaFh)

Thursday 25 (The biological day)				
Time	**Place**	**Chair**	**Speaker**	**Title**
9:00 –10:30	University of Havana (Salón 250, Inside "Varona" building))	Walking tour by the University of Havana & group snapshot		
10:30 – 11:00		**Coffee fracture**		
11:00 – 11:30		O. Sotolongo	S. Douady	Adaptation of reticular networks
11:30 – 12:00			A.J.M. Cornelissen	Gastrovascular morphogenesis in the jellyfish *Aurelia Aurita*
12:00 – 12:30			Aug. González	The role of fluctuations in carcinogenesis
12:30 – 14:30		**Avalunch**		
14:30 – 15:00	University of Havana (Salón 250, inside "Varona" building)	A. Rivera	R. Cao, Jr	Gold Nanostars as a platform to develop Doxorubicin photodelivery systems
15:00 – 15:30			J. Álvarez	Prepulse-dependent facilitation of Ca^{2+} current in rat ventricular cardiomyocytes has a strong voltage-dependent component
15:30 – 16:00		**Coffee fracture**		
16:00 – 16:30		E. Altshuler	R. Cao	Driving forces and perturbations in the formation of self-assembled monolayers on gold surfaces
16:30 – 17:00			R. Mulet	Statistical mechanics of metabolic networks
17:00 – 18:30			THINK VIBROTS	Introduction to vibrots (Altshuler) Mechanics of a single Vibrot (Pérez-Adán, Freixas, & Torres) Dancing to the vibes: Interaction of actively rotating granular particles (Ch. Scholz)

Friday 26 (The granular day)				
Time	**Place**	**Chair**	**Speaker**	**Title**
9:00 – 9:30	University of Havana (Salón 250, Inside "Varona" building)	A.J.Batista-Leyva	R. Cruz	Cooling kinetics of granular shapes and mixtures
9:30-10:00			F. Pacheco	The collapse of a pressurized gas cavity inside a sand bed
10:00 – 10:30			O. Sotolongo	Shale gas, fracking and earthquake triggering
10:30 – 11:00		**Coffee fracture**		
11:00 – 11:30		A.J.Batista-Leyva	O. Ramos	Mimicking earthquakes with a granular experiment
11:30 – 11:45			Lherminier	Acoustic revealing of granular internal structure
11:45 - 12:00			H. Torres	Confinement controls intruder penetration into granular matter
12:00 – 12:15			L. Alonso	Lock-in accelerometry to follow sink dynamics in shaken granular matter
12:15 –12:30			Alb. González	A simple analytical model for the exponential velocity profile of granular flows down a heap
12:30 – 14:30		**Avalunch**		
14:30 – 15:00	University of Havana (Corridors, "Varona" building)	J.O. Fossum	Poster session including fluid fractures	
15:00 – 15:30				
15:30 – 16:00				
16:00 – 16:30				
16:30 – 17:00				
17:00 – 17:30	University of Havana (Aula Magna)		T. Pöschel	Dissipation of Energy in Granular Matter in the Absence of Gravity
17:30 – 18:00			D. van der Meer	A granular ratchet: Spontaneous symmetry breaking and fluctuation theorems in a granular gas
18:00 – 18:30			Best poster award ceremony followed by power law cutoff	

Poster presenters (19):

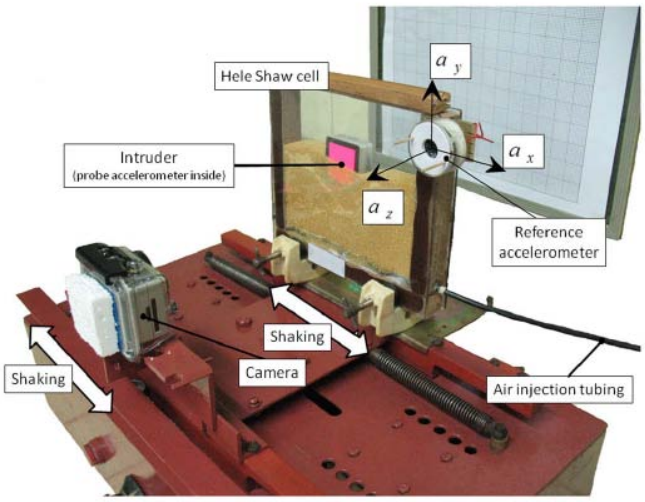
L. Alonso & G. Sánchez-Colina (Physics Faculty, University of Havana, Cuba): *"Lock-in" accelerometry to follow sink dynamics in dry granular matter*
A. Borroto & A. García-Gordillo (Physics Faculty, University of Havana, Cuba): *In-plane transport anisotropy in BSCCO-Ag multi-filamentary tapes*
R. O. Caballero (Physics Faculty, University of Havana, Cuba) *Living on the edge: transfer and traffic of E. coli in a confined flow*
K. García (CIM, Cuba) *How Regulatory T cells impinge on Tumor Immunobiology?*
D. Hernández-Enríquez (Benemérita Universidad Autónoma de Puebla, México) *Repulsive granular systems: hourglass and granular gas*
S. Lherminier (ILM, Université Lyon 1, France) *Acoustic revealing of granular internal structure*
Asor M. Martínez (CIPIM, La Habana, Cuba) **Rigid clay Palygorskite as slow release system for antibiotics**
A.Lam (IMRE, University of Havana, Cuba) *Benzalkonium chloride micelles formation and its interaction with drugs: Dissipative Particle Dynamics simulation*
D. León (ICIMAF, Cuba) *Radiation, errors in DNA replication, and cancer*
Sheyla Montero & R. Martín (Chemistry Faculty, University of Havana, Cuba): *Cancer glycolysis: entropy production rate and sensitivity analysis in the stationary state*
L. F. Ponce (Centro de inmunologia Molecular, La Habana, Cuba) *Common gamma chain: relevant for the IL2-IL2R affinity? A mathematical approach*
O. Ramos (ILM, Université Lyon 1, France) *Non-trivial accelerations in subcritical crack growth*
G. M. Rodríguez-Liñán (Instituto de Física, Universidad Autónoma de San Luis de Potosí, México) *Long-range effective potential between two rods in a 2D granular fluid*
E. C. Santos (NTNU, Norway) *Intercalation of Ciprofloxacin into Lithium-Fluorohectorite at different PHs*
Christian Scholz, Thorsten Pöschel (Institute for Multiscale Simulation, Friedrich-Alexander Universität Erlangen-Nürnberg, Germany) *Dancing to the vibes: Interaction of actively rotating granular particles*
F. Tejera & A. Reyes (Physics Faculty, University of Havana, Cuba): *Quantitative experiments in disturbed ants*
H. Torres (Physics Faculty, University of Havana, Cuba): *Extraterrestial sink dynamics in granular matter*
L. A. Torres-Cisneros (Instituto de Física, Universidad Autónoma de San Luis de Potosí, México) *Stick-Slip motion of granular dense flows detected trough experiments and numerical simulations*
L. Valdés (IFAL, University of Havana, Cuba): *Interaction between a synthetic clay (LiFh) and NSAIDs drugs*

TALKS

Lock-in accelerometry to follow sink dynamics in shaken granular matter (15 min)

L. Alonso
"Henri Poincarè" Group of Complex Systems, University of Havana, La Habana, Cuba. (lalonso@estudiantes.fisica.uh.cu)

In collaboration with: G. Sánchez-Colina[1], E. Martínez[1], A. J. Batista-Leyva[2], C. Clement[3], C. Fliedner[3], R. Toussaint[3] and E. Altshuler[1]
[1]"Henri Poincarè" Group of Complex Systems, University of Havana, La Habana, Cuba.
[2]Instec, Cuba
[3]IPGS, Strasbourg, France



The set up. A Hele-Shaw cell and a camera are synchronously shaken in the lateral direction. Accelerometers attached to the Hele-Shaw cell and the intruder bring the key information to quantify the sink dynamics.

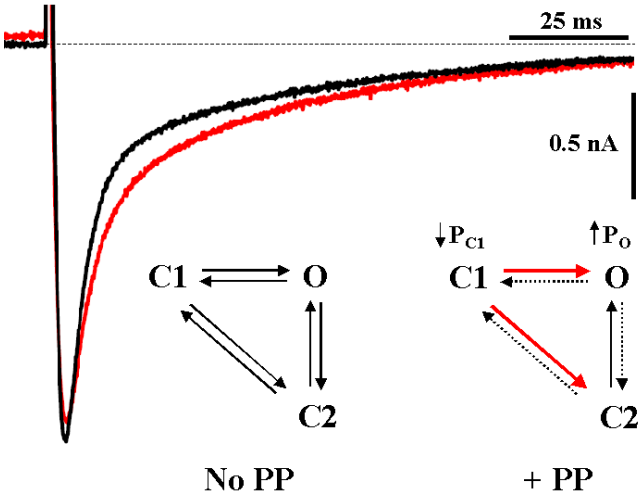
Understanding the penetration dynamics of intruders in granular beds is relevant not only for fundamental physics, but also for geophysical processes and construction on sediments or granular soils in areas potentially affected by earthquakes. While the penetration of intruders in two dimensional (2D) laboratory granular beds can be followed using video recording, this is useless in three dimensional (3D) beds of non-transparent materials such as common sand. Here, we propose a method to quantify the sink dynamics of an intruder into laterally shaken granular beds based on the temporal correlations between the signals from a *reference* accelerometer fixed to the shaken granular bed, and a *probe* accelerometer deployed inside the intruder. Due to its analogy with the working principle of a lock-in amplifier, we call this technique lock-in accelerometry.

Prepulse-dependent facilitation of Ca^{2+} current in rat ventricular cardiomyocytes has a strong voltage-dependent component (30 min)

Julio L. Alvarez
Laboratory of Electrophysiology. Institute of Cardiology and Cardiovascular Surgery. Havana, Cuba. (alvarezj@infomed.sld.cu)

In collaboration with: J. Alvarez-Collazo[a], M. Sampedro-Castañeda[a], L. Galán Martínez[a], A.I. López-Medina[a], G. Vassort[a], J. L. Alvarez [a]
a Laboratory of Electrophysiology. Institute of Cardiology and Cardiovascular Surgery. Havana, Cuba.

Cardiac L-type Ca^{2+} current (I_{CaL}) plays a key role in excitation and excitation-contraction coupling in heart. The decay of I_{CaL} during depolarization (inactivation) depends on both Ca^{2+} (calcium-dependent inactivation, CDI) and voltage (voltage-dependent inactivation, VDI). Fast (τ_{fast}) and slow (τ_{slow}) time constants of I_{CaL} inactivation have been arbitrarily assigned to CDI and VDI, respectively. "Facilitation" of I_{CaL} by high stimulation rates or by depolarizing prepulses (PP) is characterized by an increase in τ_{fast}. To explain this phenomenon, a decreased CDI, due to a lower Ca^{2+} load of the sarcoplasmic reticulum (SR), has been proposed. However, there is no convincing evidence that low PP (not activating I_{CaL}) evoke a release of Ca^{2+} from the SR that could explain a decreased SR load. VDI of I_{CaL} has not been considered to explain facilitation. Here we studied in more detail the mechanism of I_{CaL} facilitation by low PP using isolated rat ventricular cardiomyocytes. Increases in τ_{fast} at a test pulse to 0 mV by PP (not activating I_{CaL}) were associated with hyperpolarizing shifts in I_{CaL} kinetics. Several experimental conditions aimed to decrease CDI did not abolish the increase in τ_{fast} by PP. Our results suggest that this kind of I_{CaL} facilitation is also associated to a strong VDI mechanism. A model is proposed in which depolarizing PP allow the Ca^{2+} channel to dwell longer times in the open state.



I_{CaL} recorded with a test pulse at 0 mV without (black) and with prepulse (red). In the simplified Markovian model dashed and red arrows indicate decreased and increased rate constants, respectively. P_{C1} and P_O are the steady-state probabilities of these states.

In vitro measurements of proton transport and directed vesicle motion in cell-like environments (30 min)

Daniel Bonn
Institute of Physics, University of Amsterdam, The Netherlands
(d.bonn@uva.nl)

Proton transport and directed vesicle motion are two key processes in living cells. However these are usually difficult to measure or observe in vivo, due to the crowded environment in any cell. Macromolecular crowding alters the properties of molecules in a solution when high concentrations of macromolecules such as proteins are present. Such conditions occur routinely in living cells; for instance, the cytosol of Escherichia coli contains about 300–400 mg/mL of macromolecules. I will show how microfluidics can be used to meaure proton mobility in such an environment, and show that the crowding can lead to a decrease of the proton mobility of two orders of magnitude. I will also show that microfluidics can be used to study directed vesicle motion, and the naifold of processes that can lead to such transport.

Living on the edge: transfer and traffic of *E.coli* in confined environments (15 min)

R. O. Caballero
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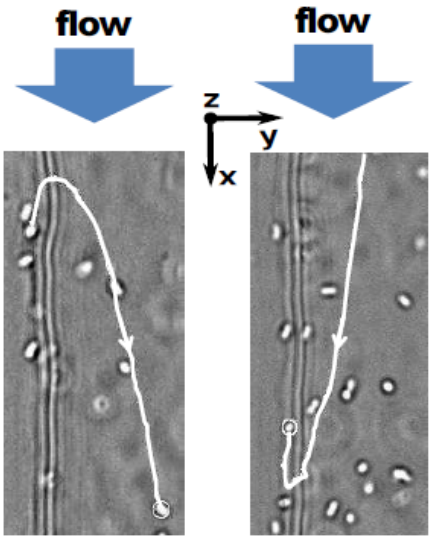
In collaboration with: N. Figueroa-Morales[1], G Miño[3], A. Rivera[4], A. Lindner[1], E. Clément[1] and E. Altshuler[1]

[2] PMMH-ESPCI, France
[2] MIT, USA
[3] Zeolites Engineering Lab, IMRE, University of Havana, Cuba
[4]"Henri Poincarè" Group of Complex Systems, University of Havana, La Habana, Cuba.

We study quantitatively the transport of *E. coli* near the walls of confined microfluidic channels, and in more detail along the edges formed by the interception of two perpendicular walls. Our experiments establish the connection between bacterial motion at the surface and at the edges, as well as the robustness of upstream motion at the edges. *E. coli* are able to migrate upstream along the edges up to very large shear rates compared to the flat surfaces. Their speed at the edges mainly results from collisions between bacteria moving along this single line. We show that upstream motion is possible not only at the edge but takes place in an "edge boundary layer" whos size varies with applied flow rate. We quantify the bacteria fluxes along the bottom walls and edges and show that they result from both the transport velocity of bacteria and the decrease of surface concentration due to erosion with flow rate. We rationalize our findings as a function of the local variations of the shear rate in the rectangular channels and hydrodynamic attractive forces between bacteria and walls.



Attachment and detachment of bacteria to an edge. The snapshots show a microfluidic cell of rectangular crossection seeing from below. Left: a bacterium moving upstream along the edge is detached and incorporates to the "bulk" of the flow. Right: a bacterium being dragged by the "bulk" flow attached to the edge and starts to swim upstream.

Driving forces and perturbations in the formation of self-assembled monolayers on gold surfaces (30 min)

R. Cao
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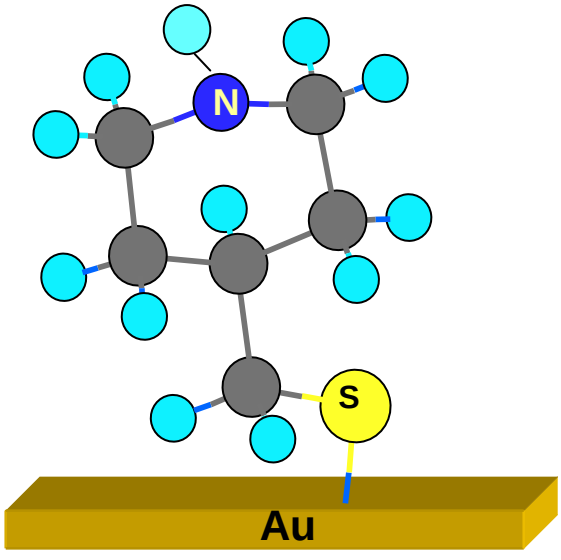
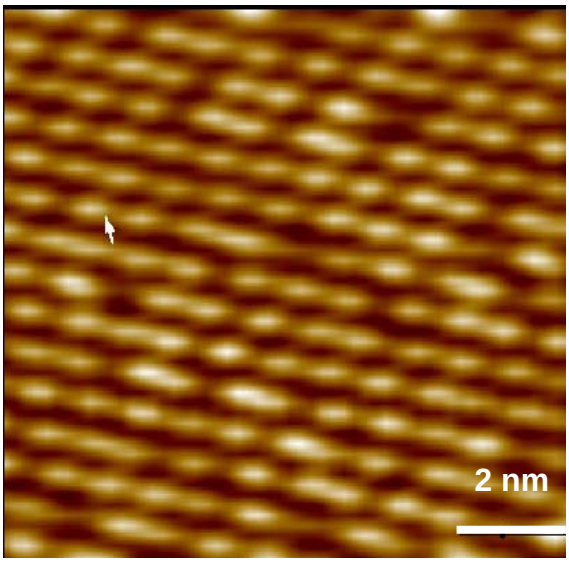
Self-assembled monolayers (SAMs) can be formed on the surfaces of different types of materials through chemical interactions (chemisorption) in order to modify the properties of the capped material. In the specific case of nanoparticles, the formed SAM also protects them from aggregation.

Different parameters act as driving forces in the formation of SAMs, mainly: chemical affinity and molecular interactions. These factors will be analyzed for the cases in which small molecules and large biomolecules are used as capping agents. A comparison between the supramolecular and covalent immobilization of biomolecules will also be analyzed.

Different factor can affect the formation and stability of SAMs, such as pH, electrostatic repulsions and long chain lengths of the self-assembled biomolecules, especially when one SAM is formed over another to form multilayers. A way to reduce these perturbations is using the layer-by-layer method (LbL), which also will be analyzed.

The analysis of the different driving forces and perturbations in the formation of SAMs will be presented using results of the author on flat surfaces, electrodes and nanoparticles of gold.





AFM

These examples will mainly include AFM images and electrochemical determinations.

R. Villalonga, R. Cao, A. Fragoso, *Chem. Rev*. **2007**, *107*, 3088-3116.
R. Cao, Jr., A. Díaz, R. Cao, A. Otero, R. Cea, M. C. Rodríguez-Argüelles, C. Serra, *J. Am. Chem. Soc.* **2007**, *129*, 6927-6930.
R. Cao, Jr., A. M. Díaz-García, R. Cao, *Coord. Chem. Rev*. **2009**, *253*, 1262-1275.
D. G. Abradelo, R. Cao, S. Schlecht, *RSC Adv.* **2013**, *3* (44), 21461 – 21465.

Gold Nanostars as a platform to develop Doxorubicin photodelivery systems

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In collaboration with: A. Hernández-Montoto[1], R. Amaro[1], R. Cao[1].

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Gold nanoparticles present an excellent combination of properties like chemical inertness, surface chemistry and optoelectronic properties dependent of the size and shape, that makes them ideal for biomedical applications like development of drug photodelivery systems. In this sense it is important to develop drug photodelivery systems that interact with radiations from the Near Infrared zone of the electromagnetic spectrum (650-900 nm). One of the gold nanoparticles that interact with that region of the spectrum are the gold nanostars (AuNSt).
In the present work AuNSt were used to develop doxorubicin photodelivery systems that activate the delivery by two mechanism of action: 1- by taking advance of the light-to-heat transduction properties of gold nanoparticles or 2- by the uses of upconversion properties of gold nanoparticles combined with organic photocleavageable ligands.
For the first system AuNSt were modified with cyclodextrin polymers were used to load Doxorubicin via host-guest interaction. In order to improve the drug loading capacity cyclodextrin polymers were derivatized with groups with negative charges (carboxilates or sulfates). The obtained structures were observed to charge 36% wt of doxorubicin and a discharge capacity of 8% at the low power density of 100 mW.
The second system was prepared by the modification of the gold nanostars with a doxorubicin derivative that contains a nitrobencene photocleavageable molecule as linker. Such system was observed that during the irradiation with a 808 nm laser beam of 50 mW releases doxorubicin by the disruption of the photocleavable linker.

Gastrovascular morphogenesis in the jellyfish *Aurelia Aurita* (30 min)

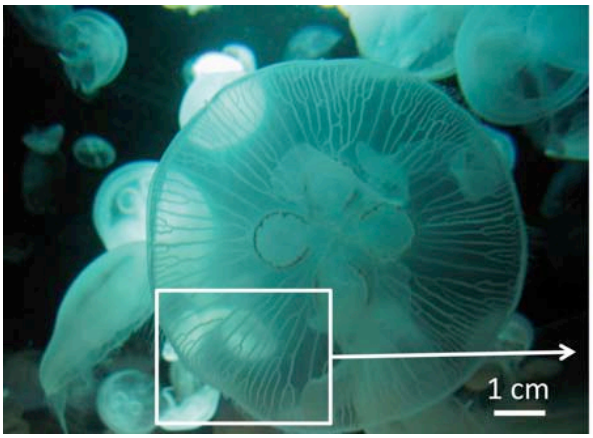
Annemiek JM Cornelissen
Laboratoire Matières et Systèmes Complexes, UMR 7057, CNRS &UniversitéParis-Diderot, Paris, France. (annemiek.cornelissen@univ-paris-diderot.fr)

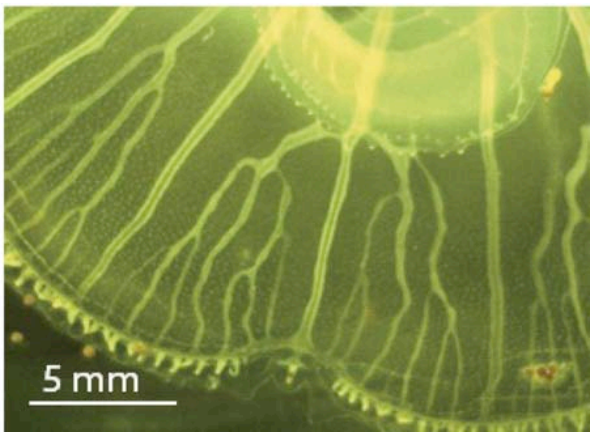
In collaboration with: C. Gambini[1], S. Song[1], B. Mauroy[2], P. Dantan[1], A. Peaucelle[1], G. Balavoine[3]

[1]Laboratoire Matières et Systèmes Complexes, UMR 7057, CNRS &Université Paris-Diderot, Paris, France.
[2]Laboratory J.A. Dieudonné, Nice Sophia-Antipolis
[3]Group for Evolution and development of metazoans at the Jacques-MonodInstitute, CNRS & Université Paris Diderot

Morphogenesis of living systems is controlled by a complex of processes in which also mechanical forces plays a role. Mechanical forces can contribute either on a cellular scale by impacting on the signaling pathways, or on a tissue scale affecting the cell movements and deformations (compression, extension, intercalation,and rearrangement etc).

*Aurelia Aurita*has a relatively simple branched gastrovascular pattern. We aim to understand how mechanical self-organized processes are involved in the morphogenesis of this typical vascular structure.The canals grow in a monolayer membrane of cells, the endoderm. We observed that as soon as the jellyfish has obtained its circular shape, canals sprout off from the ring canal and grow at the tip by accumulation and stacking of endodermal cells followed by differentiation of the endodermal cells into canal cells. We hypothesized that these processes are induced by compressive constraints in the endoderm generated during each muscle contraction of the jellyfish. In analogy with crack propagation the vessels grow to relax the highest compressive stresses.The boundary conditions, the already existing vessels define the compressive stress field generated in the endoderm. With this algorithm wecan explain the typical vascular patterns seen in *Aurelia*. We have challenged these hypotheses with experimental and numerical studies and during my presentation I will show you the results.





Adaptation of reticular networks (30 min)

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In collaboration with: P. J. Lopez[1], J. Derr[2], J. M. Cornelissen[2], C. Lagesse[2], C. Bouchon[3]

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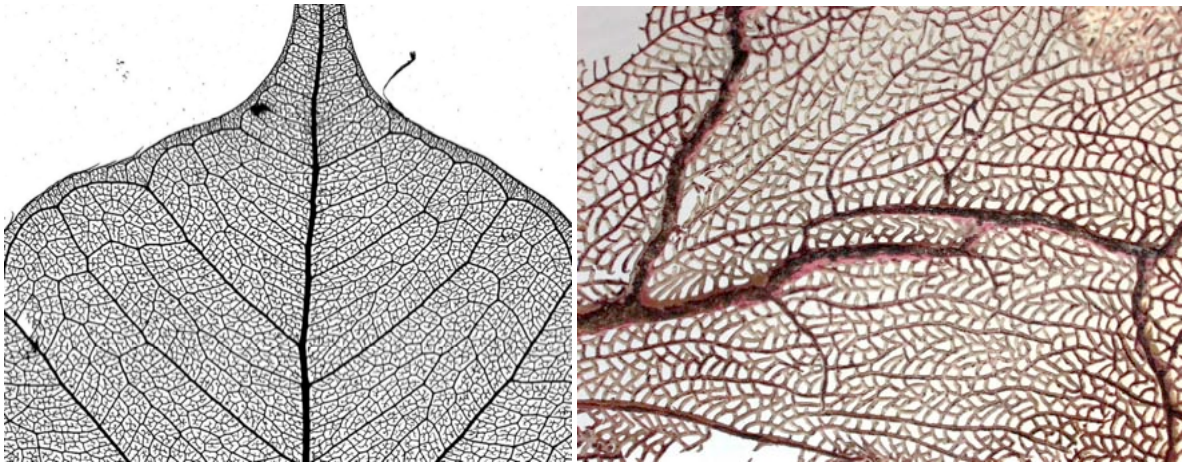
Complex networks are very common in Nature, and can be distinguished between 2 class, the tree-branched ones, with only separating branches, like trees, rivers, DLA, …, and the reticular ones, forming many loops, like leaf veins, city streets, gorgons, … On the first ones, fractal measurements were made, and on the later ones more sophisticated measurements derived from network theory, such as betweeness or small world properties. However, their planar geometry leads to disappointing results, and few measurements are done taking into accounts precisely the particularities of their planar geometry.

Taking the example of Cities and previous works, we reintroduce the notion of "streets", meaning elements that can group many small-scale elements, the segment between one crossing and the next, to form Multi-scale elements. These elements have many properties, leading to border stable results, and are able to reveal the structure and functioning of the pattern.

It is then interesting to look at the history of formation and growth of the pattern and correlate it with the measurements. In this process the growth of the gorgons (sea-fans), common in the Caribbean's, are very special as their patterns do no show the usual stable hierarchy. They also show a mechanical reinforcement, to resist the waves, that seems simply adapted to the local deformation and which does not follow the historical hierarchy, contrary to the other patterns. The efficiency of these two strategies should be compared.



Veins of a *Ficus religiosa* leaf (from BoddhGaya), skeleton of a *Gorgonia flabellum* (from la Habana)

Active structuring of colloidal particles on drops by electric fields including electroformation of Janus and patchy colloidal shells (30 min)

Jon Otto Fossum
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In collaboration with: Paul Dommersnes
NTNU, Norway

We show through very simple experiments, that electro-hydrodynamic and electro-rheological effects in leaky-dielectric liquid drops can be used to structure and dynamically control colloidal particle assemblies at drop surfaces, including electric-field-assisted convective assembly of jammed colloidal "ribbons" and electro-rheological colloidal chains confined to a two-dimensional surface. Our development and understanding of such phenomena enable creation of a "pupil-like" structure that can be actively controlled, i.e. a colloidal shell that extracts and contracts as electric field strength is changed. The observed phenomena also serve as a basis for fabrication of different jammed colloidal shells, including Janus and patchy shells. The studies were published in [1], and in [2]. In addition, several extensions of those works that are presently in progress will be mentioned.

[1] *Active structuring of colloidal armour on liquid drops*, P. Dommersnes, Z. Rozynek, A. Mikkelsen, R. Castberg, K. Kjerstad, K. Hersvik and J.O. Fossum, NATURE COMMUNICATIONS 4:2066, DOI: 10.1038/ncomms3066 (2013)

[2] *Electroformation of Janus and patchy capsules*, Z. Rozynek, A. Mikkelsen, P.Dommersnes and J.O. Fossum, NATURE COMMUNICATIONS 5:3945, DOI: 10.1038/ncomms4945 (2014)

The role of fluctuations in carcinogenesis (30 min)

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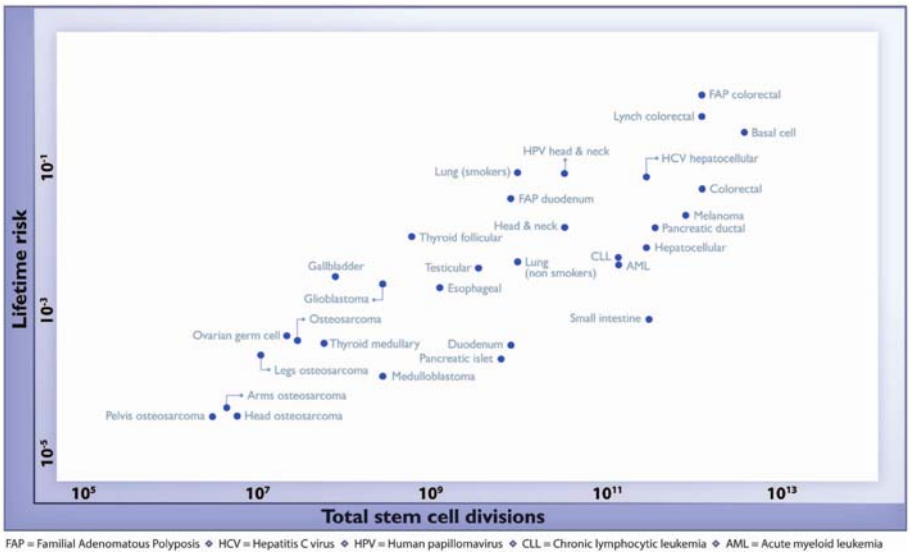
I discuss recent results by Tomasetti and Vogelstein (Science, 2 JANUARY 2015, VOL 347, ISSUE 6217, page 78) on the role of errors in the DNA replication process in the genesis of cancer. I show that their results are consistent with a Cauchy (Lorentzian) distribution of fluctuations, and discuss possibilities for the physical origin of such a distribution.



Lifetime risk for cancer in a tissue vs the number of stem cell divisions in that tissue (from the Tomasetti and Vogelstein, 2015)

A simple analytical model for the exponential velocity profile of granular flows down a heap (15 min)

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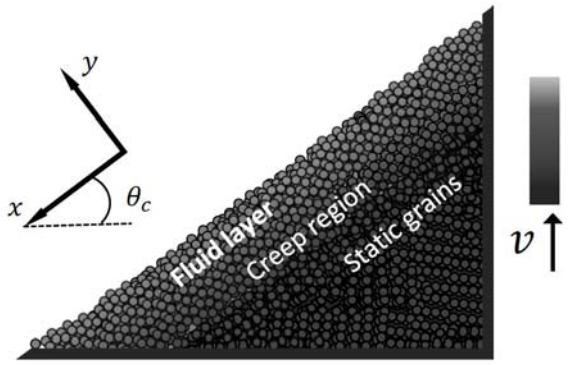
In collaboration with: E. Martínez-Román[1], Alfo José Batista-Leyva[2], and Ernesto Altshuler[1]

[1] "Henri Poincarè" Group of Complex Systems, University of Havana, La Habana, Cuba.
[2] Instec, Cuba



Landslides, mudflows, debris, avalanches, pyroclastic flows, flows of grains through funnel, hopper, silos, chutes or vertical channels…those are some of the most extended kinds of granular flows that we can observe or produce in our everyday sight. In spite of this, many processes still require further understanding, like the appearance of complicated patterns, fluctuations in magnitudes such as pressure or velocity, presence of in-homogeneities and the role of the wall stresses in confined flows; neither has a general theoretical framework for granular rheology been achieved.

In relation to cramped flows, research has focused on a slow displacement of grains below a rapidly flowing surface layer, in steady state, which is established, for example, in a Hele-Shaw cell. This slow flowing region was commonly considered to be composed by static grains, but it actually exhibits an exponential velocity profile that contrasts with the very well-studied linear profile at the upper fluid region. Additionally, this region, named as *creeping flow*, is important in geophysical processes and mechanisms of segregation, diffusion and mechanical response of materials.

Nonetheless, the description of the creeping flow has been mainly conducted on experimental or numerical research. We present here a simple and analytical model where we obtain the exponential velocity profile in a creeping region established in a heap. The essential aspect of this characterization lies on considering the influence of the walls, in accordance with what has been extensively reporte. Specifically, we take into account the Janssen effect and determine the other forces that act in the granular components of the creep region in the heap.

Cooling kinetics of granular shapes and mixtures (30 min)

R.C. Hidalgo
"Grupo de Medios Granulares", Universidad de Navarra,
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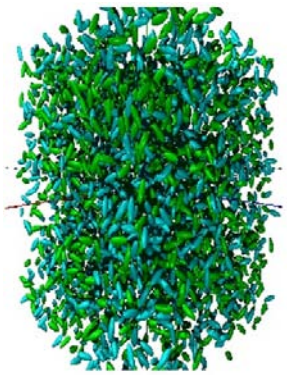
We have numerically studied the cooling kinetics of granular shapes and mixtures. In my talk, I will introduce a hybrid GPU-CPU implementation of an accurate Discrete Element Model (DEM) of system of ellipsoids, rods and mixtures of rods and spheres.

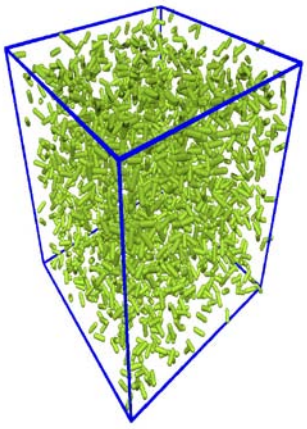
For the ellipsoids we combine the exact mathematics derivation of contact points between ellipsoids with the advantages of the GPU-NVIDIA parallelization strategy. This novelty makes the analytical algorithm computationally feasible when dealing with several thousands of particles. Additionally, we have implemented the specific kernels to describe the analytic contact between three-dimensional spherocylinders.

As benchmarks, we have simulated granular gasses of frictionless particles (homogenous systems composed by rods and ellipsoids). In all cases, we have identified a homogeneous cooling state (HCS), where the time dependence of the system's intensive variables occurs only through a global granular temperature. Our outcomes complied with the statistical mechanical laws and the results were in agreement with previous results. Hence, we have found a uniform cooling process, which was in excellent agreement with Haff's law, when using an adequate rescaling time τ. Our results suggested that the relevant time scale of the cooling process can be derived from particle elongation ξ and the restitution coefficient.

Taking in advantages of our implementation, we have also explored the cooling kinetics of mixtures composed by rods and spheres. Moreover, we have analytically derivative the cooling kinetics equations assuming that equipartition is fulfilled. Hence, new insights are provided namely suggesting that the mean field description of the cooling dynamics of elongated particles is only conditioned by the particle shape and the energy equipartition among the internal degrees of freedom of the particles.



S.M Rubio, P. Lind and D. Maza



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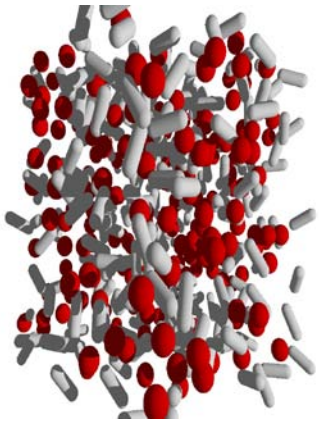

D.Serero and T. Poschel

Acoustic revealing of granular internal structure (15 min)

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(sebastien.lherminier@univ-lyon1.fr)

In collaboration with: R. Planet[1], G. Simon[1], L. Vanel[1], O. Ramos[1]

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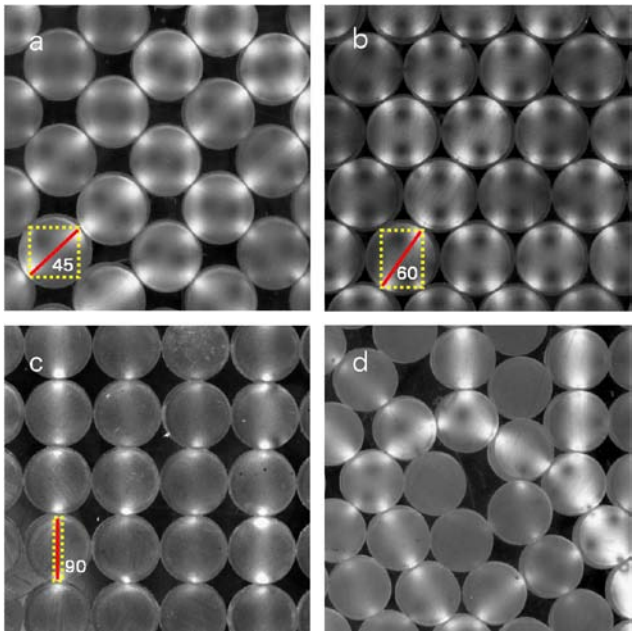
In granular materials, the global mechanical response of the system is governed by local interactions between neighboring particles. Therefore, it is very useful to have access to the internal structure of the material in order to predict its evolution, in particular the occurrence of avalanches (unjamming). Since the internal structure is known to show anomalies before an avalanche, the monitoring of its characteristics can be a good way to predict large collapsing. Acoustic is one of the most used tools to analyze the internal structure of materials. However, granular systems are still reticent to leave clear fingerprints on acoustic waves. This "misbehavior" is directly related to the fact that, in a granular medium, loads are transferred through contact mechanisms between neighboring particles creating force chains, responsible for a huge degree of heterogeneity inside the material.

However, we have done an experiment where acoustic measurements reveal the internal structure of the granular packing.



We have been able to show that the velocity of sound waves in a 2D pile of cylinders under compression is linked to the internal network of contacts between the disks, and specifically the evolution of this waves speed versus the compression load gives information about the number of contacts between particles in the pile.
We have also explained this relation thanks to the compression behavior of one single cylinder depending on its coordination number.
Finally, a random pile of cylinders has been monitored during a progressive compression, showing an average transition from 2 to 4 contacts during the process.

- S. Lherminier, R. Planet, G. Simon, L. Vanel and O. Ramos, *Revealing the structure of a granular medium through ballistic sound propagation*, Phys. Rev. Lett. 113, 098001 (2014).

Dynamic collective behavior and phase separation of active colloids
(30 min)

Erik Luijten
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Suspensions of active colloidal particles have emerged as prototypical systems for the investigation of collective phenomena that can be either static or dynamic in nature. Here, I will demonstrate how induced many-body interactions result in unexpected and until now unexplored aggregation and phase behavior. These observations, obtained through a combination of experiments and computer simulations, reveal striking connections between colloidal self-assembly and collective dynamics, and between dynamic behavior and classical thermodynamics. Moreover, a remarkable variety of collective dynamics can be realized in a single system merely by variation of the external electric field.

About the definition of "clogging transition" in bottlenecks (30 min)

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In collaboration with: R. Cruz-Hidalgo, A. Garcimartín, I. Zuriguel
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When certain group of particles/bodies passes through a bottleneck, the particles flow rate can be very different depending on the ratio between outlet dimension and particle size. Indeed, when the exit size becomes comparable to the size of a few particles, the flow becomes intermittent and eventually, the clog of the exit can be observed.

This phenomenon occurs at very different scales and also with very different types of "particles", ranging from atoms to human beings in the displacement of multitudes.

Despite the ubiquity of this situation, not exist at the moment a clear definition of what exactly a "clogging transition" means. Very recently we introduce a systematic approach to analyze the generalities of this phenomenon by comparing different types of systems ranging from colloidal systems to animal dynamics. In the image, a typical animal escape situation is depicted. As is obvious from the spatio-temporal diagram introduced in the figure (the horizontal direction corresponds to a stacked green line profile), the sheep flow is intermittent and the characteristic of such intermittencies provides a valuable tool to analyze the clogging regime.

In this presentation we will introduce the analysis of this intermittencies and how to use them to describe a hypothetical "clogging phase space" [1] where to compare systems of very different nature.

[1] Clogging transition of many-particle systems flowing through bottlenecks. ***Scientific Report 4:7324. DOI:10.1038/srep07324 (2014).***

Mechanics and rheology of Pickering films (15 min)

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In collaboration with: Z. Rozynek[1,2], P. Dommersnes[1] and J. O. Fossum[1]

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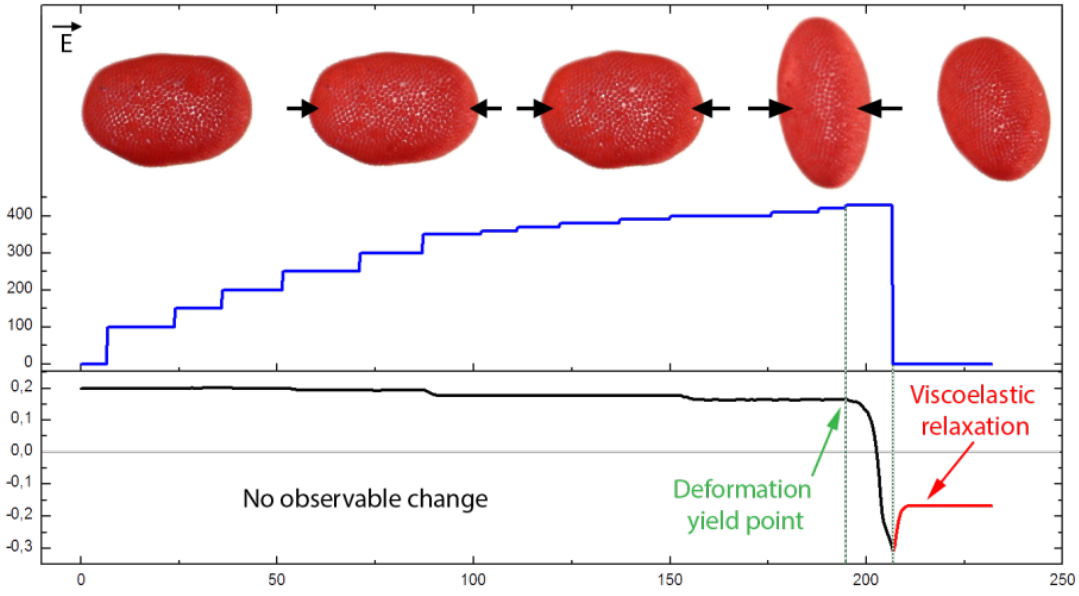
[2] Institute of Physical Chemistry, Polish Academy of Sciences, Warsaw, Poland.

Drops fully covered by particles, so called Pickering emulsion drops, are (among other applications) used to stabilize emulsions and are ideal templates for producing particles and advanced capsules [1]. Recent studies show how electrohydrodynamic circulation flows in drops can structure free particles on drop surfaces [2], but there appear to be few studies on the dynamics of Pickering drops subjected to electric field.

We investigate both the rheology and dynamics of Pickering drops subjected to DC E-fields. Such as leaky-dielectric drops in E-fields, free surface charges accumulate at colloidal capsule surfaces and create an electric stress forcing the capsule to deform. By using different particle packing and drop geometries, we examine how stiffness and shape of Pickering droplets influence the macroscopic emulsion yield stress. Although there have been some studies on the response of particle covered drops or bubbles to shear flow [3] or other mechanical forces [4], there are very few reports on the plasticity of Pickering drops. Here we demonstrate plasticity of leaky-dielectric capsules by the utilization of a uniform DC E-field which offers great control of the compressive stress exerted on capsules as the applied stress can easily be adjusted, reversed or turned off.



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[2] P. Dommersnes et al., Nat. Commun. **4**, 2066 (2013)
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Directed molecular evolution to create a new anti-tumor antibody (30 min)

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In collaboration with: Gertrudis Rojas[1], Ana V. Casadesus[1], Ute Krengel[2]

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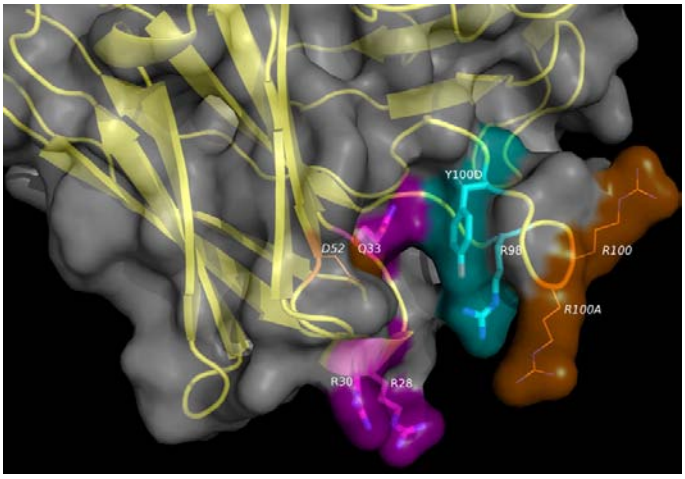
Directed evolution is a high-throughput genetic engineering method that mimics Darwinian selection in order to modify the function of a protein. The phage display technology, which uses viruses that infect bacteria, is commonly employed for this purpose. The key here is that each individual phage carries a single protein mutant together with the genetic information encoding for this mutant. By gene randomization, a large library of protein variants is phage-displayed and then subjected to several rounds of selection/amplification to isolate the best mutant(s) from the library. While the size of the randomization space can be huge, the actual size of phage libraries is usually in the order of 10^9 individuals. A rational, computer-assisted design of the library may help to optimize the randomization space.

N-glycolyl (NGc) GM3 and N-acetyl (NAc) GM3 are two structurally related antigens, the only difference between them being the addition of a tiny hydroxyl group in the NGc version. Both NGc-GM3 and NAc-GM3 are promising molecular targets for cancer immunotherapy. 14F7, on the other hand, is a monoclonal antibody (mAb) that binds very specifically and with high high affinity only to NGc-GM3, showing anti-tumor effects *in vitro* and *in vivo*. However, no antibody specific for NAc-GM3 and with such remarkable properties has been obtained.

Aiming to obtain a mutant antibody specific for NAc-GM3, and believing that the small structural differences between the two antigens increase our odds, we embarked into a directed evolution of the 14F7 mAb. We used a strategy that combines the screening of a rationally designed, large phage display library with subsequent refined mutagenesis. Surpassing our initial expectations, we obtained a dual-specific mutant antibody, called 7C1, able to bind with high affinity the two tumor-associated antigens. Moreover, the 7C1 mAb was able to kill (*in vitro*) tumor cells expressing either NGc- or NAc-GM3, or both.



Close-up on the 14F7 binding site structure, showing (in magenta) the three amino acids that are critical for the recognition of both NGc- and NAc-GM3, resulting from mutations S28R, T30R, and W33Q.

(Taken from: Engineering the binding site of an antibody against N-glycolyl GM3: from functional mapping to novel anti-ganglioside specificities. Rojas G, Pupo A, Gomez S, Krengel U, and Moreno E., ACS Chem Biol 8, 376-86, 2013.)

Statistical mechanics of metabolic networks (30 min)

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Cellular metabolism is one of the most investigated systems of biological interactions. While the topological nature of individual reactions and pathways in the network is quite well understood, there is still a lack of comprehension regarding the global functional behavior of the system. In the last few years flux-balance analysis (FBA) has been the most successful and widely used technique for studying metabolism at system level. This method strongly relies on the hypothesis that the organism maximizes an objective function. However only under very specific biological conditions (e.g., maximization of biomass for *E-coli* in reach nutrient medium) the cell seems to obey such optimization law. A more refined analysis not assuming extremization remains an elusive task for large metabolic systems due to algorithmic limitations.

In this work we propose a novel algorithmic strategy that provides an efficient characterization of the whole set of stable fluxes compatible with the metabolic constraints. Using a technique derived from the fields of statistical physics and a proper parametrization of the problem we designed a message passing algorithm to estimate the size of the affine space containing all possible steady-state flux distributions of metabolic networks. We first compare the accuracy of our algorithm with the results of an exact algorithm on small random networks. We also verify that the predictions of the algorithm match closely those of Monte Carlo based methods in Random Networks and in the case of the Red Blood Cell metabolic network.

Then we test the effect of gene knock-outs on the size of the solution space in the case of *E-coli* central metabolism.

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The collapse of a pressurized gas cavity inside a sand bed (30 min)

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In collaboration with: F. E. Loranca-Ramos and J. L. Carrillo Estrada
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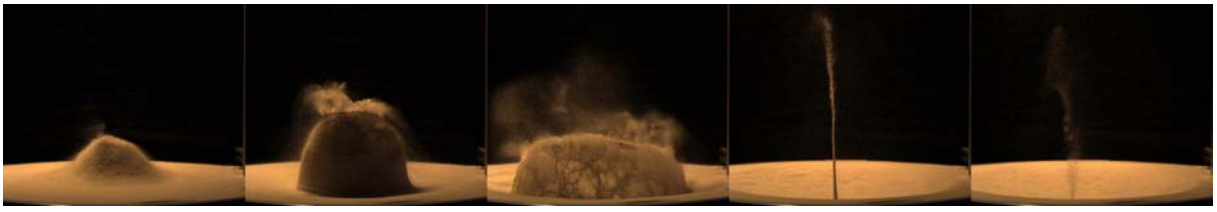
It is well known that craters observed in lunar and planetary surfaces were mostly produced by meteorite impacts[1]. On Earth, the most famous case is the Chicxulub crater in Mexico, related with the Cretaceous-Tertiary extinction of dinosaurs 65 millions years ago. But there are alternative processes, such as volcanic eruptions and explosions, which can also produce craters[2,3]. For instance, a *maar* is a natural depression created by an underground steam explosion that occurs when magma comes into contact with shallow ground water. Similarly, *subsidence craters* can be artificially (and undesirably) produced in oil drilling operations: if the machinery punctures a pocket of natural gas under extremely high pressure, the overlying rock layers may not be able to contain it; the pocket explodes releasing the gas, and the cavity collapses forming a crater.

During the last decades, low speed impact experiments on granular materials have been an alternative to study the fundamentals of impact cratering[4]. Here we study for the first time, at laboratory scale, the cratering process due to the explosion and collapse of a pressurized air cavity inside a sand bed. When the cavity breaks, the liberated air rises up through the overlying granular layer and produces a violent explosion (a vertical corona); it depressurizes the cavity and, as the gas is released, the sand sinks under gravity generating a crater. We found that the crater dimensions are totally determined by the initial cavity volume; the pressure does not affect the morphology because the confined air escapes with the corona before the surface sinking. In contrast with impact craters, a raised rim is not formed because the subsidence area is always wider than the corona and, consequently, the expelled grains fall inside the depression. We also found that, regardless the cavity shape, the crater rim evolves into a circle as the cavity location is deeper, which could explain why most of subsidence craters observed in nature are rounded. Moreover, for shallow spherical cavities, a collimated granular jet[5] emerges from the collision of sand avalanches that converge concentrically during the last stages of the process, revealing that the collapse under gravity is the main mechanism driving the jet formation.



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Dissipation of Energy in Granular Matter in the Absence of Gravity (30 min)

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In collaboration with: Marcus N. Bannerman[1], Michael Heckel[2], Jonathan E. Kollmer[2], Patric Müller[2], Achim Sack[2], Martin Tupy[2], Fabian Zimber[2]

[1] School of Engineering, University of Aberdeen, Aberdeen, UK
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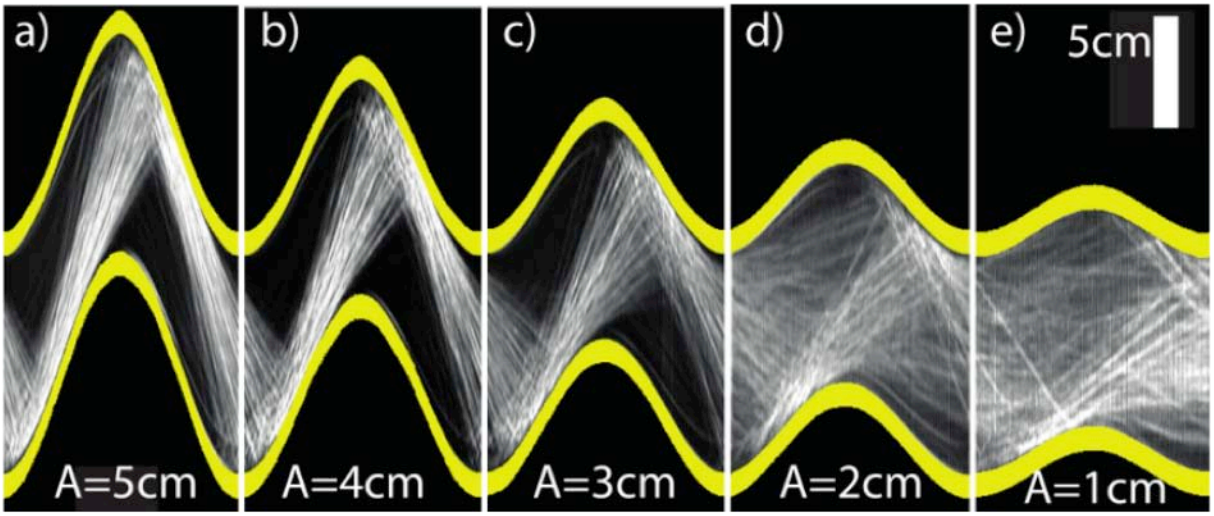
When containers partially filled by granular material are subjected to vibration, part of the energy of the grains is dissipated because of inelastic collisions of the particles with one another and with the walls. This property of granular matter can be exploited in technical devices of different type called granular dampers. Granular dampers have a number of interesting properties which will be discussed. For instance, the oscillation of a spring may be attenuated by means of a granular damper, however, in difference to viscous dampers, the amplitude decays nearly linearly in time up to a finite value, from there on it decays much slower. We quantitatively explain the linear decay, which was a long-standing question.



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Mimicking earthquakes with a granular experiment (30 min)

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In collaboration with: S. Lherminier[1], R. Planet[1], G. Simon[1], K. J. Måløy[2], L. Vanel[1]

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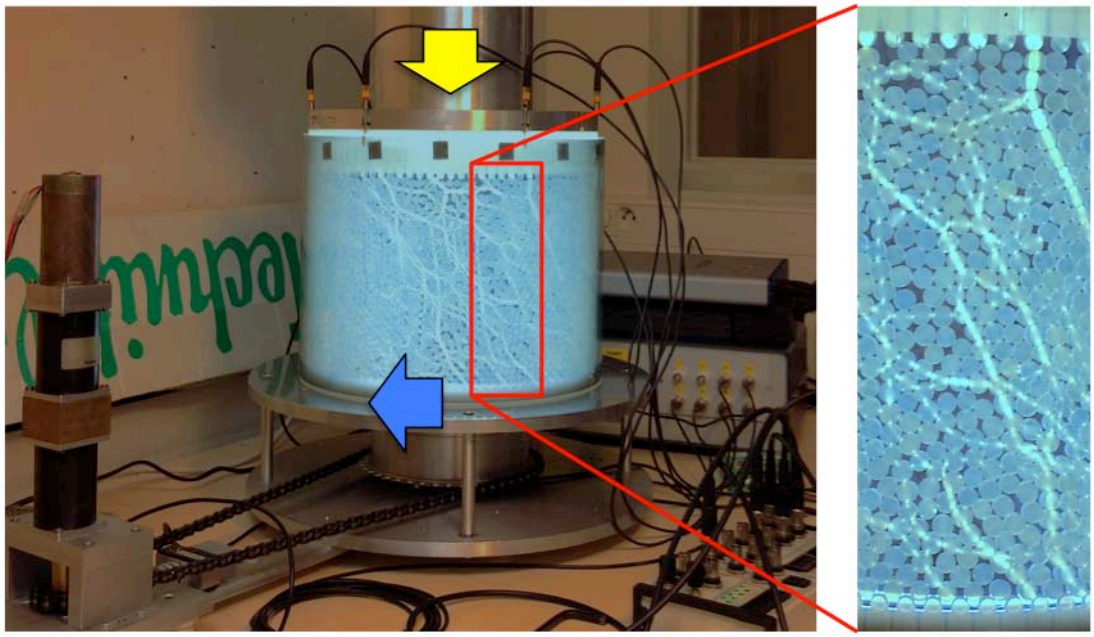
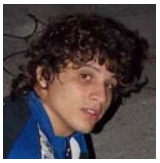
In order to analyze different questions related to earthquakes (and scale-invariant phenomena in general) we present an original experimental setup that mimics the dynamics of a tectonic fault by studying a two-dimensional granular layer that is sheared *continuously* while submitted to a controlled confining pressure. As the "(tectonic) plates" move in relation to each other at a controlled and very low speed, shear stresses build up on the packed grains, and eventually they are liberated through sudden avalanches (reorganization of the pack), with sizes distributed following a power law (similar to the Gutenberg-Richter law). Acoustic measurements will be the main source of information. However, both the position of all the grains and the force networks in the structure will be monitored.

We will present the first preliminary results obtained in this experiment, which show a very good resemblance with real earthquakes.



- R. Planet, S. Lherminier, G. Simon, K. J. Måløy, L. Vanel and O. Ramos, *Mimicking earthquakes with granular media* (submitted).



Uninformed sacrifice: ants do not act collectivelly against danger (15 min)

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In collaboration with: F. Tejera and E. Altshuler

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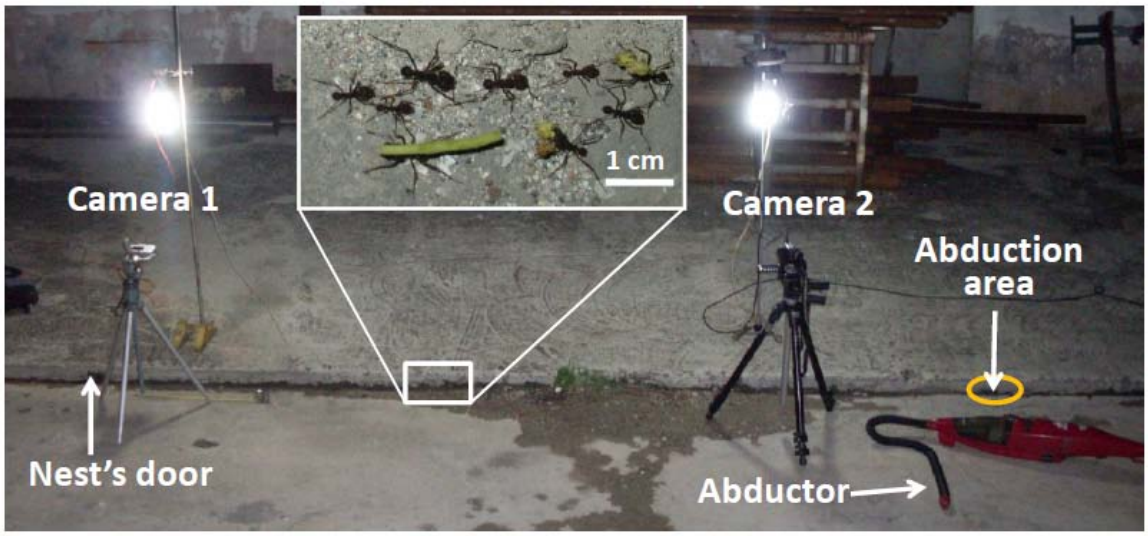
Animals are regularly confronted with the conflict between foraging and avoiding predation by other species or other members of the same species. There is evidence among solitary animals suggesting that individuals are able to estimate the relative weight of these possibilities and adjust their behavior accordingly. In particular, ant foraging is submitted to numerous threats –from rain to predators– but the strategies of how the swarm reacts to them is poorly understood. One of the most amazing features of many species of ants are foraging lines that span hundreds of meters from the nest to the feeding sources. Foraging ant are particularly vulnerable, and the ability to balance risk of death vs. value of food can provide a competitive advantage to the colony. Unlike solitary animals, ants collect food not only for their own consumption, but for the maintenance of the entire colony as well. In fact, the death of a worker (of many workers) is not the end of reproduction and therefore it is generally viewed as a cost that the colony is willing to pay. But how many ants the colony can afford to sacrifice? How foraging ants react collectively to an obvious danger? These are some of the questions we attempt to answer in this paper.

We have approached the problem by abducting leaf-cutter ants from the species *Atta insularis* at a given point of the foraging trail in natural conditions, and quantifying its effect on several parameters of the foraging traffic in space and time. Contrary to common wisdom, our results reveal that ants do not pass to each other information to help foraging partners avoiding the abduction danger: the observed decrease in the foraging activity due to abduction can be explained simple by the decrease in the total available number of foragers.



Hydration, cation-exchange process and storage ability of clays particles (15 min)

Éverton C. Santos[1,2]

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In collaboration with: L. Michels[1], M.A.S. Altoé[3], J.O. Fossum[1], and Heloisa N. Bordallo[2]

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Smectite clays are among the most abundant and inexpensive minerals on Earth, making it be broadly used in the modern industry. Like other materials such as colloidal systems, polymers, biomaterials, etc., clays have presented big importance in advanced materials science, receiving attention by scientist from a wide range of areas.

Clays are usually made by tetrahedral and octahedral sheet that, depending on their composition, may have a net negative charge, which are balanced by interlayer cations. One of the most important properties of layered clay particles is the possibility of these interlayer cations be replaced by another, thus obeying the interlayer's charge balance. Even more interesting is their swelling capacity making possible to trap small molecules, such as water, CO2 as well as being hosts for drug encapsulation.

In this talk will be presented some recent results related with the hydration and the cation-exchange process, as well as related with the trapping and storage of molecules.

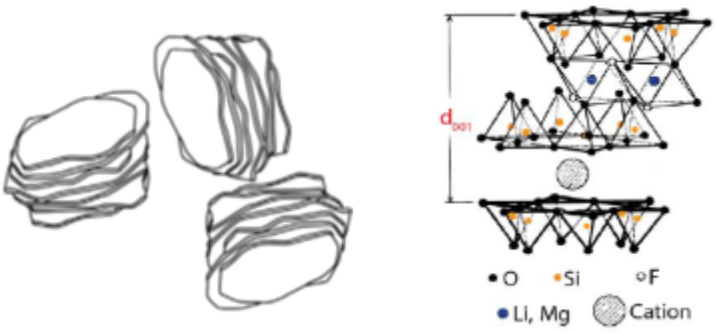

Figure 1: Clay particles forming stacking structures (left) and Fluorohectorite layer (right).

Shale gas, fracking and earthquake triggering (30 min)

O. Sotolongo
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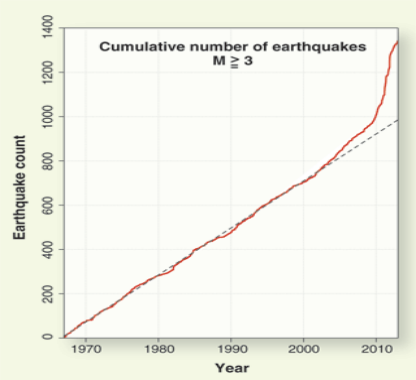
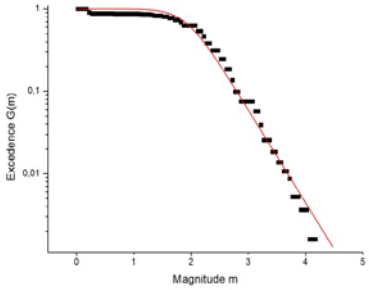
During the past several years, natural gas production from shale gas is increasing and absorbs much attention worldwide. This is due to impressive advances in the technology of producing oil and natural gas trapped in deep shale formations, that has also been the cause of the present lowering of the prices of oil and gas. Oponents argue that the new technique, commonly called "fracking", produces leaks of gas and chemicals used during hydraulic fracturing that could contaminate groundwater and impact public health.



But in our opinion another important risk emerges with fracking: the rise of new seismic zones in the lands used for fracking. Indeed, in many zones of the United States where fracking has been applied in shale gas exploitation, and in spite of official denial of any relation between fracking and seismic activity, there are signals of an abrupt increase of earthquake occurrences.



In our speech we expose a model of earthquakes based in the existence of fragment-asperity interaction between underground plates, mediated by irregular distribution of fragments size, from which a distribution of earthquakes by magnitude is obtained. This model is applied to the energy distribution of recently produced earthquakes in Oklahoma. The good fitting indicates that the hypothesis of fracking as a cause of earthquakes is, at least, reasonable and deserves much attention.

Transmission of danger information in ants (15 min)

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In collaboration with: A. Rivera[1], O. Ramos[2], M. Turner[3], E. Altshuler[4]

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We have designed and performed experiments to probe the ability of ants to transmit individual-individual danger information within a short range. In our experiments, two horizontal Hele-Shaw cells are separated by different kinds of barriers. An *information permeable* (IP) barrier consists in a row of vertical pins that allow antennal contact between ants located into each cell, but do not allow ants to move from cell to cell. An *information impermeable* barrier (II) consists in thick pins that do not allow passing through, neither antennal contact. If the two cells are filled up with ants with an IP barrier, and an insect repellent is poured into the right one, the ants into the left cell move away from the barrier. That does not happen if the right cell contains no ants. The same couple of experiments (i.e. ants or no ants into the right cell) performed with a II barrier gives no significant shift away from the barrier of the ants in the left cell. So, we conclude that one of the functions of the antennal contact between ants is the transmission of danger information.

Two cells separated by a barrier permeable to information, but not to mass. When an insect repellent in injected into the right cell, ants in the left cell move away from the barrier (i.e., to the left). *But that happens only if there are also ants in the right cell, sot they transmit the « panic information » to partners in the left cell.*

Confinement controls intruder penetration into granular matter (15 min)

H. Torres
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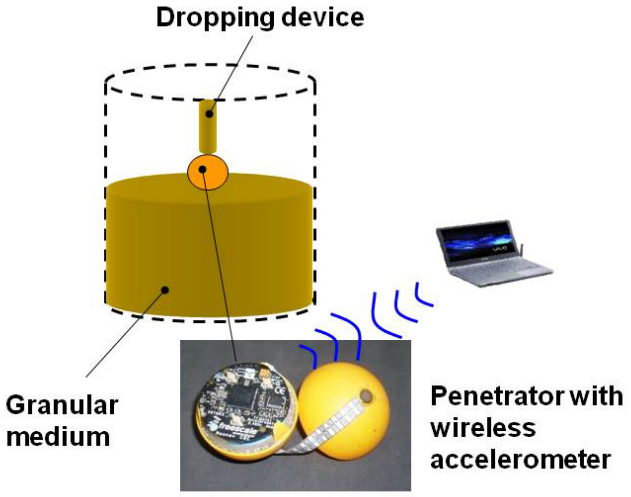
In collaboration with: E. Altshuler ("Henri Poincarè" Group of Complex Systems, University of Havana, La Habana, Cuba)



Using wireless accelerometry, we systematically study the penetration dynamics of a spherical intruder in granular matter contained into cylinders as a function of confinement. Our results reveal that the penetration dynamics depends both on the dimensions of the container and on the nature of its walls. In particular, the final penetration depth decreases as the radius of the container decreases until it saturates, and a similar tendency is observed as the roughness of the walls is increased. Moreover, we identify that the \Janssen term" of the forces acting against penetration increases as the container decreases its radius or the walls get rougher. This shades new light on the role of force chains in the equation of motion of an intruder penetrating granular matter, and hints at new technologies to control sedimentation in silos.

Connecting the physics of swarming animals and active matter (30 min)

M. S. Turner
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In collaboration with: D. J. G. Pearce, A. Tamsett, A. Miller and G. Rowlands

Bird flocks, insect swarms and fish shoals resemble fluids made up of many individuals where the controlling interactions are social rather than physical in character [1]. Some progress has been made reverse-engineering candidates for these interactions that are local in space, either in a metric-based [2] or topological sense [3,4]. A question that has been largely overlooked is whether the interactions should be expected to be local in the first place. We discuss the evidence for them having a non-local character and, furthermore, that there is a natural choice for this that is consistent with the cognitive limitations of a bird's vision. We study the global character of the flocks that emerge from this model and their various phenotypes. Most significantly, an emergent state arises in which the probability that a typical bird can see out (sky) in any direction divided by the probability that its view is blocked by other bird(s) is O(1). We refer to this state as being marginally opaque. We present experimental data on bird flocks that confirm this prediction and discuss how these models may naturally be associated with evolutionary fitness, as well as being physiologically plausible.

Next I draw an analogy with a thermodynamic system of thermophoretic colloids [5]. In our work these are heated by a focussed external light source. We show that these systems can undergo first order transitions from compact to disperse states as the light intensity is varied. Intriguingly, we find that the same state of marginal opacity emerges: no compact state with a density below marginal opacity is stable. This reveals a previously unidentified connection between social and thermodynamic swarms.

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[3] A. Cavagna et al., Scale-free correlations in starling flocks. PNAS 107, 11865 (2010).
[4] M. Ballerini et al., Empirical investigation of starling flocks: a benchmark study in collective animal
behaviour. Anim. Behav. 76, 201 (2008)
[5] J. A. Cohen and R. Golestanian, Emergent comet-like swarming of optically driven thermally active colloids, arXiv:1309.3318

Ciprofloxacin intercalation into a synthetic clay (NaFh) (15 min)

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In collaboration with: J. Jiménez[1], I. Pérez[2], E. L. Hansen[3†], Z. Rozynek[3‡], L. C. de Ménorval[4],
E. Altshuler[5], J. O. Fossum[3], A. Rivera[1]

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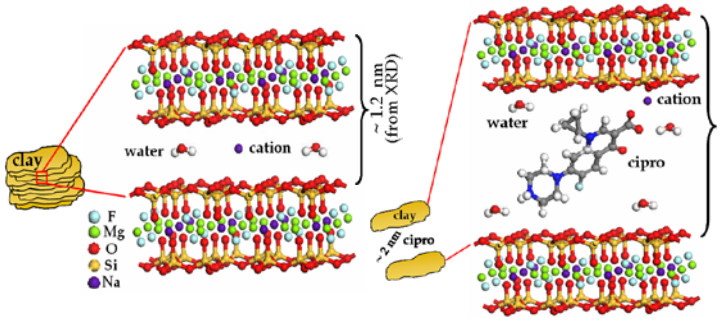
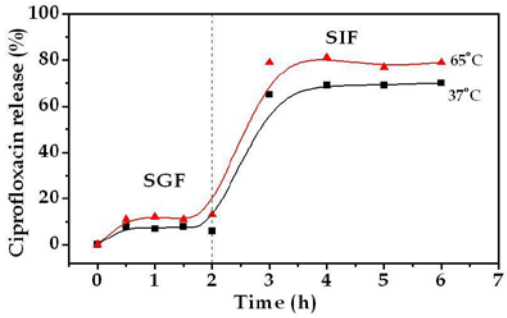
In the last years, smectite clays charged with organic molecules have attracted the attention of the scientific community, since their physical and chemical properties allow numerous applications. Reports on the use of fluorohectorite (Fh), a commercially available synthetic smectite, as a drug hosting material, can be found in the literature. Several authors have reported the incorporation of drugs and their slow release from Fh. We have recently demonstrated the successful incorporation of Ciprofloxacin (Cipro) in a Li-Fh clay. Based on that, in this work the optimization of the Cipro intercalation into NaFh, as well as its release from the system are evaluated. The influence of different physical parameters in the process allowed us demonstrating that the drug intercalation into the clay depends of the temperature, the initial drug concentration and the pH of the medium. The optimal conditions for the preparation of the NaFh-Cipro composite were established. The characterization by infrared spectroscopy (IR) and X-ray diffraction (XRD) indicated that the drug molecules were actually incorporated between the clay layers. The drug release profile from the composite −in simulated gastric fluid (SGF) and simulated intestinal fluid (SIF)showed that the Cipro incorporation is reversible. It also confirmed that the drug release profile corresponds to a diffusion (or zeroth-order) mechanism. Thus, it is possible to design slow release formulations based on NaFh which meet the pharmaceutical standards for these kinds of systems.



Schematic representation of the atomic structure of the LiFh clay and the LiFh with intercalated Cipro



Cipro sustained release from Cipro-NaFh system in SGF and SIF

A granular ratchet: Spontaneous symmetry breaking and fluctuation theorems in a granular gas (30 min)

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In collaboration with: P. Eshuis[1], S. Joubaud[2], K. van der Weele[3], D. Lohse[1]

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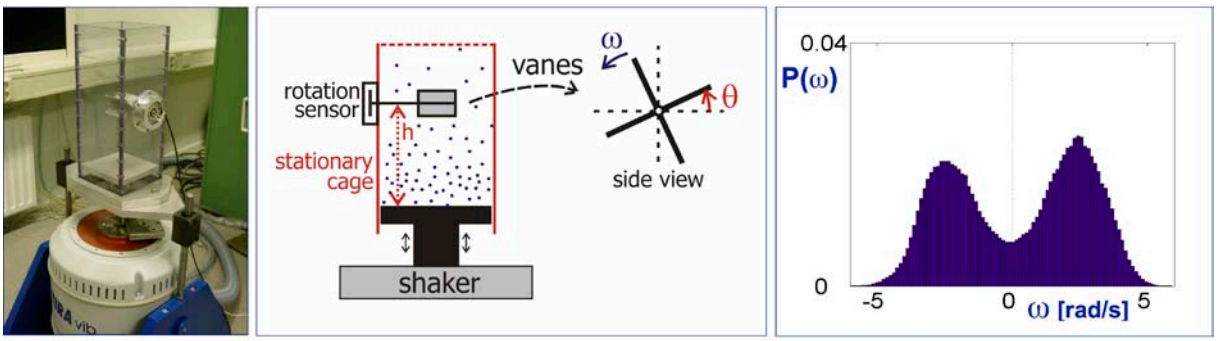
We construct a ratchet of the Smoluchowski-Feynman type, consisting of a rotor with four vanes that are allowed to rotate freely in a vibrofluidized granular gas. The necessary out-of-equilibrium environment is provided by the inelastically colliding grains, and the equally crucial symmetry breaking by applying a soft coating to one side of each vane. The onset of the ratchet effect occurs at a critical shaking strength via a smooth, continuous phase transition. For very strong shaking the vanes interact actively with the gas and a convection roll develops, sustaining the rotation of the vanes.

Next, we investigate the validity of fluctuation theorems for such an asymmetric rotor experiment in a granular gas. A first state, with a Gaussian distribution of the angular velocity, is found to be well described by a first order Langevin equation. We show that fluctuation theorems are valid for the injected work and for the total entropy production. In a second state, the angular velocity distribution is double peaked due to a spontaneous symmetry breaking: A convection roll develops in the granular gas, which strongly couples to the rotor. Surprisingly, in this case, similar symmetry relations hold, which lead to a good prediction for the height ratio of the two peaks.



POSTERS

In-plane transport anisotropy in BSCCO-Ag multi-filamentary tapes

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Composite structures such as High-*Tc* multi-filamentary tapes display a complex anisotropy arising from the combination of the "intrinsic" anisotropy of the filaments and that associated to the morphology of the superconducting-metal composite. In this paper we characterize the "in-plane" anisotropy of BSCCO-Ag tapes, i.e., the difference between the transport properties along the longitudinal axis and those along the transverse direction also lying on the wide face of the tape. In particular, we demonstrate that the dissipation associated to transport along the transverse direction approaches that of the longitudinal direction as the temperature or the current increase, which may be relevant to transport applications near "rupture".

Living on the edge: transfer and traffic of E. coli in a confined flow

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When flowing in confined media, bacterial suspensions show anomalous "reconcentrations" due to hydrodynamic interactions with the boundaries [1]. In particular, microfluidic experiments have highlighted the presence of upstream motion of bacteria persisting over large distances [1, 2].

We find that once swimming along the edges, bacteria move at a speeds quite independent of the fluid velocity, and very sensitive to concentration, being the upstream swimmers faster than the downstream swimmers, fact that we are able to explain in the frame of direct interactions between bacteria. We quantify for the first time the upstream migration that extends from the edges to the surfaces, forming what we call an active boundary layer, that we characterize. Moreover, we observe concentration asymmetries between opposite edges of the channel and we associate those phenomena with rheotaxis taking place far from the lateral edges of the channel [3, 4]. We show that erosion of bacteria moving on the edges is slower compared to erosion from the bottom and top walls

[1] E. Altshuler, G. Miño, C. Pérez-Penichet, L. del Río, A. Lindner, A. Rousselet, and E. Clément, Soft Matter, 9, 1864-1870, (2013)
[2] J. Hill, O. Kalkanci, J. L. McMurry, and H. Koser, Physical Review Letters, 98, 088101, (2007)
[3] Tolga Kaya and Hur Koser, Biophysical Journal, 105, 1514-1523, (2012)
[4] Marcos, Henry C. Fu, Thomas R. Powers, and Roman Stocker, PNAS, 109(13), 4780-4785, (2012)

How Regulatory T cells impinge on Tumor Immunobiology?

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[1]Center of Molecular Immunology, La Habana, Cuba
[2] Instituto Gulbenkian de Ciencia, Oeiras, Portugal

Aiming to get a better insight on the impact of regulatory CD25+CD4+ T cells in tumor-immunobiology, a simple mathematical model was formulated and studied. This model is an extension of a previous model for the dynamics of autoreactive regulatory cells and effector cells that interact upon their co-localized activation at the antigen presenting cells (APCs). It assumes that tumor growth stimulates the activation and migration to the adjacent lymph node of fresh APCs loaded with tumor antigens. These APCs stimulate the growth of both Effector and Regulatory T cells, which may then migrate to the tumor site and induce tumor cell destruction. Our results predict the existence of two alternative dynamic modes of unbounded tumor growth. In the first mode, the tumor induces the expansion of Effector T cells that outcompete regulatory T cells, but nevertheless fail to control the tumor. In the second mode, the tumor induces a balanced expansion of both Effector and Regulatory T cells, which prevents the tumor from being destroyed by the immune cells. Tumors characterized by a high specific growth rate, low immunogenicity, and that are relatively resistant to T cell destructive functions, will grow in the first mode; conversely, tumors that have a slow specific growth rate, that are immunogenic, and/or that are more sensitive to destruction by T cells will grow in the second mode. Overall this results provides a simple explanation to the observation that the development of some tumors expand regulatory T cells while others do not, predicting how some key dynamical properties of the tumor determine either one or the other type of behavior.

We study how these two tumor classes respond to different therapies, namely vaccination, immune suppression, surgery, and different combinations.. We show 1) how the timing and the dose applied in each particular treatment, determine whether the tumor will be rejected, with or without concomitant autoimmunity, or whether it will continue progressing with slower or faster pace; 2) that both regulatory T cell dependent and independent tumors are equally sensitive to vaccination, although former are more sensitive to T cell depletion treatments and are unresponsive to partial surgery alone; 3) that surgery, suppression, and vaccination treatments, can synergistically improve their individual effects, when properly combined. Particularly, we predict rational combinations helping to overcome the limitation of these individual treatments on the late stage of tumor development.

Silo discharge of a repulsive granular medium

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Institute of Physics, Benemérita Universidad Autónoma de Puebla, C.P. 72570, Puebla, México.--

The most widely accepted law that predicts the flow rate of grains with diameter d_p through an orifice (D_0) and its dependence on different parameters was proposed by Beverloo et al. [1], where W=C ρ_0(g^1/2)(D_0-kd_p)^B is the average mass discharge rate through the orifice, C and k are empirical discharge and shape coefficients respectively, ρ_0 is the apparent density, and g is the acceleration of gravity. One of the most interesting issue is the dependence of the flow rate with a B=5/2 power of the diameter of the orifice en 3D and B=3/2 in 2D. For those cases we observe a linear behavior in the flow rate, in contrast with hydrodynamic systems. During the last decades, experiments with high speed cameras on granular materials have been an alternative to study the fundamentals of granular matter dynamics. Here we study the flow rate of magnetic granular matter and the universality of the Beverloo's Law.

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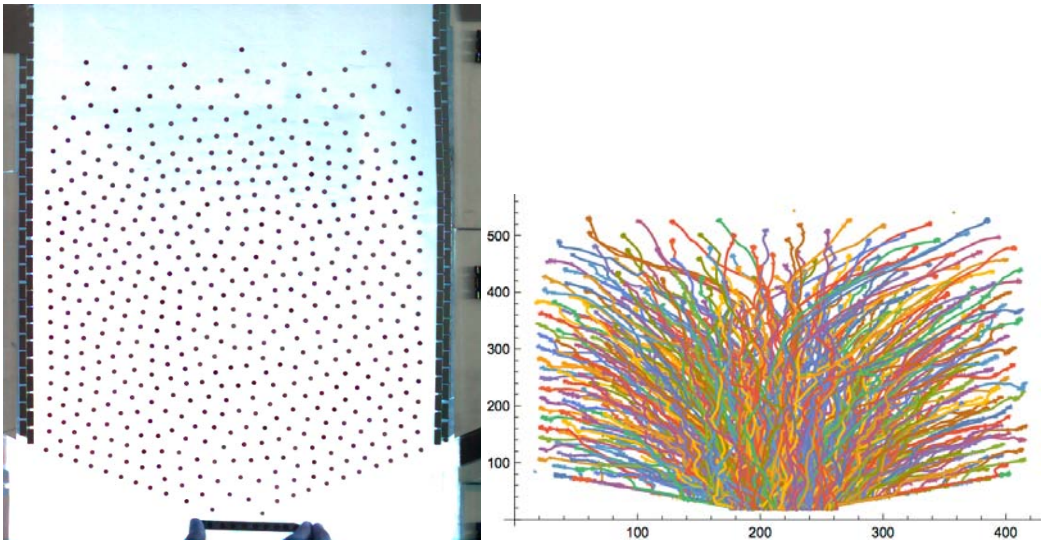

Figure: (Left) Picture of the system used to study the flow of repulsive granular matter through an orifice. (Right) Path followed by every particle plotted after the tracking on high speed videos.

Benzalkonium chloride micelles formation and its interaction with drugs: Dissipative Particle Dynamics simulation

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Surfactants are very important molecules with great diversity of applications in industry. In particular, the surfactant benzalkonium chloride (BC) has been widely used in pharmaceutical industry. The aggregation process of BC in water has been studied in order to determine the shape and size of their micelles. However, different aggregation numbers have been suggested in the literature using experimental techniques [1,2]. That is why we want to modeled this process in order to know the details of the aggregation process. The time to reach the equilibrium in aggregation process of surfactants is between the microseconds and the seconds, which is a very long time scale for an atomistic Molecular Dynamics simulation. In the particular case of BC, which has a very low critical micellar concentration (cmc), in order to reproduce the cmc work conditions we need more than 1 surfactant molecule per 7400 water molecules. Therefore, we have chosen a mesoscopic method, the Dissipative Particle Dynamics (DPD), to model the BC aggregation process and the encapsulation of model drugs (sulfamethoxazole and metronidazole) by BC. Different simulation boxes formed by 560000 particles of water, surfactant and drug molecules are modeled for a simulation time in the order of milliseconds. The micelles in all cases are sphericals and the size changes in dependence of the initial surfactant concentration. Also, we can observe that less polar drugs are encapsulated by the micelles.

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[2] C.A. Gracia, S. Gómez-Barreiro, A. González-Pérez, J. Nimo, J.R. Rodríguez, J. Colloid Interface Sci. 276 (2004) 408.

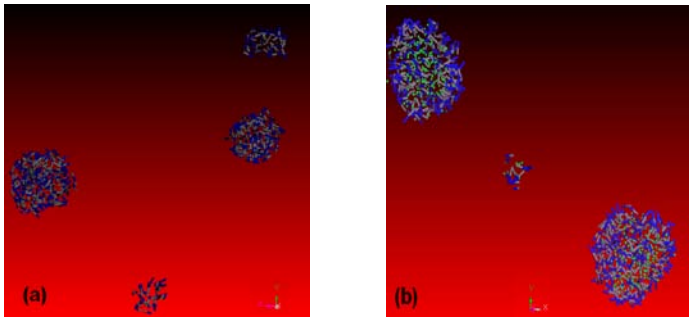

Figure 1 (a) BC micelles formed at concentration above cmc (b) Drugs encapsulation inside micelles. In the figure water molecules are not included and the gray-blue sticks are the CB molecules and the green points are the sulfamethoxazole molecules.

Radiation, errors in DNA replication, and cancer

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There are many evidences relating cancer with exposure to ionizing radiations. The underlying mechanism, however, is not completely known yet. The reasons for this are many-folds: the huge dimension of the DNA molecule, the complex dynamics of its replication and interaction with radiation, the repair mechanisms acting and the cellular level, and the immune response of the multicellular organism.

In the present work, we include, in the observed correlation between lifetime cancer risk and the accumulative number of stem cell divisions in a tissue [1], a new variable related to the effective radiation dose received by that tissue. A better correlation is obtained, and the increase of the number of new cases of some cancer kinds in the last years can be explained through a sensitive coefficient to radiation of each tissue. A way to take into account other carcinogenic factors is suggested also.

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Acoustic revealing of granular internal structure

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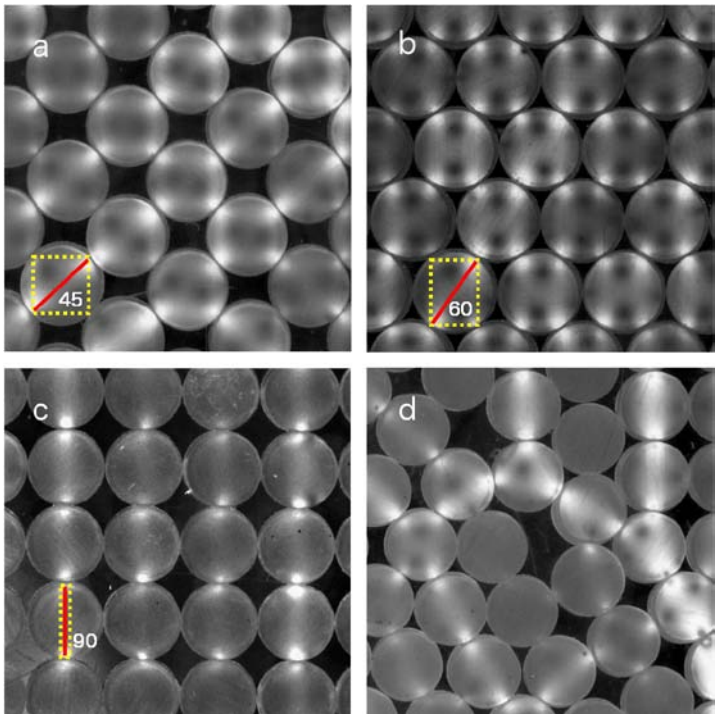
In granular materials, the global mechanical response of the system is governed by local interactions between neighboring particles. Therefore, it is very useful to have access to the internal structure of the material in order to predict its evolution, in particular the occurrence of avalanches. Since the internal structure is known to show anomalies before an avalanche, the monitoring of its characteristics can be a good way to predict large collapsing. Acoustic is one of the most used tools to analyze the internal structure of a material. However, granular systems are still reticent to leave clear fingerprints on acoustic waves. This "misbehavior" is directly related to the fact that, in a granular medium, loads are transferred through contact mechanisms between neighboring particles creating force chains, responsible for a huge degree of heterogeneity inside the material.

Here we present an experiment where acoustic measurements reveal the internal structure of the granular packing.



We have been able to show that the velocity of sound waves in a 2D pile of cylinders under compression is linked to the internal network of contacts between the disks, and specifically the evolution of this waves speed versus the compression load gives information about the number of contacts between particles in the pile. With this information it is possible to predict the internal structure of the packing. We have also explained this relation thanks to the compression behavior of one single cylinder depending on its coordination number.

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Rigid clay Palygorskite as slow release system for antibiotics

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Among the many benefits offered by clays, is its safety for the human health, which makes them materials widely used by man since prehistoric times. Based on its properties as adsorbents and ion exchangers, the pharmaceutical industry exploits these porous materials both as active principle and drug support. Recently, in our country it has been found a significant deposit of natural palygorskite, whose benefits are now being evaluated.

In the present paper, we studied the incorporation of ciprofloxacin (Cipro) –a broad-spectrum antibiotic widely used for the high efficiency– into the rigid clay palygorskite (Paly). In previous works [1,2], the intercalation of this model drug was evaluated, in natural and synthetic clays, with promising results. Here, different chemical–physical parameters such as pH, initial concentration of drug contact time and temperature were monitored in order to select the optimal incorporation conditions [3]. The obtained solids were characterized by XRD, IR and TG, and the release profiles were also evaluated in the light of pharmaceutical standards. The results showed a good incorporation of Cipro into Paly, and the release profiles suggest that palygorskite can be used as support material of Cipro for pharmaceutical use.

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Cancer glycolysis: entropy production rate and sensitivity analysis in the stationary state

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In previous works [1,2,3] it has been shown how the entropy production rate can be employed to detect the fundamental steps of a mechanism in the complex network of chemical reactions. The goal of this work is to extend the thermodynamics formalism previously developed to the dynamical behavior for glycolysis network model of AS-30D and HeLa tumor cells in stationary state. The application of sensitivity analysis and entropy production rate in stationary state allowed us to identify 10 reactions that were fundamental from the 20 that regulate the glycolysis process of AS-30D hepatoma and HeLa tumor cells. In fact those reactions are potentials targets for cancer treatments. It was demonstrated the existence of an excellent correlation between entropy production rate and intracellular pH_i.

For a glycolysis network model conformed by 20 reactions, 9 of them were identified (Fig 1, left). For HeLa cells, 3 reactions match with previous identified by sensitivity analysis (4, 7, 14) and 3 of them were reported [4] by MCA (2, 3, 4). In Hepatoma AS-30D 4 reactions match with previous identified by sensitivity analysis (2, 3, 7, 14) and 3 of them were reported [4] by MCA (2, 3, 4).

In glycolysis process, the entropy production rate in hypoxia conditions is major (fig. 1,right) comparing which normoxia one, indicating that in low oxygen conditions the process is more complex and robust. Under these conditions, tumors are more resistant and aggressive [5].

In both cases the 14th reaction (ATPase) was identified as the most important one. It is known that ATPase plays a fundamental role in intracellular and extracellular pH control [6] and in therefore this reaction is over expressed in many metastatic tumors types, in which a positive correlation between the level of their expression and the invasion and metastasis has been observed.

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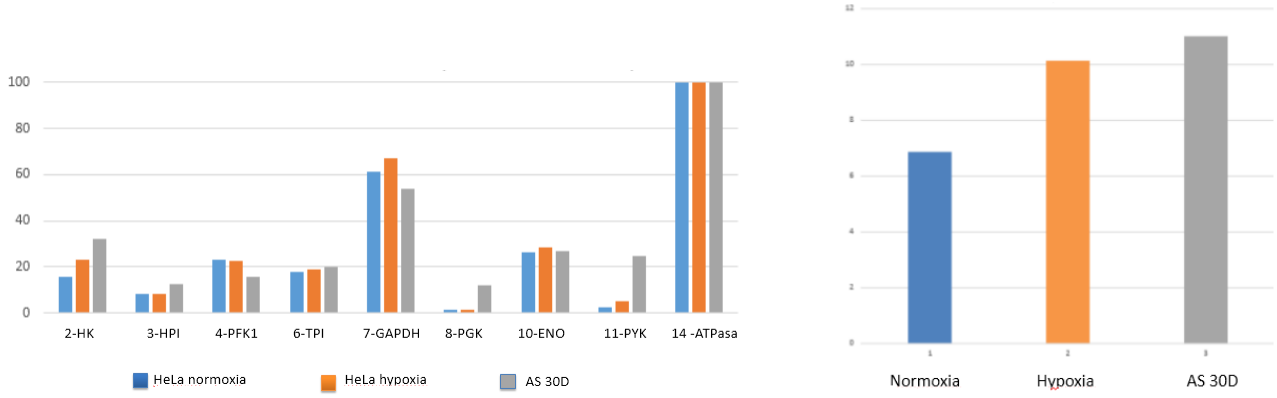

Figure1: (Left) Entropy production rate (normalized values) for HeLa normoxia, hypoxia and AS 30D. (Right) Total the entropy production rate for AS 30D and HeLa cells.

Common gamma chain: relevant for the IL2-IL2R affinity? A mathematical approach

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Interleukin-2 (IL-2) mediates its function in target cells through a multimeric receptor (IL-2R), which is constituted by three different chains: IL-2Rα, IL-2Rβ and IL-2Rγc. The mechanism for assembling the different subunits to yield IL-2/IL-2Rαβγ complexes on the cell membrane remains to be elucidated. We demonstrate, through mathematical modeling, that the affinity conversion model, in spite of being a simple model, is compatible with experimental data of IL2 binding to the cells. The mathematical model developed here, allow us to study how γc contributes to the apparent affinity of IL2:IL2R complex. The model predicts that the apparent affinity of IL2:IL2R complex is directly proportional to the γc expression, proposing a relevant role of this chain in the IL2R assembly. Furthermore, we simulate the effect of an antagonist IL2 mutant, that have affected the interaction with γc (IL2 no-γ). In particular, we study the effect of competition between IL2 and IL2 no-γ for binding to IL2R. We obtain that, at high concentration of IL2 no-γ, is possible to displace IL2 from the formation of signaling complexes IL2/IL-2Rβγc and IL2/IL-2Rαβγc. The mutant efficacy can be improved, by enhancing its interaction with IL-2Rα or IL-2Rβ. Overall, our results predict a relevant role for the γc expression, in the capacity of cells to capture IL2, despite being unable to bind IL2 along. This affects the capacity of IL2 no-γ mutants to compite with IL2 in a real scenario, which can be solved by increasing its affinity for IL-2Rα or IL-2Rβ.

Non-trivial accelerations in subcritical crack growth

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If a material is loaded beyond a certain critical limit it will suddenly break. However, even a subcritical load is able to break the sample, but in a time-dependant manner. If the material is heterogeneous and the load subcritical, a crack will grow slowly, by discrete steps, until it reaches a critical length where the whole system fails. Here we present two processes that accelerate the crack growth: The first one is the presence of very fast aftershocks [1]. They are only detectable by high frequency measurements, and even fast image acquisitions will deliver a misleading statistical description of the fracture process. In particular, the power-law exponent of the step size distribution (equivalent to the Gutenberg-Richter law in the case of earthquakes) will depend on the frequency of analysis. The second source of acceleration corresponds to the interaction of the crack with the disorder of the material, resulting in a faster subcritical propagation in a more disordered scenario [2]. This result has strong practical implications, because standard methods testing the resistance of materials to fracture seem not being sensitive to differences in disorder.

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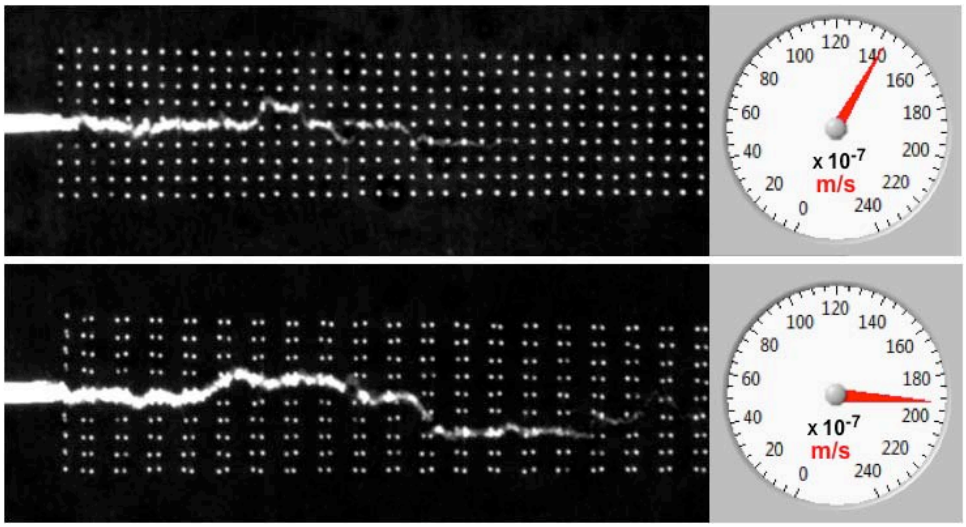

Long-range effective potential between two rods in a 2D granular fluid

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We present in silico simulations on a granular system consisting in a quasi-2D gas of spheres with a rod-like intruder and a fixed rod acting as a wall. We present effective potentials between this two rods as a function of dynamic friction and restitution coefficient between spheres and rods, obtained by inverting a radial distribution function. We find an oscillating behavior of the potential resulting from a layering of particles on the rods' surfaces. A long-range potential is observed to act at a distance as far as 20 sphere radii, strongly depending on both the restitution coefficient and friction coefficient.

Lock-in accelerometry to follow sink dynamics in shaken granular matter

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Understanding the penetration dynamics of intruders in granular beds is relevant not only for fundamental physics, but also for geophysical processes and construction on sediments or granular soils in areas potentially affected by earthquakes. While the penetration of intruders in two dimensional (2D) laboratory granular beds can be followed using video recording, this is useless in three dimensional (3D) beds of non-transparent materials such as common sand. Here, we propose a method to quantify the sink dynamics of an intruder into laterally shaken granular beds based on the temporal correlations between the signals from a *reference* accelerometer fixed to the shaken granular bed, and a *probe* accelerometer deployed inside the intruder. Due to its analogy with the working principle of a lock-in amplifier, we call this technique lock-in accelerometry.

Intercalation of Ciprofloxacin into Lithium-Fluorohectorite at different PHs

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Over the last decade, different porous materials have been used as hosts for drug encapsulation, and recently, due to its swelling properties and cation-exchange capacity, clays have been added to this list [1]. Additionally to its swelling properties and cation-exchange capacity, clays have been shown to be non-toxic for trans-dermal application and oral administration [2].

In this poster are presented an initial analysis of the intercalation of Ciprofloxacin, a broad-spectrum antibacterial agent, into the layers of the synthetic smectite *Lithium – Fluorohectorite* at different PHs. Is showed that the intercalation of the drug molecules is strongly dependent of the PH, being more effective at lower than higher PHs.

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Dancing to the vibes: Interaction of actively rotating granular particles

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The phase behavior of active matter, such as swimming bacteria, flocks of animals or even humans currently attracts huge interest in soft-matter physics. In these systems, in particular when the active particles have a complex shape, a huge variety of novel features is observed.

Here we introduce a system of active granular particles. Such active granulates can be created using rapid prototyping technology using an ingenious walker design introduced in [1]. Such particles can be excited to perform active rotation, driven by external vertical vibrations, therefore called Vibrots. We investigate systems of a large number of interacting Vibrots of either equal or opposite sense of rotation. The monodisperse case represents a new model system for quasi-2D granular gases driven homogeneously by active rotation. For the bidisperse system of opposite sense of rotation we observe segregation as previously predicted by numerical simulations [2].

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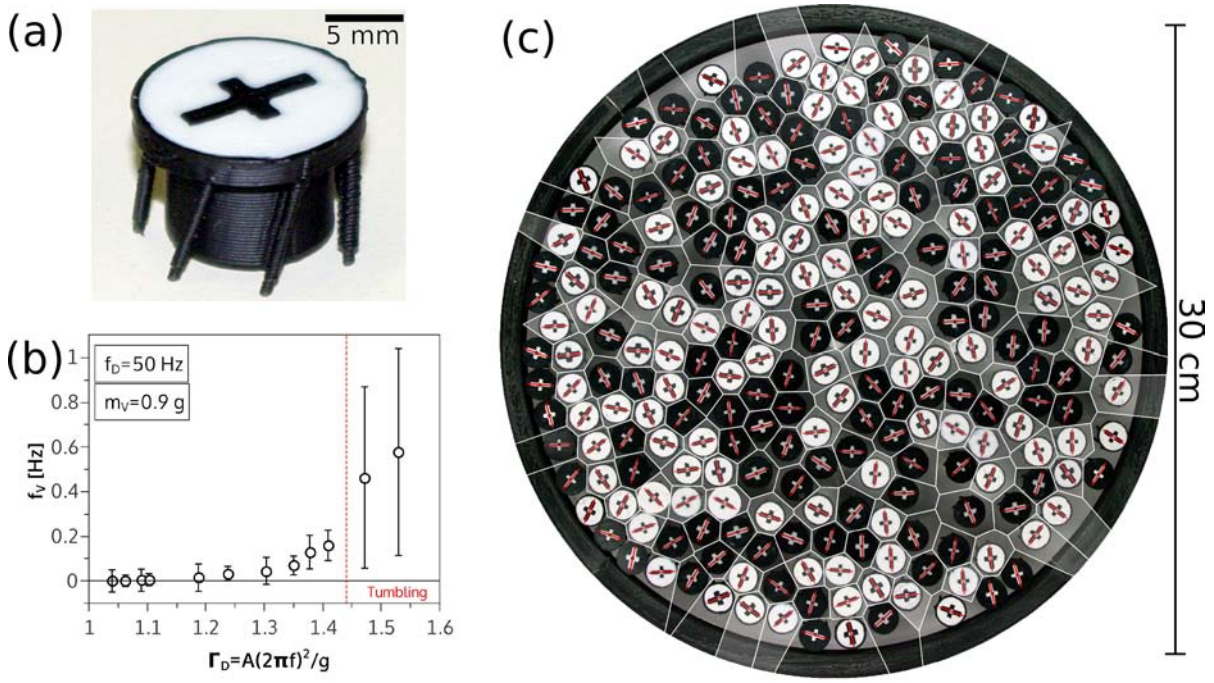

Figure: (a) Vibrot produced by rapid prototyping. (b) Dependence of mean rotational frequency f_V of the Vibrot on the driving acceleration Γ_D. Rotational motion is observed from $\Gamma_D \sim 1.1$ and larger. For significantly large accelerations the particles enter a tumbling state with significantly faster rotation but also larger variance of the instantaneous rotational velocity. (c) A circular system with a mixture of 128 counter-clockwise (white) and 127 clockwise (black) rotating Vibrots. As an overlay the orientation of the particles and the Voronoi tessellation corresponding to the particle positions is shown.

Quantitative experiments in disturbed ants

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In this poster, we offer a condensed overview of two groups of experiments exploring collective ant behavior in danger conditions.

First, we study the foraging dynamics of ants under danger conditions. We have approached the problem by abducting leaf-cutter ants from the species *Atta insularis* at a given point of the foraging trail in natural conditions, and quantifying its effect on several parameters of the foraging traffic in space and time. Contrary to common wisdom, our results reveal that ants do not pass to each other information to help foraging partners avoiding the abduction danger: the observed decrease in the foraging activity due to abduction can be explained simple by the decrease in the total available number of foragers.

Secondly, we have designed and performed experiments to probe the ability of ants to transmit individual-individual danger information within a short range. In our experiments, two horizontal Hele-Shaw cells are separated by different kinds of barriers. An *information permeable* (IP) barrier consists in a row of vertical pins that allow antennal contact between ants located into each cell, but do not allow ants to move from cell to cell. An *information impermeable* barrier (II) consists in thick pins that do not allow passing through, neither antennal contact. If the two cells are filled up with ants with an IP barrier, and an insect repellent is poured into the right one, the ants into the left cell move away from the barrier. That does not happen if the right cell contains no ants. The same couple of experiments (i.e. ants or no ants into the right cell) performed with a II barrier gives no significant shift away from the barrier of the ants in the left cell. So, we conclude that one of the functions of the antennal contact between ants is the transmission of danger information.

Extraterrestial sink dynamics in granular matter

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While the penetration of objects into granular media is well-studied, there is little understanding of how objects settle in gravities, g_{eff}, different from that of Earth—a scenario potentially relevant to the geomorphology of planets and asteroids and also to their exploration using man-made devices. By conducting experiments in an accelerating frame, we explore *g*eff ranging from 0.4 g to 1.2 g.

Surprisingly, we find that the rest depth is independent of *g*eff and also that the time required for the object to come to rest scales like $g_{eff}^{-1/2}$. With discrete element modeling simulations, we reproduce the experimental results and extend the range of *g*eff to objects as small as asteroids and as large as Jupiter. Our results shed light on the initial stage of sedimentation into dry granular media across a range of celestial bodies and also have implications for the design of man-made, extraterrestrial vehicles and structures.

Stick-Slip motion of granular dense flows detected trough experiments and numerical simulations

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Anomalous stages of increasing and decreasing avalanche front velocity, or stick-slip motion, were found through experiments of granular dense flows. Additionally, a speed increase at the slope change starting the deposition zone, or high speed ejection is reported. We corroborate through molecular-dynamics numerical simulations the same stick-slip behavior and high speed ejecta in the avalanche front velocity plots. Furthermore we found, in experiments and simulations, two main regimes of the instantaneous avalanche front velocity: a viscous regime and an unpredictable one, characterized by a stick-slip motion with a critical velocity between 4 m/s and 5 m/s.
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Interaction between a synthetic clay (LiFh) and *NSAIDs* drugs

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NSAIDs are *non-steroidal anti-inflammatory drugs*, including those with analgesic, antipyretic and anti-inflammatory effects. It is one of the most widely used group of drugs. It includes a large range of compounds that, although hardly having a direct chemical relationship, they share therapeutic activities and side effects, essentially at the level of the gastrointestinal tract. Clays are widely used in the pharmaceutical industry both as active components and as excipients.

In the present work, we studied the intercalation of *NSAIDs* acetaminophen, ibuprofen, sodium diclofenac, aspirin and tramadol into the synthetic clay Li-fluorhectorite (LiFh). Different parameters of the drug-clay system –pH, drug initial concentration, time and interaction temperature– were optimized in order to evaluate the clay as slow release support [1,2]. The solids after drug interaction were characterized by XRD, IR and TG. The best result was obtained for tramadol and sodium diclofenac, which demonstrated a higher affinity to LiFh. The drugs release profile from the composites showed that their incorporation is a reversible process, and it meets the pharmaceutical standard reported in the literature for these kinds of systems. A low intercalation for the rest of the drugs was observed.

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Some tips to operate in Havana

(by E. Altshuler)

Safety

Havana is pretty safe –definitively much safer than most Latin American capitals. However, you might be exposed to two types of thefts: pickpockets, and pulling cameras and other loosely hanging stuff. To prevent it, avoid close-packed human crowds, and hold expensive cameras and the like near your body. Using the Cuban-peso (CUP) bus system can easily bring you into the close-packing scenario. While serious observers say that returning alone to your hotel at 5:00 after spending the night in some obscure cabaret in Havana is perfectly safe, we cannot suggest it as the ideal *modus operandi* –especially if you have to deliver a talk the same day!. It is also advisable not to leave valuables at plain sight in your hotel room.

People approaching you in the streets

Cubans are very friendly, but some are overwhelmingly friendly. You may be approached by unknown people saying they'd like to be your friends. Unfortunately, that may be just the zero-order of the series. In a few minutes they will offer to guide you through the city, money exchange services, cigars, housing, transportation, Viagra, women, men,...It can be eventually annoying. We suggest you to kindly decline any offers, using a "No, thank you", or "No, gracias". Eventually kids may ask for coins or chewing gum ("chicklets").

Cuban currency

As in the two-fluid model of Superconductivity, two currencies circulate in Cuba: The Cuban Peso (CUP) and the Cuban Convertible Peso (CUC). [1 CUC ~ 23-24 CUP; 1 EUR ~ 1.25 CUC]. The CUC is typically used in hotels, non-LADA, non-1950's car taxis, and also in many stores and restaurants. If you plan to spend a short time in Cuba, you'll be basically using CUC's (see some CUC bills in the picture). To differentiate the use of the two currencies in different scenarios requires a special intuition hard to develop in a few days' visit. An easy-to-figure out situation would be a street vendor offering a toasted peanut cone ("maní"): –"How much is it?"– you'd ask –"Un peso"– they'd say. *That* means 1 CUP, not 1 CUC.

We very strongly suggest bringing cash to Cuba, and exchange it by CUC's in official exchange establishments (including the money for hotel payment). It is a good idea to exchange EUR or NOK (for example), but not USD, since there is an extra tax on those. On top, US-based credit cards don't work.

How to communicate

In the streets, English eventually works, but if you speak some words in Spanish or even Portuguese, it will help quite a bit. Professionals, people connected to tourism, and those spontaneously approaching you in the streets to be your friends, are generally able to communicate in English and possibly also in French, Russian, Italian, or Portuguese. There is, at least, one serious report of being approached in Norwegian without much preamble while standing on a street in Havana, but that's not a typical scenario.

Transportation

While Old Havana itself is walkable, motorized transportation may be useful to go to Vedado, Miramar, Playas del Este, etc., from Old Havana. We suggest using taxis in Cuban Convertible Pesos (CUC) from CUBATAXI or PANATAXI. They can be identified because they are new, non-LADA, non-1950's cars.

Since the use and interpretation of taximeter data by TAXI drivers is generally quite nonlinear, we suggest asking for the approximate fare *before* entering the TAXI. For example: "¿Cuánto es el viaje a la Universidad de La Habana?" (How much is the fare to the University of Havana?). To give a reference frame, it is worth noting that a trip from "José Martí" airport to downtown Havana could be in the range 20–25 CUC, while a trip from Old Havana to the University of Havana should not be more than, say, 5-6 CUC. If instead of a conventional TAXI you get a COCO-TAXI (a yellow motorcycle with three wheels and a spheroidal cabin in most cases), the fare should go a little bit up, following some accounts. If, when asked, the TAXI driver tells you an amount beyond reasonable limits, you apply the same formula as for the people-approaching-to-be-friends: "No, gracias", or "Gracias, demasiado caro" ("Thanks, too expensive"). Very probably you'll get a reasonable counter-proposal right away.

Tourism buses are a relatively inexpensive way to get around, including Playas del Este – some 20 km east from Old Havana. Purchase a 5 CUC ticket, and you can use them the whole day, at any bus stop. A popular stop is at Parque Central, just facing hotel "Inglaterra". The first bus departs to Playas del Este at 9 AM.

Physical Contact

In Cuba, physical contact is in the DNA of society: friends and colleagues shake hands everyday (male-to-male), or kiss everyday (male-to-female, female-to-female…and lately also male-to-male!). They also touch your body to underline their speech –not all of it, of course. Warnings from health authorities pointing out transmission of disease through handshakes and kisses are miserably hopeless: it's equivalent to suggest Norwegians to stop skiing because they have the highest statistics of broken ankles in the world. At any rate, in the academic context, Cubans do their best to forget the physical contact part of the folklore.

Diseases

Tap water can almost kill you in some countries of the region, but certainly not in Havana. However, if you abuse drinking Cuban tap water, you can go back home in bad microbial company: *Giardias* and *Amoebas*. So, avoid drinking tap water, and also eating greens served in places of doubtful sanitation. It is fair to assume that alcohol in mojitos and daiquirís compensate for the eventual tap-water ice in the drinks…another good reason to demand the right amount of rum in them!

By the end of the XIX Century, Cuban scientist Carlos J. Finlay discovered that diseases like the Yellow Fever could be transmitted by mosquitoes: thanks to his finding, sanitary measures were taken that allowed the Panama Canal to be finished. Nowadays, the basic serious disease in Cuba transmitted by a mosquito is the Hemorrhagic Dengue (it is only carried by the species *Aedes Aegypti*, with legs stripped in black and white). It mainly spreads in the summer months, and with low probability due to systematic sanitary measures. So, we have a few suggestions: (a) Bring mosquito repellent, and use it (b) When it gets dark, mosquitoes get really excited. Avoid being in shorts in the open at that time, especially at the beach. Actually they are quite effective attacking during the whole night, since the sleeper is off-guard: avoid sleeping in places without air conditioning during summer months –including June. Otherwise, use a mosquito net (c) If you feel feverish, with strong headache and joint pain, immediately inform it to the organizers or hotel personnel.

Regarding diseases, it is much more probable to get sunburn, to which you are exposed particularly from 11 to 15 hours. Try to avoid direct sunshine exposure during that time of the day…and bring even more sun-block lotion than insect repellent!

Weather

The period May – September feels hellishly hot in Havana, although maximum temperatures of 32 – 35 Celsius do not look very impressive: the problem is *high humidity*! So, bring light cotton clothing, with emphasis in *white and light colors* in general. Some excellent tourist guides on Cuba recommend dark clothes to "camouflage" sweat marks: that's an incredibly wrong choice! Sandals and shorts are good for the hot weather, but bad to protect your body against mosquitoes, so better bring a couple of options. On top, June can be a rainy month: bring also an umbrella. But don't panic: scientific meetings usually take place in air conditioned rooms with leak-free roofs: no hot, no mosquitoes. Hotels follow the same standards.

Get used to *Lo real-maravilloso*

Famous Cuban writer Alejo Carpentier coined the Caribbean's atmosphere as "Lo real-maravilloso" (The real-wonderful). You can get a first-hand feeling of it if you happen to run into some of the many supposed applications of the "pyramidal energy" –an initiative of a bunch of local, enthusiastic pseudo-scientists. In spite of the systematic fight against such ideas by hardcore Cuban scientists –very especially Cuban physicists!– you can find a dish called "Plancha Salvaje" in the menu of "La Torre de Marfil" restaurant, consisting in a combination of three types of meat…conveniently "energized" inside a pyramid!.

Main campus, University of Havana. The "Varona" building is behind the tree at the center (Photo: E. Altshuler).

Aula Magna, University of Havana (Photo: E. Altshuler)

El Morro castle (Photo: M Jovaiša)

Cannon shot at El Morro-Cabaña castle (photo: O. Ramos)

Hotel Nacional de Cuba

Cuba Pasión restaurant (alias IKEA) (Photo: E. Altshuler)

El Gato Tuerto restaurant-bar (Photo: E. Altshuler)

La Casona de 17 restaurant-bar (Photo: E. Altshuler)

Maps and locations directly or indirectly connected to MarchCOMeeting'15