Abstracts from

March*COM*eeting'12

Complex matter physics: materials, dynamics and patterns

Havana, Cuba, March 6-9, 2012

Edited by:

Ernesto Altshuler and Jon Otto Fossum

Invited speakers:

L. Kadanoff (Univ. Chicago, USA)
D. Barkley (U. Warwick, UK)
A. J. Batista-Leyva (Instec)
B. Behringer (Duke Univ., USA)
E. Clément (ESPCI, France)
H. van Damme (LCPC/ESPCI Paris, France)
P. Dommersnes (Universitè Paris 7, France)
O. Douchot (ESPCI, France)
D. Durian (Univ. Pennsylvania, USA)
E. Fort (Univ. Paris 7, France)

Havana landscape in red, René Portocarrero, 1962:

E. Grude Flekkøy (Univ. Oslo, Norway)
J. Ch. Geminard (ENS-Lyon, France)
I. Ippolito (UBA, Argentina)
H. Jaeger (Univ. Chicago, USA)
T.H. Johansen (Univ. Oslo, Norway)
G. Helgesen (IFE, Norway)
M. H. Jensen (NBI Copenhagen, Denmark)
K.D. Knudsen (IFE, Norway)
J. Mathiesen (NBI Copenhagen, Denmark)
J. Nieto (Univ. Havana, Cuba)
R. Pynn (Univ. Indiana, USA)
S. Raaen (NTNU, Norway)
O. Ramos (Univ. Lyon1, France)
C. Ruiz (PIIT-Monterrey, Mexico)
S. Santucci (ENS-Lyon, France)
B. Sandnes (NTNU, Norway)
T. Shinbrot (Rutgers Univ., USA)
O. Sotolongo (Univ. Havana, Cuba)
P. Tabeling (ESPCI, France)
L. Tuckerman (ESPCI, France)
R. Toussaint (Univ. Strasbourg, France)
G. Vasconcelos (UFPE, Recife Brazil)

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materials, dynamics and patterns

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Webedition

Group photo taken at the stairs of the University of Havana:

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True complexity

For some, a meeting on Complexity is like a big sack where can you put whatever you like. Eventually that approach results in a disjoint collection of subjects, were the only common feature is that each author has conveniently sprinkled some of the “magic keywords" to his/her talk or poster, such as "emergent phenomena", "strange attractor" or "self-organization".

We have done our best to circumvent that risk in the March*COM*eeting.

Indeed, the abstracts you'll find below share important aspects beyond the use of some “magic keywords”. In addition to the aim to quantify and model phenomena using mathematical and computational tools –as generally expected in the field of Physics–, many of the subjects approached are strongly nonlinear, and contain many degrees of freedom. In fact, when one examines the submitted contributions, it is easy to see the proliferation of quite specific subjects, such as avalanches –which can be explicitly found in the title of several abstracts spanning from granular matter and complex fluids, to superconducting vortex dynamics.

Perhaps the most complex issue we have faced, has been to organize this meeting in Cuba –a "strange attractor"[1] where local physics is striving to survive against all kinds of material shortages.

The small, but enthusiastic Cuban community of physicists working in the field of Complexity (many associated to the "Henri Poincarè" Group of Complex Systems at the University of Havana) is one of the forces pushing towards the development of local physics, sometimes using the strategy of "animating" old and/or inexpensive equipment by the injection of fresh ideas. We hope that the celebration of the March*COM*eeting in Havana will catalyze –perhaps in more than one way –that process.

It is fair to say that the March*COM*eeting has been possible due to the extraordinary support of the Centre for Advanced Study at the Norwegian Academy of Sciences and Letters (CAS), and also to the contribution of the "Abdus Salam" International Centre for Theoretical Physics (ICTP). The Physics Faculty, and the IMRE, University of Havana, and the Cuban Physical Society should be also thanked for their organizational support and enthusiasm. But the key element for the celebration of the March*COM*eeting has been the extraordinary will to go ahead with the project of most participants.

We hope you will spend a wonderful week in Havana, where the end of each scientific session on the Physics of Complexity doesn't mean at all that complexity has ended.

Ernesto Altshuler
Jon Otto Fossum

[1] Some hints to navigate into the attractor are found at the end of this booklet

Thank you to our sponsors:

ICTP
The Abdus Salam
International Centre for Theoretical Physics

Thank you to our local organizers:

"Henri Poincarè"
Chair of Complex Systems,
Physics Faculty,
University of Havana

March*COM*eeting'12:

The Organizing Committee

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Department of Physics, Norwegian University of Science and Technology (NTNU), Trondheim, Norway

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"Henri Poincarè" Group of Complex Systems, Physics Faculty, University of Havana, Cuba.

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Physics Department, University of Oslo

Knut Jorgen Måløy
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The local Organizing Committee

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

Opening:

Ernesto Altshuler

Jon Otto Fossum

Opening:

Norwegian Ambassador to Cuba: John Petter Opdahl:

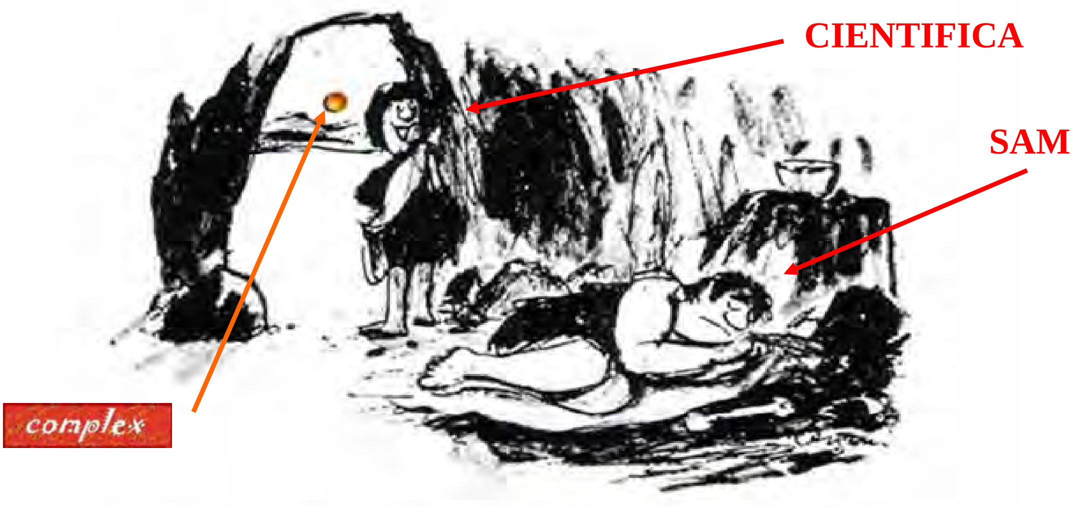
President Scientific Council, University of Havana: Dr. Luis A. Montero:


Why are we here?
(At this workshop in Havana)


Why are we here?
(At this workshop in Havana)
TAXI
BDJ161
HES616


Why are we here?
(At this workshop in Havana)

Why are we here?
(<u>fex.</u> At this workshop in Havana)



«HEY, SAM, THE BIG ROUND YELLOW THING CAME UP AGAIN»

To ask and answer some basic questions in the light of Complexity

Leo Kadanoff wrote:

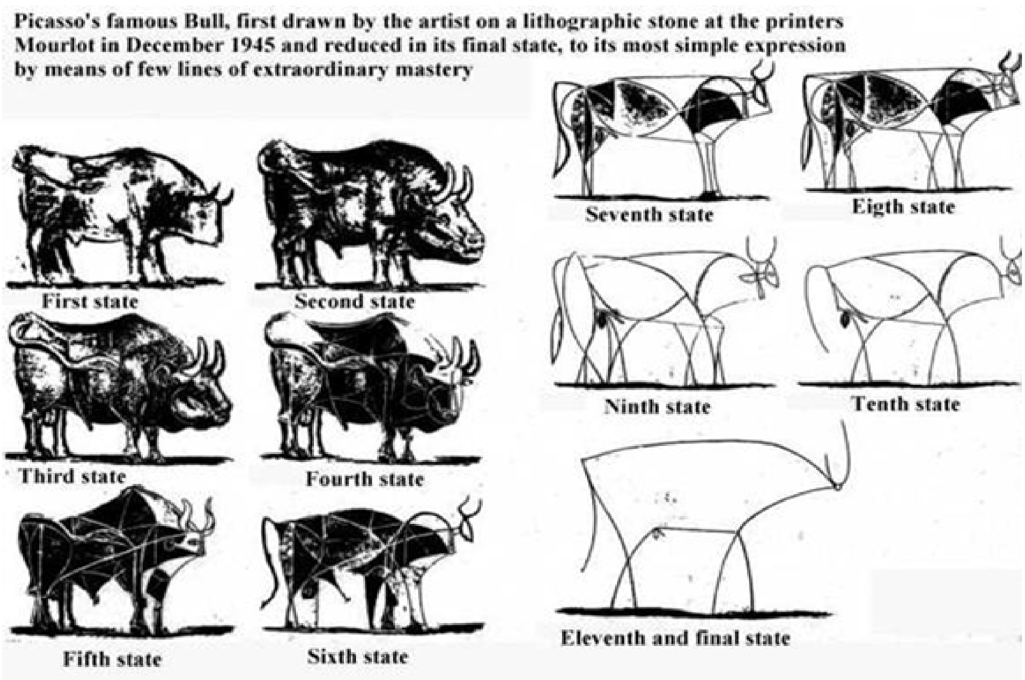
To extract physical knowledge from a complex system, one must focus on the right level of description

from the right level of observation.
(J.O. Fossum)

"No, Donaldson, they don't look like ants, they look like consumers."

Right level of observation:

Removal of redundancy



March*COM*eeting'12, Havana, March 6-9, 2012: *Spatial-temporal diagram*

Registration on Monday, from 18:00 – 20:00, at "Ambos Mundos" (1st floor)

Time	Tuesday 6	Wed. 7	Thursday 8	Friday 9	Time
08:30-09:00	Second Moment registration				08:30-09:00
09:00-09:20		Sandnes	Knudsen	Dommersnes	09:00-09:20
09:20-09:50	Establishing the power laws	Flekkøy	Helgesen	León	09:20-09:40
		Mathiesen	Coffee fracture and bus to UH (Yutong's law)	García	09:40-09:50
09:50-10:00	L. Kadanoff			Cruz	09:50-10:00
10:00-10:20		Toussaint		Clemént	10:00-10:20
10:20-10:40	Dauchot	Santucci		Miño	10:20-10:30
				Figueroa-Morales	10:30-10:40
10:40-11:10	Coffee Fracture			Coffee Fracture	10:40-11:10
11:10-11:30	Geminard	Raaen	Van Damme	O. Sotolongo	11:10-11:30
11:30-11:50	Durian	Pynn	Behringer	Lage	11:30-11:40
				Nieto-Villar	11:40-12:00
11:50-12:00	Ruiz-Suárez	Niebling	Jaeger		
12:00-12:10		Alm Eriksen		Tabeling	12:00-12:20
12:10-14:00	AvaLunch		Group snapshot (& Lunch instability)	Visit to Cigar Factory	12:20-14:00
14:00-14:10	Ippolito	Rozynek		AvaLunch	14:00-15:50
14:10-14:20		SaintYves			
14:20-14:30	Ramos	Hemmen	Traffic Flow		
14:30-14:40		Castberg			
14:40-14:50	Vasconcelos	Mauroy			
14:50-15:00		del Río			
15:00-15:30	Coffee fracture				
15:30-15:50	Shinbrot	Ortiz			
15:50-16:10	Batista-Leyva	Guillamón			
16:10-16:20	Martínez-Román	Vestgården			
16:20-16:30	Waitukaitis	Yurchenko	Bergli		
16:30-16:40	Poster session (with fingering food and fluid instability)	Fracture			
16:40-17:00			Reiter		
17:00-17:20		Hoyos	Hernández		
			Moura		
17:20-17:40		Jensen	Fort		
17:40-18:00		Round Table*	Tuckerman	Cut-off & Rhum table	17:40-18:00
18:00-18:20			Barkley		18:00-18:20
18:20-19:40			19:40 Bus departs to "shot noise" ceremony		18:20-19:40
19:40-20:00				Life in Turbulence?	19:40-20:00
20:00-21:30		Supper (conductivity)			20:00-21:30

*Complex systems: doing cutting-edge experimental Physics on a small budget: (Moderator: Fossum / Panel: Altshuler, Måløy, Bouchaud, Ippolito, Sotolongo, Tabeling)

Chairmen:

	Tuesday	Wednesday	Thursday	Friday
Morning	Altshuler/Fossum	Bouchaud/Helgesen	Pynn/Sotolongo	Altshuler/Fossum
Afternoon	Måløy/Dommersnes	Knudsen/Johansen	Vasconcelos/Jensen	

Location color code:

	"Ambos Mundos" hotel		"San Gerónimo" Campus		Aula Magna, Main University Campus

Obispo Street and Hotel Ambos Mundos in Old Havana:

From the Aula Magna at the University of Havana Main Campus in Vedado:

MONDAY 5
"Ambos Mundos" hotel, 1st Floor
18:00 – 20:00
REGISTRATION

TUESDAY 6

Place	Chair	Time	Activity
Ambos Mundos		**8:30 – 9:20**	Second Moment registration
		9:20 – 9:50	*Establishing the power laws/* **J. O. Fossum & E. Altshuler**
	JO F	**9:50 – 10:20**	*Synchronization: a simple process?/***L. Kadanoff**
		10:20 – 10:40	*Rheology of vibrated granular media/***O. Dauchot**
Ambos Mundos		**10:40 – 11:10**	**Coffee fracture**
Ambos Mundos	**E. Altshuler**	**11:10 – 11:30**	*Softening Induced Instability of a Stretched Cohesive Granular Layer/***J. Ch. Geminard**
		11:30 – 11:50	*Granular Impact Cratering/***D. Durian**
		11:50 – 12:10	*The morphology of impact craters: Grains vs grains/* **C. Ruiz-Suárez**
Torre de Marfil		**12:10 – 14:00**	**Avalunch**
Ambos Mundos	**K. J. Måløy**	**14:00 – 14:20**	*Influence of relative humidity on avalanche phenomenon in granular piles/***I. Ippolito**
		14:20 – 14:40	*Scale invariant avalanches: a critical confusion/* **O. Ramos**
		14:40 – 15:00	*On the origin of power law distributions/* **G. Vasconcelos**
Ambos Mundos		**15:00 – 15:30**	**Coffee fracture**
Ambos Mundos	**P. Dommersnes**	**15:30 – 15:50**	*Electrical precursors to granular slip events/* **T. Shinbrot**
		15:50 – 16:10	*A particle on a rough inclined plane: an experimental approach /***A. J. Batista-Leyva**
		16:10 – 16:20	*Strange phenomena in Cuban sands/***E. Martínez**
		16:20 – 16:30	*Why you can walk on a suspension of cornstarch and water/***S. Waitukaitis**
Ambos Mundos		**16:30 – 19:40**	**Poster session** (with fingering food and fluid instability)

WEDNESDAY 7

Place	Ch.	Time	Activity
Ambos Mundos	**E. Bouchaud**	**9:00 – 9:20**	*"Here be dragons". A tentative phase map for granular mixtures/* **B. Sandnes**
		9:20 – 9:40	*Labyrints and frictional fluid flow/***E. G. Flekkoy**
		9:40 – 10:00	*Complex patterns and speciation on the rock /***J. Mathiesen**
		10:00 – 10:20	*Flow of dense mixed suspensions: liquefaction, avalanches and fluidofracture /***R. Toussaint**
		10:20 – 10:40	Avalanche dynamics of imbibition fronts/ **S.Santucci**
Ambos Mundos		**10:40 – 11:10**	**Coffee fracture**
Ambos Mundos	**G. Helgesen**	**11:10 – 11:30**	*Growth of metal nanostructures on graphite and their chemical properties/* **S. Raaen**
		11:30 – 11:50	*Structural Studies of Mixed Nano-Spheres and Polymers/***R. Pynn**
		11:50 – 12:00	*Dynamic aerofracture of dense granular packings* / **M.J.Niebling**
		12:00 – 12:10	*A Numerical Approach to Stick-Slip dynamics in Granular Fluids/***J. A. Eriksen**
Torre de Marfil		**12:10 – 14:00**	**Avalunch**
Ambos Mundos	**K.D.Knudsen**	**14:00 – 14:10**	*Self-organization from Electrically Polarized Clay Particles/***Z. Rozynek**
		14:10 – 14:20	*From fingering to fracture in complex fluids/***B. SaintYves**
		14:20 – 14:30	*Carbon dioxide intercalation in Na-fluorohectorite clay at near-ambient conditions/***H. Hemmen**
		14:30 – 14:40	*Using a high speed camera to study alignment of Sodium Flourohectorite/***R. Castberg**
		14:40 – 14:50	*Anisotropy in PS-clay nanocomposites/***H. Mauroy**
		14:50 – 15:00	*Transversal current transport in BSCCO-Ag tapes/***L. del Río**
Ambos Mundos		**15:00 – 15:30**	**Coffee fracture**
Ambos Mundos	**T. H. Johansen**	**15:30 – 15:50**	*Anomalous flux avalanche morphology in patterned superconducting films/***W. A. Ortiz**
		15:50 – 16:10	*Direct observation by scanning tunneling spectroscopy of some collective behaviors of vortices at very low temperatures/***I. Guillamón**
		16:10 – 16:20	*Micro- and macro-avalanches in superconductors/***J. I. Vestgården**
		16:20 – 16:30	*Formation of quasi-1D clusters in vortex matter and their role in thermo-magnetic instability of superconductors/* **V. V. Yurchenko**
		16:30 – 17:00	**Fracture**
Ambos Mundos	**J. O. Fossum**	**17:00 – 17:20**	*Novel particle, bacteria and nano-rod structures generated by ultrasonic standing waves in a resonator/***M. Hoyos**
		17:20 – 17:40	*Life in Turbulence/***M. H. Jensen**
		17:40 – 19:40	*Round Table "Complex Systems: doing cutting-edge experimental Physics on a small budget/***Altshuler, Bouchaud, Ippolito, Måløy, Sotolongo, Tabeling**
		20:00 – 21:30	**Supper(conductivity)**

THURSDAY 8

Place	Chair	Time	Activity
"San Gerónimo" campus	R. Pynn	9:00 – 9:20	*A new polymer and its temperature-induced transitions/***K. D. Knudsen**
		9:20 – 9:40	*Field induced microparticle structure formation in fluids/***G. Helgesen**
Ambos Mundos & buses		10:00 - 11:10	**Fast Coffee fracture and fast flow to the Main campus of the University of Havana in bus**
Aula Magna, University of Havana	O. Sotolongo	11:10 – 11:30	*Swelling, creep, flow and fracture in clay muds, sediments and rocks:A mesoscopic and model approach/***H. Van Damme**
		11:30 – 11:50	*Forces, fluctuations and jamming for granular materials/***R. Behringer**
		11:50 – 12:10	*Random packings under stress/* **H. Jaeger**
UH Stairs		12:10 – 12:30	**Group snapshot**
La Roca		12:30 – 14:20	**Lunch instability**
		14:20 – 14:40	**Traffic Flow: Bus to Old Havana**
Ambos Mundos	G. Vasconcelos	16:20 – 16:40	*Relaxation processes in Coulomb glasses/***J. Bergli**
		16:40 – 17:00	*Water as a complex quantum network/***G. Reiter**
		17:00 – 17:10	*A rheological model based on nonlocal relations between shear stress and velocity gradients for complex fluid/***A. Hernández**
	M.H. Jensen	17:10 – 17:20	*Vortex dynamics in multiply-connected domains/* **M. N. Moura**
		17:20 – 17:40	*Path-Memory driven dynamics: wave-particle duality with walking droplets/***E. Fort**
		17:40 – 18:00	*Name of seminar/* **L. Tuckerman**
		18:00 – 18:20	*Critical point for pipe flow/***D. Barkley**
		19:40 – 21:30	**Visit to the "Cañonazo de las 9" ceremony, across Havana harbour: Shot noise**

FRIDAY 9

Place	Ch.	Time	Activity
Ambos Mundos	J. O. Fossum	**9:00 – 9:20**	*Fractal avalanche ruptures in biological membranes/* **P. Dommersnes**
		9:20 – 9:40	*IL-2 muteins for the therapy of cancer: A success experience of combining dry and wet biology/***K. León**
		9:40 – 09:50	*Modeling the role of IL-2 in the interplay between CD4+ helper and regul-atory T cells: Studying the impact of IL-2 modulation therapies/***K. García**
		09:50 – 10:00	*On the role of the intrinsic noise on the response of the p53-Mdm2 Module/***L. Cruz**
		10:00 – 10:20	*Rheology and transport of active bacteria suspensions/* **E. Clemént**
		10:20 – 10:30	*Flow-controlled densification of E. Coli through a constriction/***G. Miño**
		10:30 – 10:40	*Study of the mechanisms of counterstream penetration of blood in vascular catheters/***N. Figueroa-Morales**
Ambos Mundos		**10:40 – 11:10**	**Coffee fracture**
Ambos Mundos	E. Altshuler	**11:10 – 11:30**	*Tsallis' formalism in radiobiology/***O. Sotolongo**
		11:30 – 11:40	*Characterizing and Improving Generalized Belief PropagationAlgorithms on 2D Edwards-Anderson Model/* **A. Lage**
		11:40 – 12:00	*Thermodynamics and complexity/***J. M. Nieto-Villar**
		12:00 - 12:20	*Experiments on droplet baed microfluidics/***P. Tabeling**
		12:20 – 14:00	**Visitis to cigar factories**
Torre de Marfil		**14:00 – 15:50**	**Avalunch**
		15:50 – 17:40	
Ambos Mundos roofstops		**17:40 – 19:40**	**Cot off & Rhum table**
			Life in Turbulence?

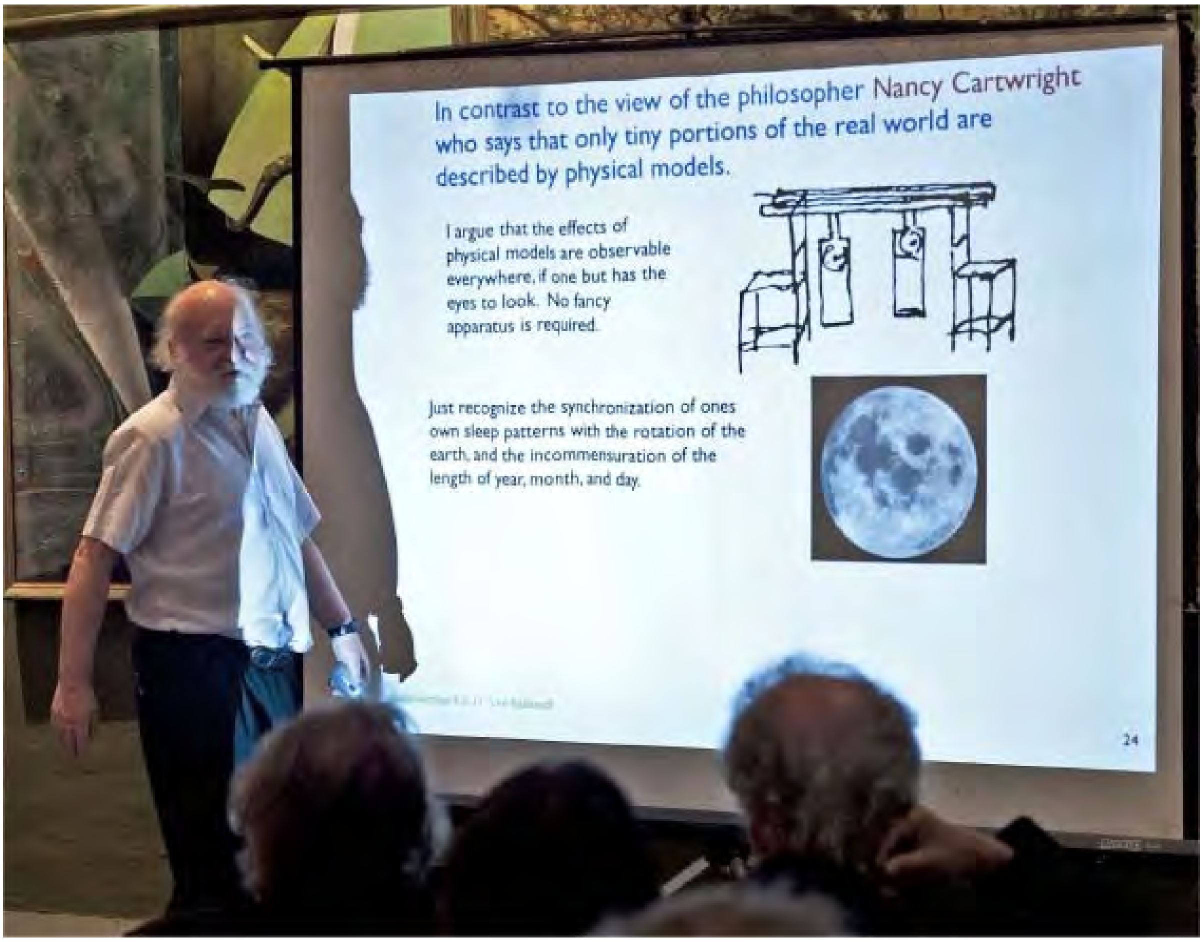
Poster presenters (33):

M. A. Aguirre (Universidad de BuenosAires, Argentina): *Discharge of a granular material through an aperture: independence of flow rate with pressure.*
J. L. Arauz-Lara (Universidad Autónoma de San Luis Potosí, México): *Hydrodynamic correlations between confined colloidal particles.*
Severine Atis (FAST Orsay Cedex, FRANCE): *Dynamics and pattern formation of self-sustained fronts in disordered flow.*
Alberto Batista (University of Havana, Cuba): *Roughness and fractality in the study of some geophysical and atmospheric phenomena.*
Joakim Bergli (University of Oslo, Norway) Experimental Demonstration of Snell's Law for Shear Zone Refraction in Granular Materials
Sebastián Bianchini (University of Havana, Cuba): *Upstream contamination in water pouring.*
Alejandro Borroto (University of Havana, Cuba): *Transversal conduction through multi-filamentary superconducting tapes.*
Rene Castberg (University of Oslo, Norway): *Electric field induced rotation of Clay particles.*
Angélica Castro (CNRS-ESPCI, Paris, France): *Aggregation forces measurement of levitating particles and cells in an ultrasonic resonator.*
Lidice Cruz (University of Havana,Cuba): *On the role of the intrinsic noise on the response of the p53-Mdm2 module.*
Rogelio Díaz-Méndez (CUJAE/University of Havana, Cuba): *Understanding the dynamics at the Spin Reorientation Transition.*
Rogelio Díaz-Méndez (CUJAE/University of Havana, Cuba): *On the equilibrium structures of the Ginzburg-Landau Hamiltonian with competing interactions.*
Jon Alm Eriksen (University of Oslo, Norway): *A Numerical Approach to Stick-Slip dynamics in Granular Fluids*
J. Fernández (University of Havana, Cuba): *Quantifying ant's traffic*
Jon Otto Fossum on behalf of Elisabeth Lindbo Hansen (Norwegian University of Science and Technology - NTNU, Trondheim, Norway): *Evaporation induced order in aqueous phases of clays.* and *The effects of temperature on the rheology and structure of clay suspensions.*
Nuris Figueroa-Morales (University of Havana, Cuba): *Study of the mechanisms of counterstream penetration of blood in vascular catheters.*
Karina García-Martínez (Centro de Inmunología Molecular, Habana, Cuba): *Modeling the role of IL-2 in the interplay between CD4+ helper and regulatory T-cells: Studying the impact of IL-2 modulation therapies*
Alberto González (University of Havana, Cuba): *The FABULAB project: low-budget experiments in the Solar System.*

Henrik Hemmen (Norwegian University of Science and Technology – NTNU , Trondheim, Norway): *X-ray studies of interlayer water absorption and mesoporous water transport in a weakly hydrated clay*
J. Iñiguez (Universidad de Salamanca/ Universidad de Valladolid, Spain): *Electromagnetic characterization of metal foams by means of low frequency induced currents.*
Alejandro Lage (University of Havana, Cuba): *Characterizing and Improving Generalized Belief Propagation Algorithms on 2D Edwards-Anderson Model.*
Anabel Lam (IMRE/ University of Havana, Cuba): *Mesoscopic simulations of micelles formation and drugs encapsulation.*
Etién Martínez (University of Havana, Cuba): *Strange flow phenomena in Cuban sands.*
Joachim Mathiesen (Niels Bohr Institute, University of Copenhagen, Denmark/PGP, University of Oslo, Norway): *Pattern formation in stressed multiphase systems*
Henrik Mauroy (Institute for Energy Technology - IFE, Kjeller, Norway): *Phase separations in PNIPA-Laponite Nanocomposites.*
Ernesto Altshuler (University of Havana, Cuba): *Flow-controlled densification of E. Coli through a constriction*
Marcel N. Moura (Universidade Federal de Pernambuco - UFPE, Recife, Brazil): *Vortex motion around multiple obstacles*
Michael J. Niebling (University of Oslo, Norway): *Numerical simulations of hydraulic fractures*
Aramis Rivera (IMRE/University of Havana, Cuba): *Clay-based composites for drug delivery: preliminary studies*
Zbigniew Rozynek (Norwegian University of Science and Technology – NTNU, Trondheim, Norway): *Clay-oil droplet suspensions in electric field*
Baudouin SaintYves (CEA-Saclay, DSM/IRAMIS/SPEC, Gif-sur-Yvette Cedex, France) : *From fingering to fracture in complex fluids*
Jørn Inge Vestgården (University of Oslo, Norway): *Avalanches in superconducting films*
Vitaliy V. Yurchenko (University of Oslo, Norway): *Formation of quasi-1D clusters in vortex matter and their role in thermo-magnetic instability of superconductors*

TALKS

Need of punctuality: the maraca cut-off


In contrast to the view of the philosopher Nancy Cartwright who says that only tiny portions of the real world are described by physical models.
I argue that the effects of physical models are observable everywhere, if one but has the eyes to look. No fancy apparatus is required.
Just recognize the synchronization of ones own sleep patterns with the rotation of the earth, and the incommensuration of the length of year, month, and day.
24

Synchronization: a simple process?

Leo P. Kadanoff
James Franck Institute, University of Chicago
(lkadanoff@gmail.com)

In collaboration with: Møgens H. Jensen , Copenhagen University, Denmark & Perimeter Institute, Canada (mhjensen@nbi.dk)

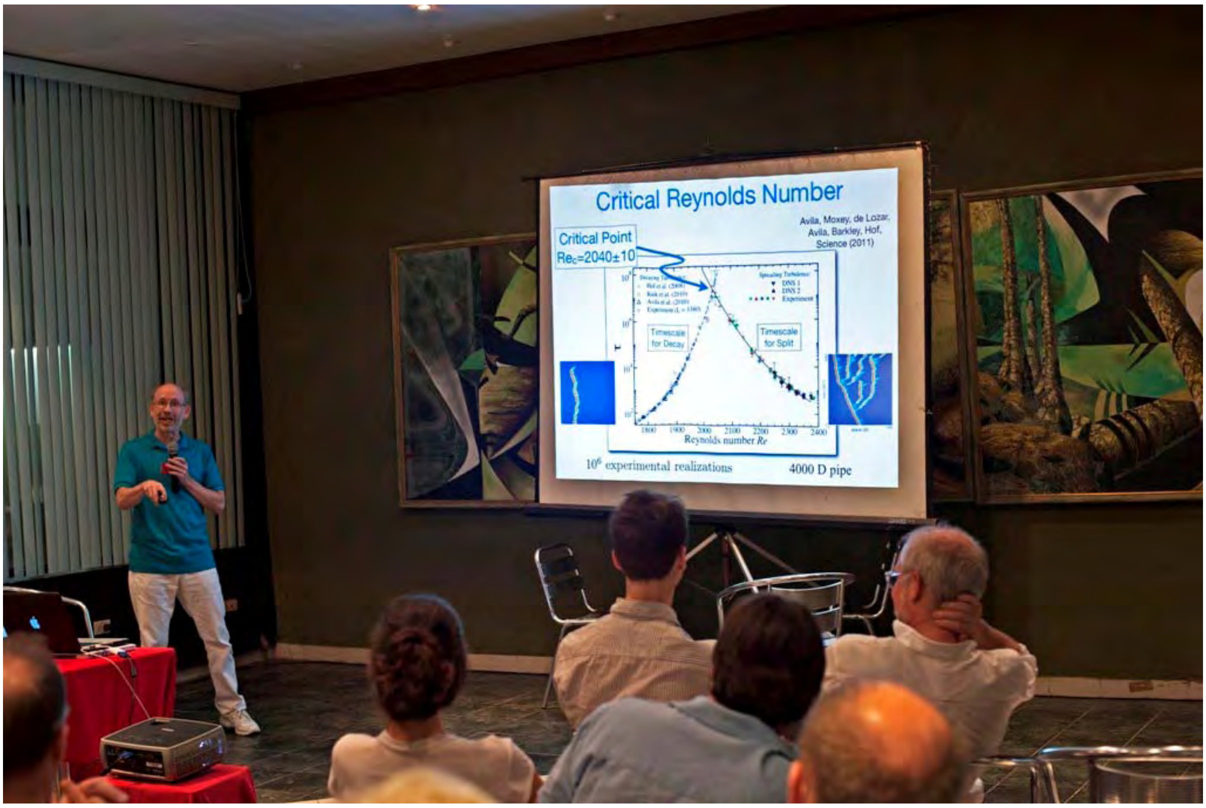
In 1665, the clockmaker Christiaan Huygens noticed that two pendulum clocks hanging on a wall tend to synchronize the motion of their pendulums. A similar scenario occurs with two metronomes placed on a piano: they interact through vibrations in the wood and will eventually coordinate their motion. The circle model, introduced by A.N. Kolmogorov and extensively analyzed by V. I. Arnold, describes this phenomenon. This model leads to a very complex phase diagram that probes the difference between rational and irrational numbers. The complexities of this phase diagram have been observed within experimental observations of fluid flow, solid state devices, and non-linear electrical circuits. It has been analyzed by physicists, mathematicians, and engineers using, among other methods, computer simulations and renormalization analysis.

Leo P.Kadanoff

Critical point for pipe flow (20 min)
Dwight Barkley
Mathematics Institute, University of Warwick, UK
(D.Barkley@warwick.ac.uk)

In collaboration with: K. Ávila, D. Moxey, M. Avila, A. de Lozar, and B. Hof.

More than 125 years ago Osborne Reynolds launched the quantitative study of turbulent transition as he sought to understand the conditions under which fluid flowing through a pipe would be laminar or turbulent. Since laminar and turbulent flow have vastly different drag laws, this question is as important now as it was in Reynolds' day. Reynolds understood how one should define ``the real critical value" for the fluid velocity beyond which turbulence can persist indefinitely. He also appreciated the difficulty in obtaining this value. For years this critical Reynolds number, as we now call it, has been the subject of study, controversy, and uncertainty. Now, more than a century after Reynolds pioneering work, we know that the onset of turbulence in shear flows is properly understood as a statistical phase transition. For pipe flow the transition corresponds to directed percolation in 1+1 dimensions. Through the statistical analysis of large samples of individual decay and proliferation events, we at last have an accurate estimate of the real critical Reynolds number for the onset of turbulence in pipe flow, and with it, an understanding of the nature of transitional turbulence.



Dwight Barkley

A particle on a rough inclined plane: an experimental approach (20 min)

Alfo José Batista-Leyva
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In collaboration with: Jesús Carlos Ruiz-Suárez, Centro de Investigaciones y Estudios Avanzados, Unidad Monterrey, MÉXICO.

In this work we developed a toy model of a bead rolling down a rough inclined plane with slope varying randomly. The system consists of a long cooper rectangle and metallic beads with different magnetization. Randomness is introduced via different orientations on the magnetic dipole moment: this different orientation implies different interaction forces between the permanent magnetic moment of the bead, and the induced magnetic dipole moment of the diamagnetic plane. Varying the angle of the incline, the initial velocity of the beads, and their magnetic moment, we explore the phase diagram (horizontal acceleration, slope), and compare it with the results of the model presented in ref. [1], and a model which considers the continuous variation of the restitution coefficient.

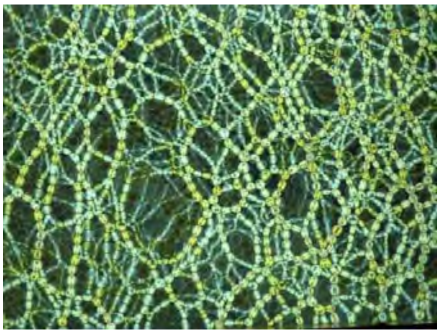
[1] U. M. B. Marconi, M. Compti, A. Vulpani. Motion of a granular particle on a rough line. Europhys. Let. 51 (6) p. 685 (2000).

Alfo José Batista-Leyva

Forces, fluctuations and jamming for granular materials (20 min)

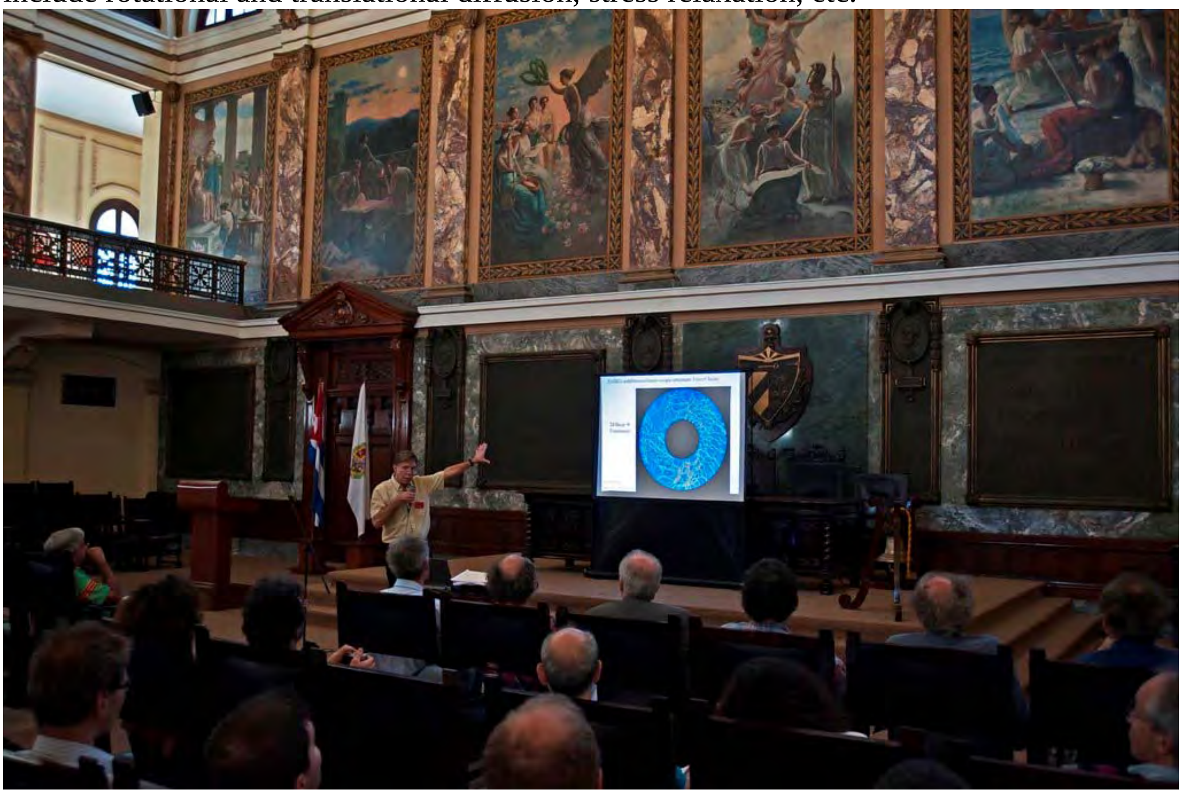
Robert Behringer
Physics Department and Center for Nonlinear and Complex Science (CNCS), Duke University, USA
(bob@phy.duke.edu)

This talk will focus on experiments to characterize the statistical properties of granular materials, particularly near jamming.



Jamming occurs for a collection of particles when the density, or some other property is varied, causing the system to change from a fluid-like state to a solid-like state. Many different types of systems exhibit this property, including not only granular materials, but also foams, colloids, suspensions, etc. Often, thi transition is modeled using collections of frictionless particles with short-range interactions.

In experiments using photoelastic particles with friction, we see a much richer behavior in the vicinity of jamming. In particular, the application of shear strain to samples below the isotropic jamming point-J, can produce jammed anisotropic states, which we call shear-jammed states. During an experiment of this type, we find that as the shear strain proceeds, the system passes from unjammed-liquid like to fragile to shear-jammed. The Fragile states are characterized by a force network that percolates in the compressive shear direction but not in the dilational direction. Shear-jammed states have a force network that percolates in all directions. As time permits, I will present work for dynamical processes near the shear-jamming region that include rotational and translational diffusion, stress relaxation, etc.



Robert Behringer

Relaxation processes in Coulomb glasses (20 min)

Joakim Bergli
Department of Physics, University of Oslo, P.O. Box 1048 Blindern, NO-0316 Oslo, Norway
(joakim.bergli@fys.uio.no)

In collaboration with: Y Galperin, Department of Physics, University of Oslo, P.O. Box 1048 Blindern, NO-0316 Oslo, Norway

Coulomb glasses are materials with electron states localized by the disorder under conditions of long-range interactions between their particles. One realization of a Coulomb glass is a doped semiconductor at low temperatures. Such systems are used as low-temperature sensors and detectors. Another example is granular metals. Coulomb glasses show complex dynamics typical for other complex systems: sluggish, non-exponential, relaxation of the conductance as well as aging and memory effects similar to those observed in structural glasses.

We report dynamical Monte Carlo simulations of relaxation processes in a Coulomb glass. Both the relaxation to equilibrium following an initial temperature quench and the fluctuations around equilibrium was studied. We find that the autocorrelation function of the energy decays as a streched exponential function indicating constrained dynamics of the system at low temperature. We also see that out of equilibrium there is an effective electron temperature established on a short timescale which slowly relaxes to the bath temperature. We also study the response of the system to an external perturbation and observe how it relaxes after such a perturbation

Joakim Bergli

Using a high speed camera to study alignment of Sodium Flourohectorite (10 min)

Rene Castberg
Physics Department, NTNU, Norway
(rene@castberg.org)

In collaboration with: Zbigniew Rozynek[1], Knut Jørgen Måløy[2], Jon Otto Fossum[1], Eirik Flekkøy[2], Paul Dommersnes[3]
[1] Physics Depatrment, NTNU, Norway
[2] Physics Department, University of Oslo, Norway
[3] MSC Univ. Paris 7

Application of an electric field induces Sodium Flourohectorite caly particles suspended in silicon oil to form chains. Studies on the order of seconds up to several minutes have been made, using WAXS and video methods. Due to the temporal resolution of these methods the initial alignment and behaviour of the particles when the field is first applied is not that well understood. By utilizing a high speed camera we have been able to measure the angle of rotation as these clay particles first align with the electric field. Using this data and a simple model we hope to be able to determine which charges are involved in the alignment when the field is applied. In addition we hope to be able to explain the effects of the amplitude and frequency of the field, the viscosity of the oil, and the shape of the particles.

Rene Castberg

Rheology and transport of active bacteria suspensions (20 min)

Eric Clément
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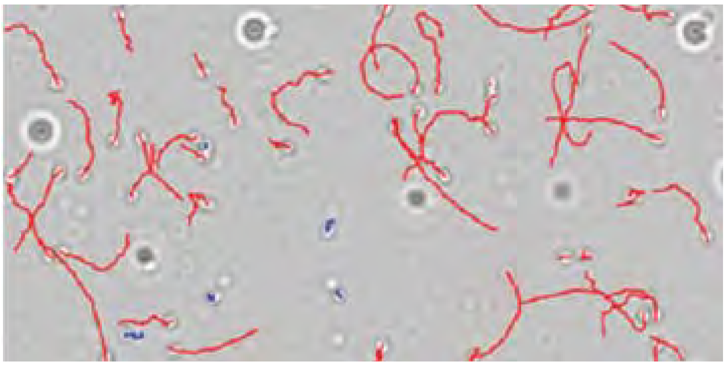
(eric.clement@upmc.fr)



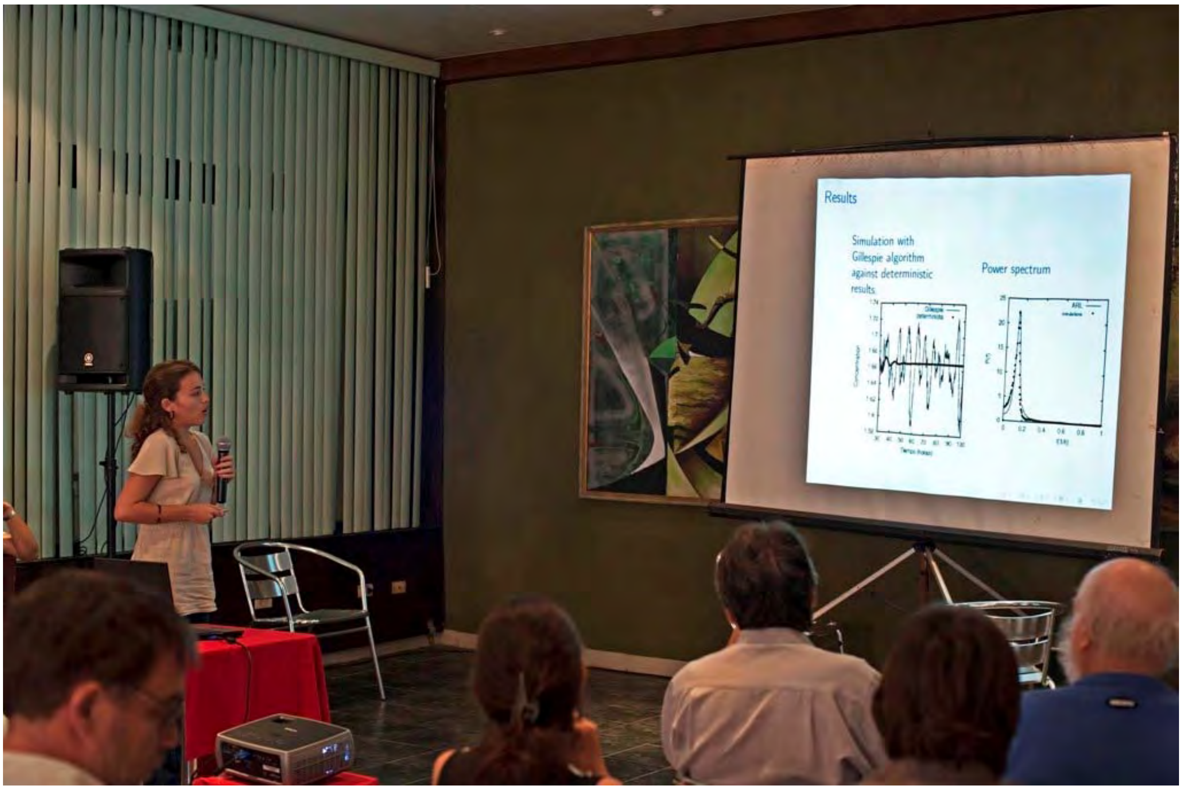
Assemblies of microscopic swimmers dispersed in a fluid display emergent properties that differ strongly from passive suspensions. The mom-entum and energy transfer balances as well the constitutive transport pro-perties are deeply modified by the active momentum sources distributed in the bulk. Anomalous constitutive properties have already been identified, such as active diffusivity, anomalous viscous response, active transport and mixing, as well as the possibility to use the fluctuations to extract work.

In this presentation I will discuss recent work done in the laboratory with wild-type E-Coli bacteria suspensions. At first, a zero flux system is studied in order to explore the effect of complex swimming activity on the Brownian motion problem. We show that, with respect to thermal Brownian motion, the tracer diffusivity is enhanced by the presence of active swimmers and increases linearly with the activity of the fluid which is defined as the product of the fraction of active swimmers by their mean velocity. Second, I will present a measurement using an original microfluidic device of active viscosity. I will show that the low shear rate viscosity of the active suspension can be lower that the viscosity of the suspending fluid.

Finally, I will present results on bacterial flow in a microfluidic device with a funnel-like constriction. An effect of flow induced symmetry breaking in the bacteria distribution along the flow axis is discussed. This effect is long range and increases with the flow velocity [2]. The resulting anomalous dispersionis related to elementary mechanisms of interaction between the bacteria and the solid boundaries.

[1] G. Mino, T. E. Mallouk,.T. Darnige, M. Hoyos, J. Dauchet, J. Dunstan, R.Soto, Y.Wang , A. Rousselet, E. Clément, Enhanced Diffusion due to Active Swimmers at a Solid Surface Phys.Rev.Lett 106, 048102 (2011).
[2] E. Altshuler, G. Miño, C. Pérez-Penichet, L. del Río, A. Lindner, A. Rousselet, E. Clément
Flow induced symmetry breaking of an active suspension through a funnel, submitted (2011).

Eric Clément



Lídice Cruz

On the role of the intrinsic noise on the response of the p53-Mdm2 Module (10 min)

Lídice Cruz
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(lcruz@fisica.uh.cu)

In collaboration with : Nuris Figueroa Morales, Roberto Mulet Genicio, “Henri Poincarè” Group of Complex Systems, University of Havana, La Habana, Cuba.

The p53 has a well established role in protecting genomic integrity in human cells. In particular, the p53-Mdm2 feedback loop seems to be the key circuit in the response of cells to damage. For many years, based on measurements over populations of cells it was believed that the p53-Mdm2 feedback loop was the responsible for the existence of damped oscillations in the culture. However, recent measurements in individual human cells have shown that p53 and its regulator Mdm2 develop sustained oscillations over long periods of time, with essentially fixed frequency but variable amplitudes. These results have attracted a lot of interest because they challenge years of mathematical models with new and accurate data on single cells. Inspired by these experiments standard models of the p53-Mdm2 circuit were modi_ed mainly introducing some biologically motivated noise that becomes responsible for the stability of the oscillations.

We follow an alternative approach, the noise that stabilizes the _uctuations is the intrinsic noise due to the _nite nature of the populations of p53 and Mdm2 in a single cell. We study three stochastic models of the p53-Mdm2 circuit. These models are studied using Gillespie's simulations, mean _eld methods and the Linear Noise Approximation. The models intend to capture the response of the p53-Mdm2 circuit in the presence of DNA damage, in its basal state, and under oncogenic signals. For the _rst two cases our results compare quantitatively well with existing experimental data in single cells. While we can not discard that other sources of noise in the cells may also be important, our results strongly support the relevance of the intrinsic noise in this kind of systems. The literature of stochastic processes gives us already standard tools to study this kind of noise. In many cases one can predict analytically whether this noise will be relevant and how much. As far as we know, none of the sources of noises proposed previously can be studied so accurately from the analytically point of view. The study of the response of the p53-Mdm2 circuit under oncogenic signals is presented as a an example of a process for which we do not have any experimental evidence, but can still be modeled looking for experimental veri_able results.

We suggest that the intrinsic noise is the main responsible for the existence of sustained oscillations in the response of the p53-Mdm2 circuit. This noise alone can explain most of the experimental results obtained studying the dynamics of the p53-Mdm2 circuit in individual cells.

Swelling, creep, flow and fracture in clay muds, sediments and rocks: A mesoscopic and model approach(20 min)

Henri Van Damme
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Like many colloidal solids, clay/water mixtures may exist in a wide variety of physical states, going from brittle cohesive-frictional solid rocks to non-Newtonian yield stress fluids. Most transport or mechanical properties are controlled by the aggregation state of the elementary nanoscopic particles and by their entanglement at mesoscopic scale. The purpose of the paper is to try to give a consistent picture of this relationship and to put it in perspective of a few environmental or energy problems.

Henri Van Damme

Rheology of vibrated granular media (20 min)

Olivier Dauchot
ESPCI – ParisTech, France
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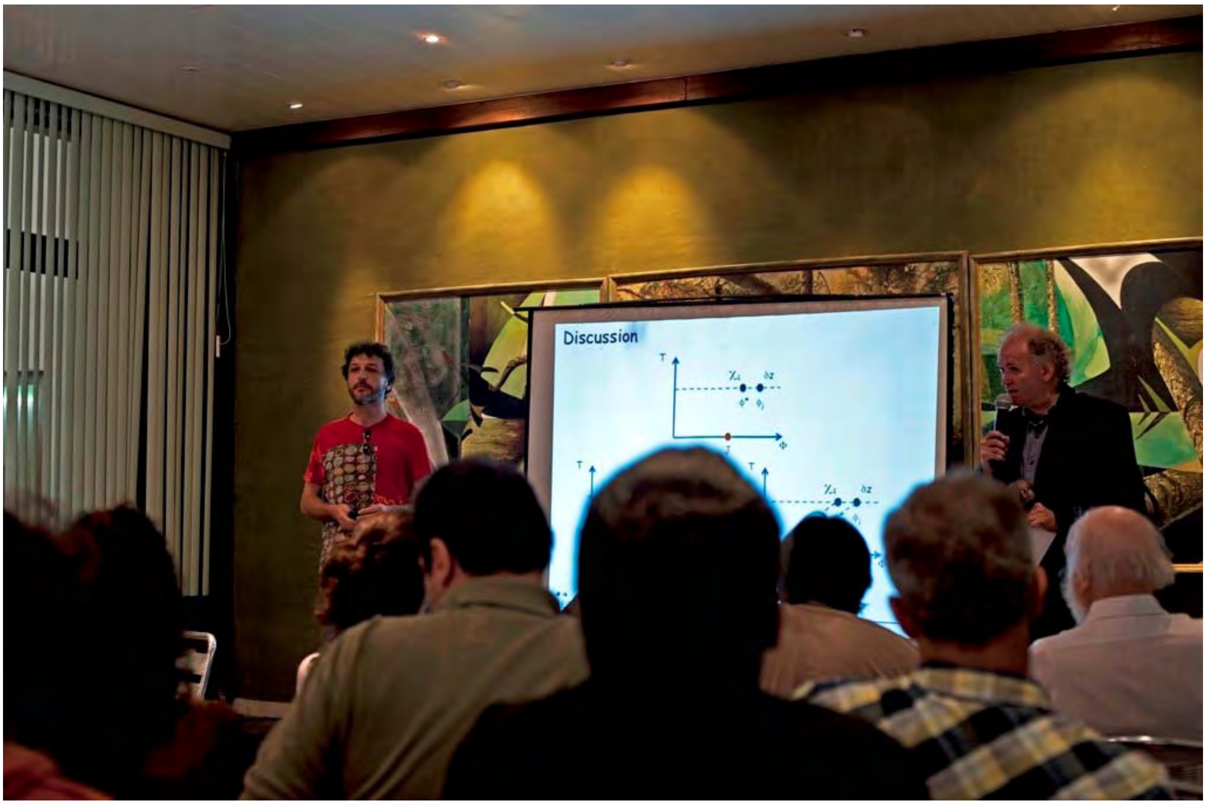
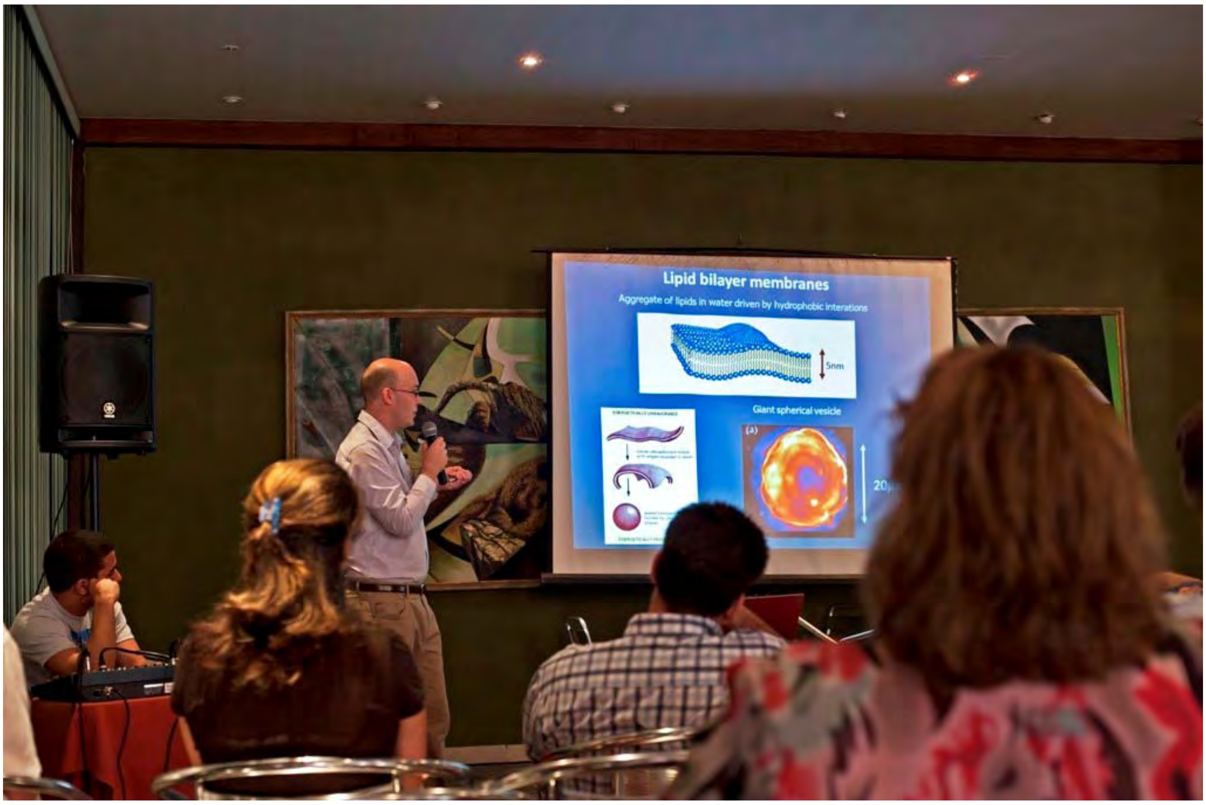
Granular media are collections of macroscopic and athermal grains which interact through dissipative, frictional contact forces and that jam in metastable configurations. Under sufficient shear stress, or when mechanically agitated, granular media yield and flow. In this talk we will discuss the following: what is the rheological scenario that connects these observations?
The classical example of a inclined layer of sand illustrates that granular media exhibit a finite flow threshold, and once the material yields, the flow rate jumps to a finite value. A simple flow scenario that captures this behavior is to assume , in analogy to static and dynamic friction, that the static yield stress is larger than the dynamic yield stress. Such scenario implies that the flow rate continuously decreases to zero when the stress (inclination angle) is lowered. In experiments, however, the flow is found to stop discontinuously: stress-controlled granular flows have a minimal flow rate.
This calls for a more elaborate flow curve including a ''forbidden'' range of flow rates.
In this talk, we firmly establish the existence of non-monotonic flow curves for granular media by probing their rheology, both in the presence and absence of externally supplied vibrations of strength . In the absence of vibrations, the flow curves exhibit a negative slope regime, with a finite yield stress, and a dip at intermediate flow rates. As we will see, this rheology can be seen as a limiting case of the more general rheology at finite vibration strength, when the yield stress vanishes and a slow but steady flow regimes develops. We also find that stress-controlled yielding, i.e., the hysteretic transition from zero flow to finite flow rate, is intimately connected to the dip in the flow curve.
Finally observing that non monotonic flow curves can be seen independently of the flow geometry and for several, but not all, granular materials, we discuss the generality of our conclusions.



Olivier Dauchot



Paul Dommersnes

Fractal avalanche ruptures in biological membranes (20 min)

Paul Dommersnes
Department of Chemical and Biological Engineering, Chalmers University of Technology, Sweden, & Matières et Systèmes Complexes, Université Paris Diderot, France. (paul.dommersnes@paris7.jussieu.fr)

In collaboration with: Irep Gözen[1], Ilja Czolkos[1], Aldo Jesorka[1], Tatsiana Lobovkina[1,3] and Owe Orwar

1. Department of Chemical and Biological Engineering, Chalmers University of Technology, SE-412 96 Göteborg, Sweden,

2. Matières et Systèmes Complexes, Université Paris Diderot, Paris 75013, France.

3. Department of Chemistry, Stanford University, 333 Campus Drive, Stanford, California 94305-5080, USA.

Lipid membranes envelope cells as well as organelles, and constitute the most ubiquitous building material in cell architecture. Cell membrane rupture is an important biological process, substantial rupture rates are found in skeletal and cardiac muscle cells under mechanical load, and active cell membrane repair mechanisms are therefore essential to preserve cell integrity. Pore formation in cell membranes is also at the heart of many biomedical applications, such as in drug delivery. According to common understanding, cell membranes rupture by formation of circular pores, and several studies consistently report circular pore rupture in lipid vesicles under strain. We observed a very different rupture mechanics in bilayer membranes and cell membranes adhering on solid supports: the rupture proceeded in a series of rapid avalanches causing fractal membrane fragmentation. The intermittent character of rupture evolution and the broad distribution in avalanche sizes is consistent with so called crackling-noise dynamics, which is characteristic to earth-quakes, fracture of solid disordered materials, dislocation avalanches in plastic deformations, and domain wall magnetization avalanches. Adhesion is widespread in biological cells, which suggest that the newly discovered rupture mechanism could be commonly occurring in cell biology. (Published in *Nature Materials* **9** , 11 908-912 (2010))

Granular Impact Cratering (20 min)

Douglas Dourian
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In collaboration with: Hiroaki Katsuragi, Patrick Mayor, and Ted Brzinski.

Experiments on the low-speed impact of solid objects into granular media have been used both to mimic geophysical events and to probe the unusual nature of the granular state of matter. Observations have been interpreted in terms of conflicting stopping forces, reminiscent of high-speed ballistics impact in the 19th and 20th centuries when a plethora of empirical rules were proposed. To settle this controversy, we have measured the projectile dynamics during impact and have both reproduced prior observations and have found that the stopping force can be decomposed into the sum of velocity-dependent inertial drag plus depth-dependent friction. Furthermore, by changing the projectile shape and by imposing an upflow of air through the granular medium, we have established that friction acts normal to the projectile surface and that grain contacts are loaded by gravity rather than by the motion of the projectile.

Douglas Dourian

A Numerical Approach to Stick-Slip dynamics in Granular Fluids (10 min)

Jon Alm Eriksen
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(jonaerik@fys.uio.no)

In collaboration with: Eirik Grude Flekkøy[1], Knut Jørgen Måløy[1], Henning Arendt Knudsen[1] and Bjørnar Sandnes[2]
[1]Department of Physics, University of Oslo
[2]Department of Physics, NTNU, Trondheim

Pattern formation in granular materials is a curious result of dissipative interactions between grains. A recent study by B. Sandness [1] points to an extraordinary diversity in the dynamics of the flow of wet granular materials displaced by air in a Hele-Shaw cell. By varying the air injection rate and the granular filling fraction several distinct morphologies were observed, and the study maps out a tentative dynamical phase diagram. We investigate a transition in thatphase diagram, from frictional fingering to Stick-slip bubbles. By integrating the surface tension, pressure and frictional forces, we trace the displacement of the interface, and reproduce the experimentally observed patterns. The numerical scheme offers a method to study the transition in detail, complimentary to the experimental observations. The simulation use a dynamical version of a quasi static algorithm developed by H.A. Knudsen and others [2], developed to simulate labyrinth patterns in granular fluids.

[1] B. Sandnes, E.G. Flekkøy, H.A. Knudsen, K.J. Måløy and H. See. Patterns and flow in frictional fluids. Nat. Commun. 2 : 288 doi: 10.1038/ncomms1289 (2011).
[2] H.A. Knudsen, B. Sandnes, E.G. Flekkøy and K.J. Måløy. Granular labyrinth structures in connfined geometries. Phys. Rev. E. 77, 021301. doi:10.1103/PhysRevE.77.021301 (2008)

Jon Alm Eriksen

Study of the mechanisms of counterstream penetration of blood in vascular catheters (10 min)

Nuris Figueroa-Morales
"Henri Poincarè" Group of Complex Systems, University of Havana, La Habana, Cuba (nfigueroa@fisica.uh.cu)

In collaboration with: O. SotolongoCosta[1], E. Altshuler[1], M. AriasZugasti[2], D. RodríguezPérez[2], A. FernándezBarbero[1]
[1] "HenriPoincaréGroup" of Complex Systems, University of Havana, La Habana, CP 10400, Cuba.
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[3] Group of Complex Fluid Physics and Nanotechnology Laboratory. Department of Applied Physics. University of Almería, Spain.

Vascular catheters are irreplaceable elements for the care of critically ill patients. They are excellent tools for controlled administration of fluids. But they are also indissolubly bounded to bloodstream infections, mainly given by the catheter bacterial colonization that occurs very often in a few hours after,its insertion, even when a perfusion fluid is injected constantly in the circulatory system, through the catheter. Previous to, microorganism colonization it has been observed the existence of a protein slim layer where populations find a favorable substrate. In order to explain the counterstream migration of this nonselfpropelled material that form the blood, we have developed a hydrodynamic model based in the flowlimited diffusion of molecules against the perfusion fluid. According to this, the counterstream diffusion occurs in a very narrow corridor next to the inner tube wall. We have also made experiments where the same physical mechanisms that produce the studied phenomenon are observed under very controlled conditions, through the use of microchanels. Our preliminar experiments seem to corroborate the main theoretical results.

Nuris Figueroa-Morales

Labyrints and frictional fluid flow (20 min)

Eirik Grude Flekkøy
Physics Department, University of Oslo, Norway
(e.g.flekkoy@fys.uio.no)

In collaboration with: B. Sandnes (NTNU), H. Knudsen (UiO) and K. J. Måløy (UiO)

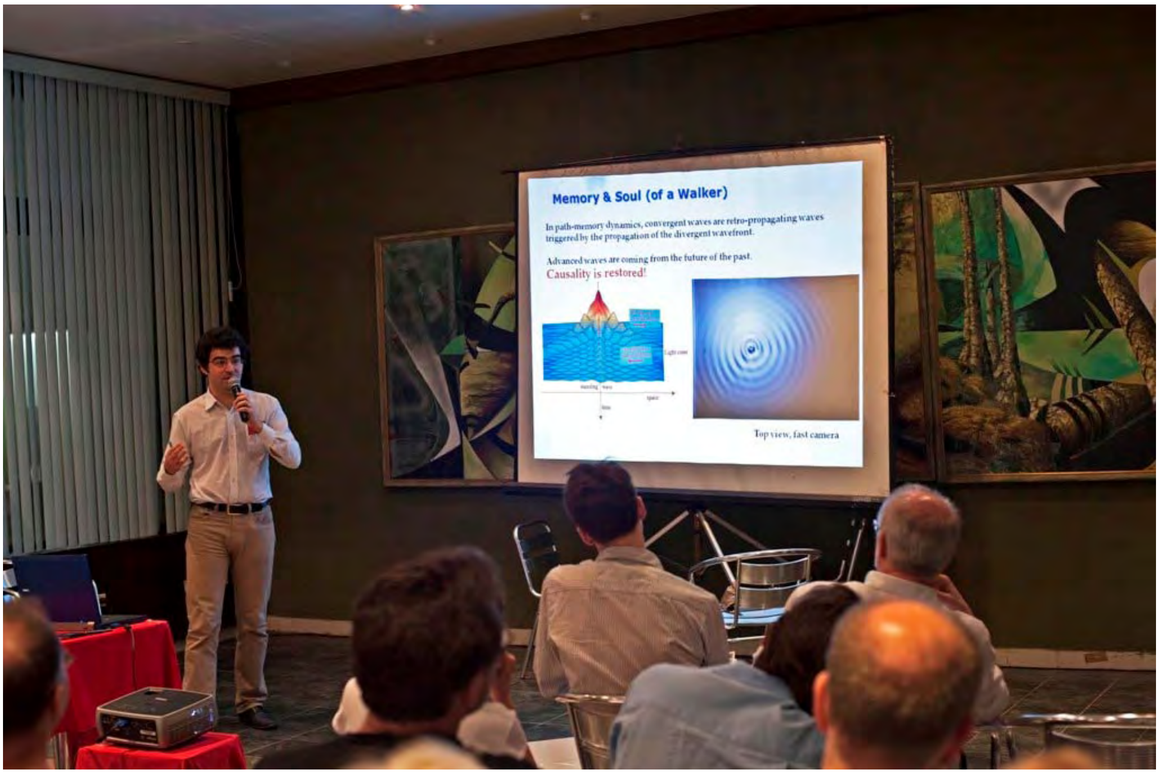
When a fluid is slowly displaced by air in a fluid-particle mixture in a Hele-Shaw cell, labyrinthine patterns emerge from the combined action of air pressure, capillarity and static friction. Such frictional fluid dynamics may be enriched by the addition of viscous forces when the process is made to happen more quickly. In the case when the quicker action comes from compressibility of the air, characteristic bubble patterns form. These patterns come from the stick-slip motion that results when the contacts of static friction breaks down and is replaced by a viscous response. When the injection rate is increased, the stick-slip motion becomes continuous and the bubble patterns are replaced by viscous fingers. The associated phase diagrams are explained by theory, and in the case of the labyrinths, reproduced through simulations. The industrial alibi for studying frictional fluids would include topics such as enhanced oil recovery and CO2 storage. These processes involve the flow in porous media, that are generally modeled as being static. This is an idealization that ignores deformation and fragmentation processes, which indeed happen. The present study of flow of- rather than in-porpus media seeks to take an alternative perspective on this matter.

Eirik Grude Flekkøy

Path-Memory driven dynamics: wave-particle duality with walking droplets (20 min)

Emmanuel Fort
Institut Langevin, ESPCI ParisTech, Université Paris Diderot, CNRS UMR 7587, 10 Rue Vauquelin, 75 231 Paris Cedex 05, France
(emmanuel.fort@paris7.jussieu.fr)
In collaboration with: Antonin Eddi, Julien Moukhtar, and Yves Couder
Matières et Systèmes Complexes, Université Paris Diderot, CNRS UMR 7057, 10 Rue Alice Domon et Léonie Duquet, 75013 Paris, France

We have recently discovered a macroscopic object composed of a material particle dynamically coupled to a wave packet. The particle is a droplet bouncing on the surface of a vertically vibrated liquid bath; its pilot-wave is the result of the superposition of the surface waves it excites. Above an excitation threshold, this symbiotic object, designated as a "walker" becomes self-propelled.
Such a walker exhibits several features previously thought to be specific to the microscopic realm. The unexpected appearance of both uncertainty and quantization behaviors at the macroscopic scale lies in the essence of its "classical" duality. The dynamics of the droplet depends on previously visited spots along its trajectory through the surface waves emitted during each bounce. Although based on fundamental concepts, commonly found in living systems, this path-memory driven dynamics is still unexplored in physics elementary objects.
This new class of memory-encoded systems which possess a spatiotemporal nonlocality shakes the frontiers between macroscopic and microscopic world. In this talk, I will present the dynamics of this object in experiments similar to the historical ones in quantum physics: diffraction and interference through slits, tunneling, Landau quantization and Zeeman-like effect. I will also discuss experimental results on walkers confined in cavities and Anderson localization.



Emmanuel Fort

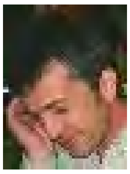
Modeling the role of IL-2 in the interplay between CD4+ helper and regul-atory T cells: Studying the impact of IL-2 modulation therapies (10 min.)

Karina García
Centro de Inmunología Molecular (CIM), La Habana, Cuba
(karina@cim.sld.cu)

In collaboration with: Kalet León (CIM, La Habana, Cuba)

Several reports have drawn a complex picture of the effect of IL-2 modulating treatments. They seem to promote indistinctly immunity or tolerance. Such complexity might derives from the dual role of IL- 2 on T cell dynamics. To theoretically address the latter possibility, we develop a mathematical model for T cells dynamics, and their relationship with IL-2. We simulate the effect of IL-2 injections, IL-2 depletion using anti-IL-2 antibodies, and IL-2/anti-IL-2 immune-complexes injection. We focus in the qualitative and quantitative conditions of dose and timing for treatments which allow them to potentate either immunity or tolerance. Our results provide reasonable explanations for the existent pre-clinical and clinical data, and further provide interesting practical guidelines to optimize the future application of these types of treatments. Our results predict that: a) Immune-complexes IL-2/Anti-IL-2 mAbs, using mAbs which block the interaction of IL-2 and CD25 (alpha chain of IL-2 receptor), is the best option to potentate immunity; b) Immune-complexes IL-2/Anti-IL-2 mAbs, using mAbs which block the interaction of IL-2 and CD122 (beta chain of IL-2 receptor), are the best option to reinforce preexistent natural tolerance; c) mAbs anti-IL-2 can be successfully used alone to treat an ongoing autoimmune disorder, promoting the re-induction of tolerance.

Karina García



Softening Induced Instability of a Stretched Cohesive Granular Layer (20 min)

Jean-Christophe Geminard
Universite de Lyon, Laboratoire de Physique, Ecole Normale Superieure de Lyon,CNRS, UMR 5672, 46 Allee d'Italie, 69007 Lyon, France
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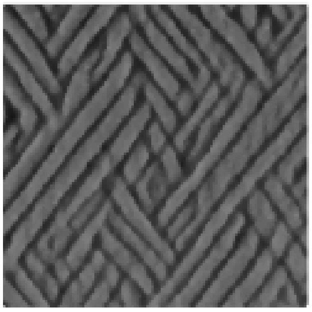
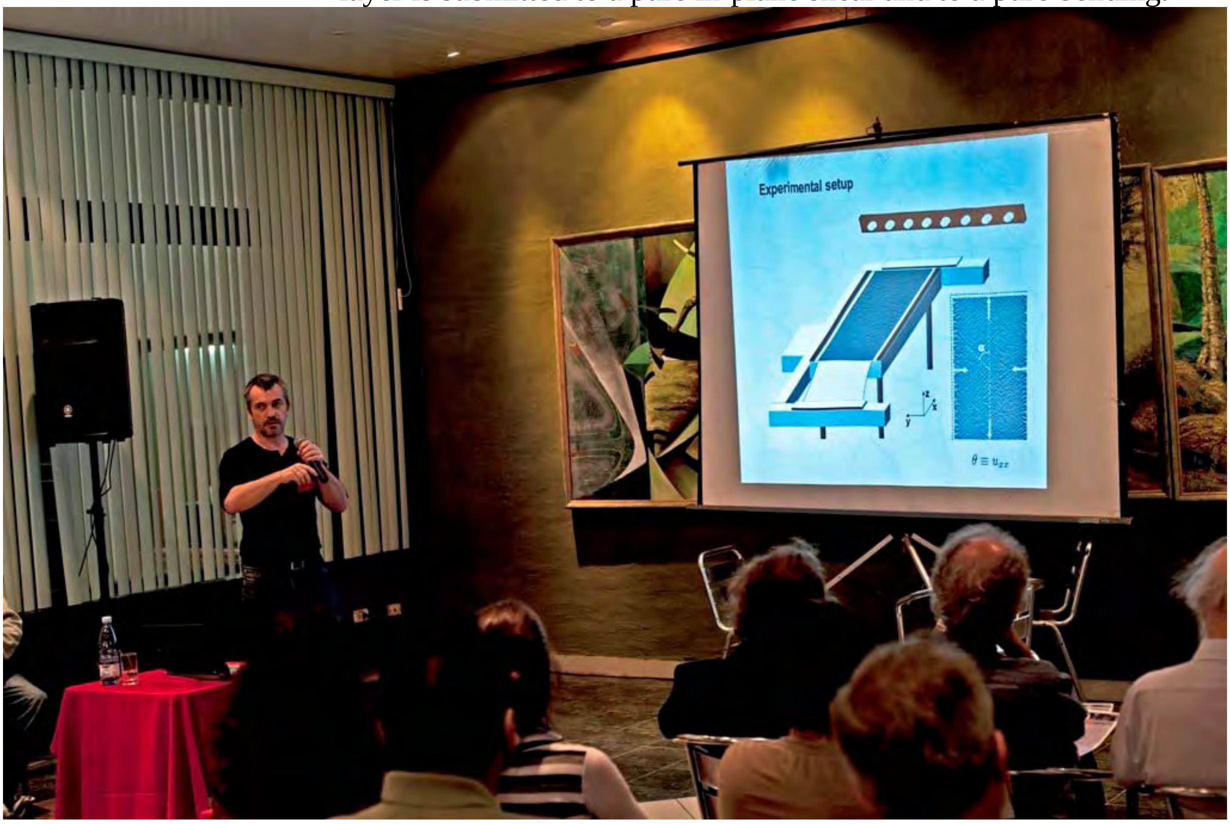
In collaboration with: Hector Alarcón (2), Osvanny Ramos (1,3), Loıc Vanel (3), Franck Vittoz (1), and Francisco Melo (2)

1 Universitè de Lyon, Laboratoire de Physique, Ecôle Normale Superièure de Lyon, CNRS, UMR 5672, 46 Allee d'Italie, 69007 Lyon, France
2 Departamento de Física, Universidad de Santiago de Chile, Avenida Ecuador 3493, Casilla 307, Correo 2, Santiago, Chile
3 Universitè de Lyon, Universitè Lyon 1, Laboratoire de Physique Matiere Condensee and Nanostructures, CNRS, UMR 5586, 69622 Villeurbanne, France



We first report on a cellular pattern which spontaneously forms at the surface of a thin layer of a cohesive granular material submitted to in-plane stretching. We present a simple model in which the mechanism responsible of the instability is the ''strain softening'' exhibited by humid granular materials above a typical strain. Our analysis indicates that such a type of instability should be observed in any system presenting a negative stress sensitivity to strain perturbations. We then report additional results obtained when the layer is submitted to a pure in-plane shear and to a pure bending.



Jean-Christophe Geminard

Direct observation by scanning tunneling spectroscopy of some collective behaviors of vortices at very low temperatures (20 min)

Isabel Guillamón
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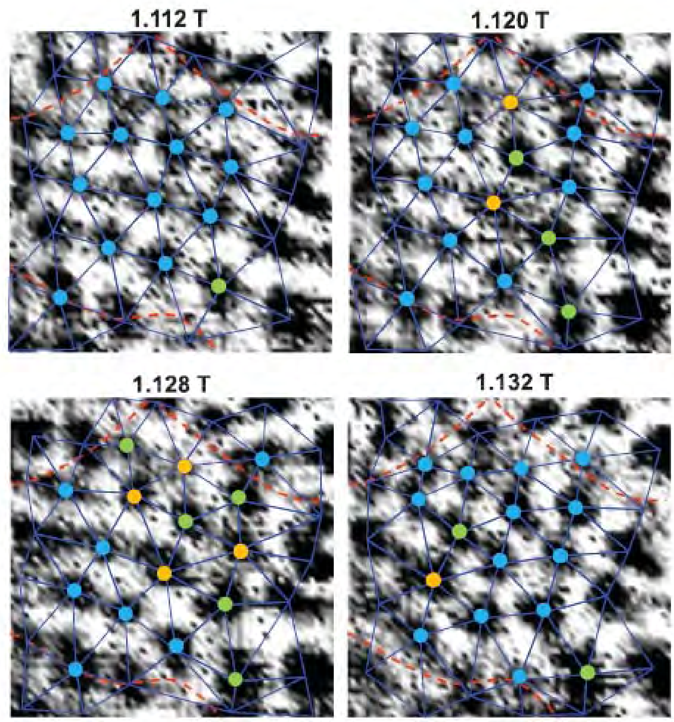
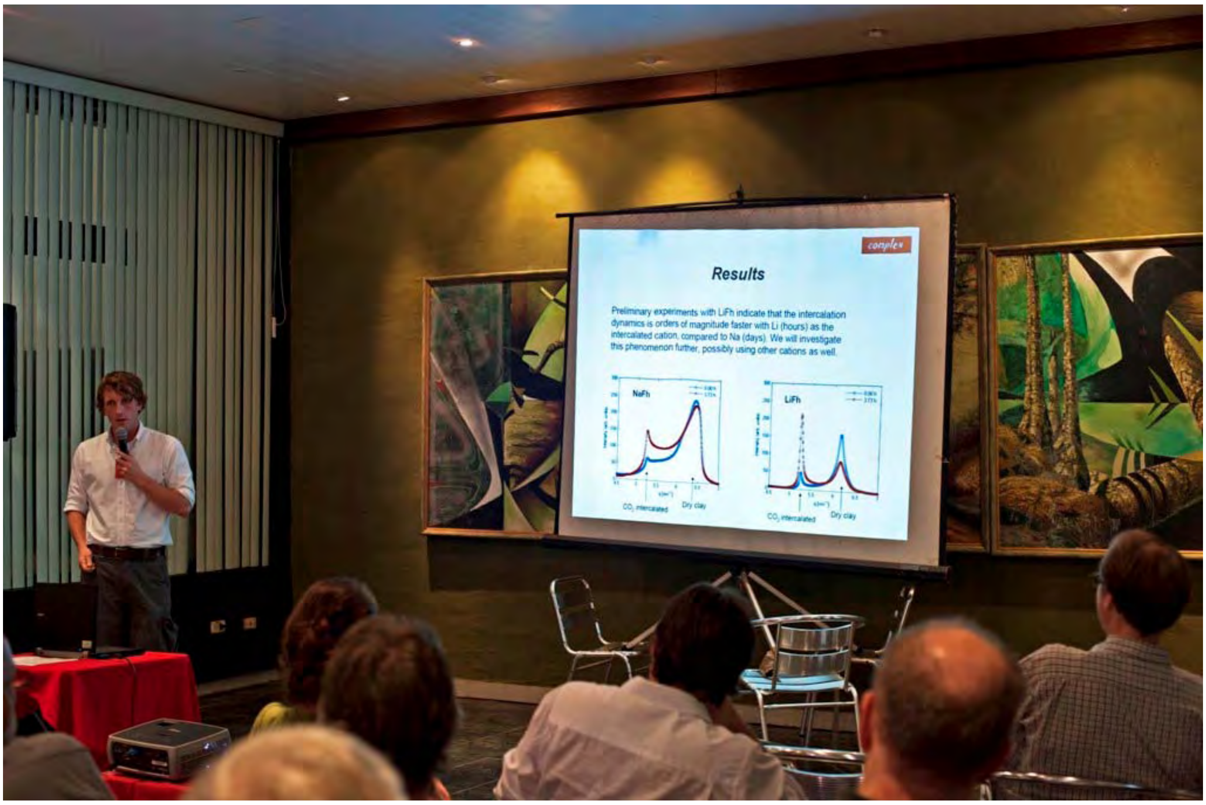
(isabel.Guillamon@bristol.ac.uk)
In collaboration with: S. Vieira , H. Suderow
Laboratorio de Bajas Temperaturas, Departamento de Física de la Materia Condensada, Instituto de Ciencia de Materiales Nicolás Cabrera, Facultad de Ciencias Universidad Autónoma de Madrid, E-28049 Madrid, Spain.



Scanning Tunneling Micros-copy and Spectroscopy (STM/S) down to 100mK is an efficient tool to make real space images of individual vortices. We ha recently observed the behavior of bundles of vortices when increasing the magnetic field. Pinning centers are given by features on the surface corrugation of the thin film sample. We find strong net vortex motion in a bundle towards a well-defined direction. We observe continuous changes of the vortex arrangements, and identify small displacements, which stress and deform the vortex bundle, separated by larger rearrangements or avalanches, which release accumulated stress. In another thin film sample without pinning centers, we observe by contrast the nearly unpinned ordered 2D vortex lattice. When increasing the magnetic field, pairs of dislocations are observed. These pairs unbind, leading to a hexatic phase, and to the fully disordered lattice, giving a direct visualization of the 2D Berezinskii-Kosterlitz-Thouless transition. Remarkably, the observed BKT transition occurs at 100 mK, and is not driven by thermal activation.

Isabel Guillamón



Henrik Hemmen

Field induced microparticle structure formation in fluids (20 min)

Geir Helgesen
Institute for Energy Technology, Kjeller, and Department of Physics, University of Oslo, Norway (Geir.Helgesen@ife.no)

In collaboration with :
Matti Knaapila[1], Arne T. Skjeltorp[1,2], Henrik Høyer[1], Jozef Cernak[3]
[1]Institute for Energy Technology, Kjeller, Norway
[2]Department of Physics, University of Oslo, Norway
[3]P.J. Safaric University, Kosice, Slovak Republic

We review how magnetic and electric fields can be used to create microparticle structures within fluids such as water, oil, polymers or ferrofluids. The particular arrangement of the electrodes will strongly influence the morphology of the clusters or networks formed, as will also rotating or oscillating fields do. The dynamics of such pattern formation will be described for various types of particles, such as colloidal microspheres, carbon nanoparticles and metal particles.

Geir Helgesen

Carbon dioxide intercalation in Na-fluorohectorite clay at near-ambient conditions (10 min)

Henrik Hemmen
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In collaboration with : Erlend G. Rolseth,[†] Davi M. Fonseca,[†,ǁ] Elisabeth L. Hansen,[†] Jon Otto Fossum,[,†,‡] and Tomás S. Plivelic.[§]*
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**E-mail: henrik.hemmen@ntnu.no (H.H.); jon.fossum@ntnu.no (J.O.F.) [ǁ]Present address: Department of Cancer Research and Molecular Medicine, Norwegian University of Science and Technology, N-7491, Trondheim, Norway*

Due to current awareness of global warming and the challenges related to carbon capture and sequestration, the interactions between clays and CO_2 are attracting attention in the scientific community. A recent molecular dynamics study by Cygan et al.[1] shows the possibility of intercalation and retention of CO_2 in smectites at 37 ^oC and 200 bar. This has led the authors to suggest that clay minerals may prove suitable for carbon capture and carbon dioxide sequestration.
In this work we add to the so far scarce experimental results in this field, by showing from x-ray diffraction measurements that gaseous CO_2 intercalates into the interlayer space of the synthetic smectite clay Na-fluorohectorite at conditions not too far from ambient. The mean interlayer repetition distance of the clay when CO_2 is intercalated is found to be 12.5 Å for the conditions -20 °C and 15 bar. The magnitude of the expansion of the interlayer upon intercalation is indistinguishable from that observed in the dehydrated-monohydrated transition for H_2O, but the possibility of water intercalation is ruled out by a careful analysis of the experimental conditions and repeating the measurements exposing the clay to nitrogen gas. The dynamics of the process is observed to be dependent on the pressure, with a higher intercalation rate at increased pressure. The rate of CO_2 intercalation at the studied conditions is found to be several orders of magnitude slower than the intercalation rate of water or humidity at ambient pressure and temperature. The conditions studied are different from most of the simulations in the literature related to geological storage, but demonstrating intercalation at less extreme conditions could prove very useful in understanding the processes involved. By avoiding extreme conditions, experimental verification of theory and simulations should become much easier, and the low pressures involved here enable the use of Kapton windows on the sample cell, thus allowing investigations with laboratory x-ray equipment instead of synchrotron sources.

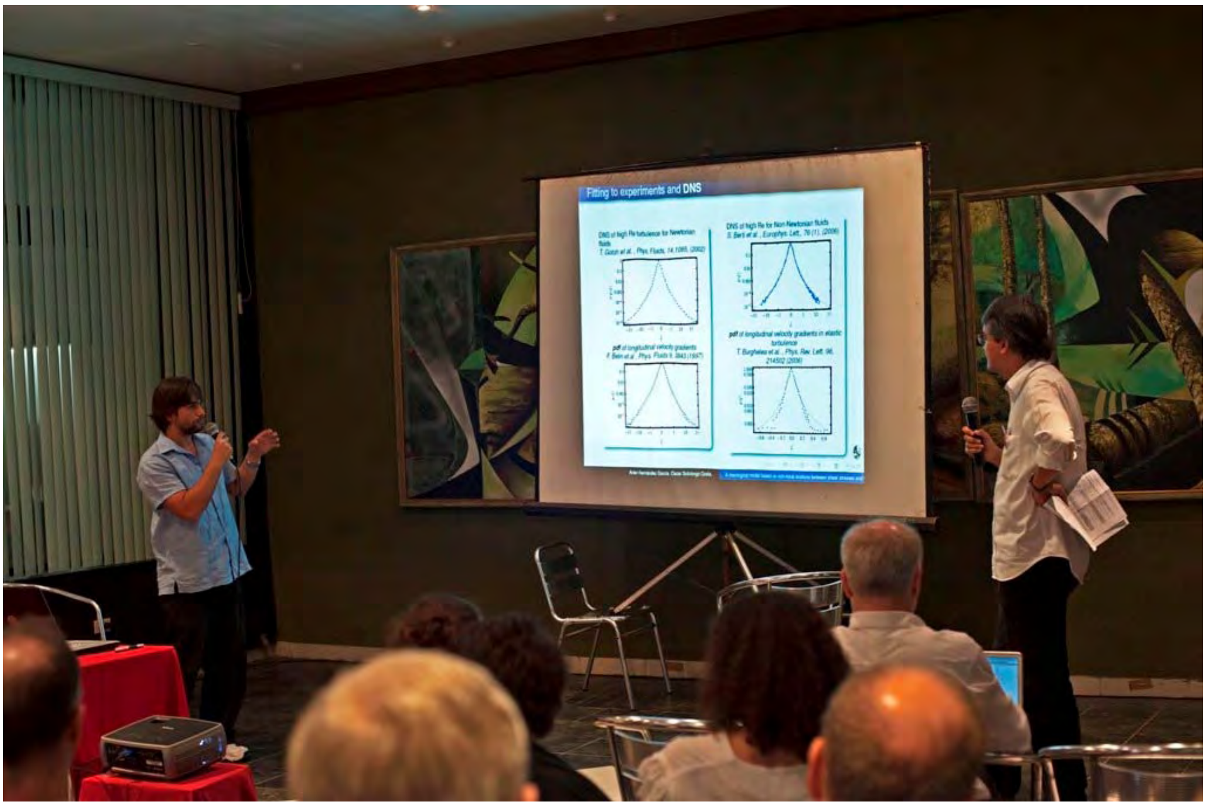
(1) Cygan, R. T.; Romanov, V. N.; Myshakin, E. M. *Natural materials for carbon capture*; Techincal report SAND2010-7217; Sandia National Laboratories: Albuquerque, New Mexico, November, 2010.

A rheological model based on nonlocal relations between shear stress and velocity gradients for complex fluids (10 min)

Anier Hernández
"Henri Poincarè" Group" of Complex Systems, Physics Faculty, University of Havana, La Habana, CP 10400, Cuba (ahernandez@fisica.uh.cu)

In collaboration with: Oscar Sotolongo Costa, Grupo "Henri Poincarè" de Sistemas Complejos, Facultad de Física, Universidad de la Habana, 10400 Habana, Cuba.

Since some experimental results seem to indicate that nonlinearities in the rheological curves of fluids with complex microstructure, even in flows at small Reynolds numbers, are driven by flow instabilities a nonlocal relation between shear stress tensor components and velocity gradients is proposed. The probability density functions of velocity gradients are obtained by extremizing the Tsallis entropy. Within this model, a constitutive equation that covers a wide range of time independent rheological properties, from shear thinning fluids to shear thickening, is obtained in terms of the generalized MittagLeffler functions. In the model, neither a particular dynamics, nor particular fluids microstructures details are considered. Good fittings to several experimental results are shown.



Anier Hernández

Novel particle, bacteria and nano-rod structures generated by ultrasonic standing waves in a resonator (20 min)

Mauricio Hoyos
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In collaboration with: Angélica Castro[1], Eric Clément[1], Wei Tiger Wang[2] and Tom Mallouk[2]
[1] PMMH, CNRS-ESPCI, Paris, France
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Particulate materials like rigid particles, cells, bacteria, vesicles, can be manipulated in a resonator by ultrasonic standing waves USW, using frequencies between 0.5 and 10MHz. In a resonator chamber, USW generated in the thickness, makes species to migrate either toward the nodes or antinodes depending on their acoustic properties. The acoustic force depends on particle volume, acoustic energy and on the acoustic contrast factor. The latter is a function of particle and suspending fluid acoustic impedances defined as the product between the density and the sound velocity the medium. Aggregates of particles and cells can have 3D or 2D structures. Recently we have set-up a pulsed ultrasound technique for generating controlled-size particle monolayers. The applications to biomimetic tissues can be foreseen. Experiments in continuous and pulsed ultrasound will be presented.
USW can be also used for manipulating living cells like bacteria. In fact, in an acoustic resonator a suspension of living bacteria can be manipulated in order to focus them in a plane far away from the walls in order to determine the roll played by the boundaries on the bacteria motility. Experiment with *e-coli* surprisingly demonstrated that a threshold concentration of bacteria generated a biofilm in levitation thus, very far from any surface. We shall show The process of biofilm formation.
Finally, preliminary experiments on manipulation of gold nano-rods have demonstrated the capability of ultrasonic standing waves to generate 1-D chains of nano-rods as well as 3D rotating structures at the levitation plane.

Mauricio Hoyos

Influence of relative humidity on avalanche phenomenon in granular piles (20 min)

Irene Ippolito
Grupo de Medios Porosos, Facultad de Ingeniería, Universidad de Buenos Aires, Argentina (iippoli@fi.uba.ar)

In collaboration with: Ignacio Gómez Arriaran (1) and Ricardo Chertcoff (2)
1 Departamento de Máquinas y Motores Térmicos, Universidad Nacional del País Vasco, San Sebastián,GIPUZKOA, España

2 Grupo de Medios Porosos, Facultad de Ingeniería, Universidad de Buenos Aires, Argentina

Stacking phenomena and avalanches of granular materials have traditionally been studied in dry conditions. However, the influence of ambient relative humidity has on the behavior of these piles is little known, but not devoid of a decisive nature. We present here the results and conclusions from tests for the characterization of characteristic geometrical parameters of two different sized granular media at different relative humidities, thus covering the entire hygroscopic range. Hygroscopic salts are used to achieve the desired relative humidity maintained in an isolated chamber where boxes were filled up with glass beads. For given waiting time and relative humidity, successive avalanches are triggered by using a controlled system dump. We determine the influence of moisture content in the interstices of the granular media, its influence on the angles of maximum stability and rest, respectively, and the relationship with the mass displaced during each avalanche. We analyze the influence of grain size, under different conditions of ambient relative humidity and the equilibration time between avalanches giving information on the surface/bulk avalanche origin phenomenon.

Irene Ippolito

Random packings under stress (20 min)

Heinrich Jaeger
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In collaboration with: Eric Brown (presently at UC Merced), Alice Nasto (presently at grad school at MIT), & Athanasios G. Athanassiadis (undergrad at U of Chicago).

The properties of sphere packings have fascinated mathematicians and scientists for ages. Within the context of jamming there has been much recent interest in the mechanical stability of random sphere packings. I will discuss some ideas and first experimental results in which the concept of a jamming transition and the associated dramatic change in mechanical properties is exploited to design the stress response of amorphous granular materials. To illustrate this I will use examples from our recent research on randomly packed granular polymers (flexibly connected chains of spheres) and shear thickening in suspensions.

Heinrich Jaeger

Life in Turbulence (20 min)

Mogens H. Jensen
Niels Bohr Institute, Copenhagen, Denmark
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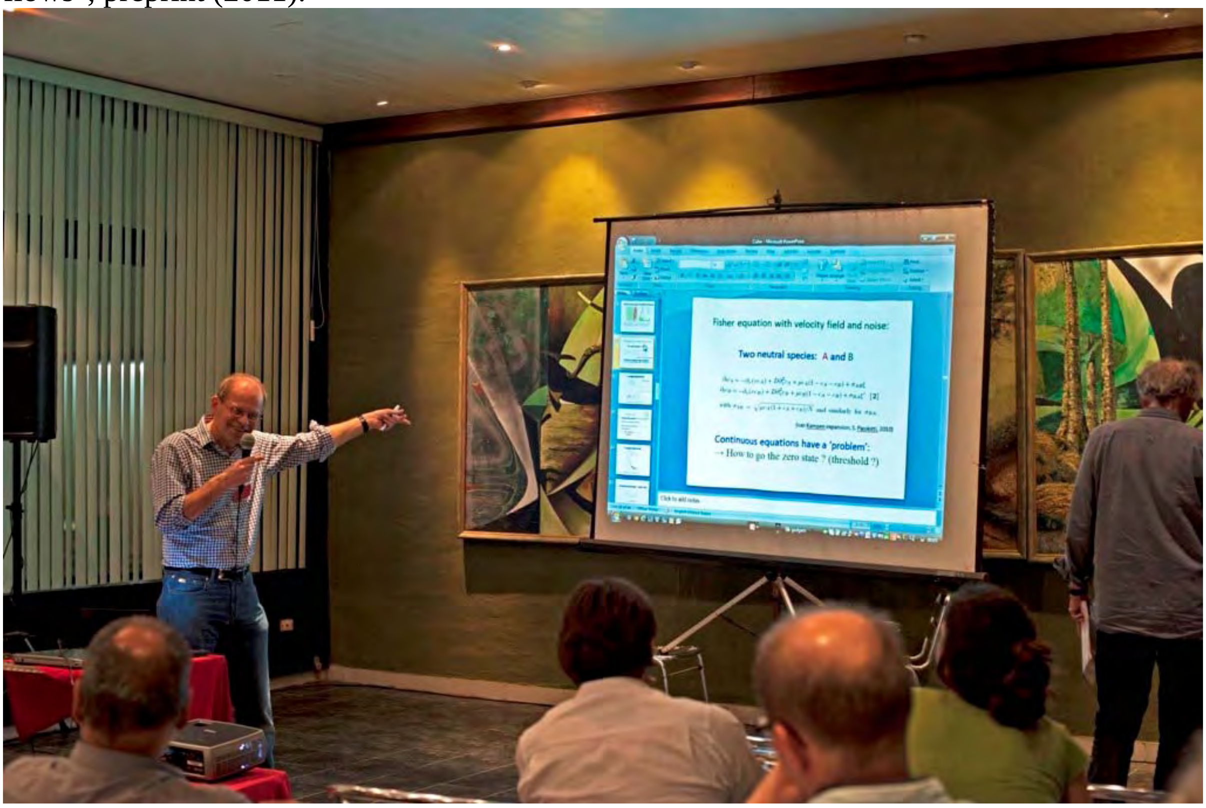
The population dynamics of species is conveniently described by the Fisher equation which introduces Fisher waves where the population grows up to the carrying capacity as it spreads in space. From satellite pictures is has been observed that plankton in the oceans exhibit 'foliated' structures on many length scales clearly influenced by the turbulent flows in the water. Recently, Benzi and Nelson applied high Reynold number flows on the Fisher equation [1] in order to described such structures. The Fisher equation is formulated in a continuous field but plankton/bacteria are individual 'particles'. We have formulated a particle model where plankton are advected in strong turbulence by the shell model [2]. We observe a huge drop in the carrying capacity due high concentrations in the stagnation points of the flow. For two neutral alleles, we find that turbulence diminishes the fixation time significantly. Furthermore, we study the fixation time and a function of flow parameters.

[1] R. Benzi and D.R. Nelson, "Fisher equation with turbulence in one dimension", Physica D 238, 2003-2015 (2008).
[2] S. Pigolotti, R. Benzi, D.R. Nelson and M.H. Jensen, "Population genetics in compressible flows", preprint (2011).



Mogens H. Jensen

Anomalous flux avalanche morphology in patterned superconducting films (20 min)

T. H. Johansen
Centre for Advanced Study, Norwegian Academy of Science and Letters, NO-0271, Oslo, Norway and Department of Physics, University of Oslo, POB 1048, Blindern, 0316 Oslo, Norway and Institute for Superconducting and Electronic Materials, University of Wollongong, Northfields Avenue, Wollongong, NSW 2522, Australia
(t.h.johansen@fys.uio.no)

In collaboration with :
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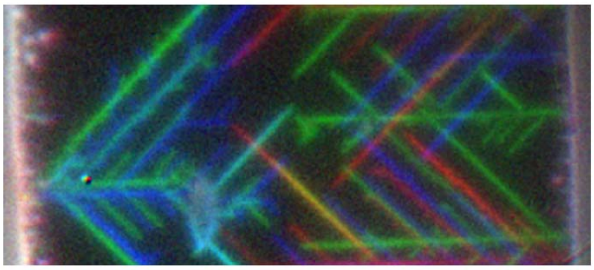
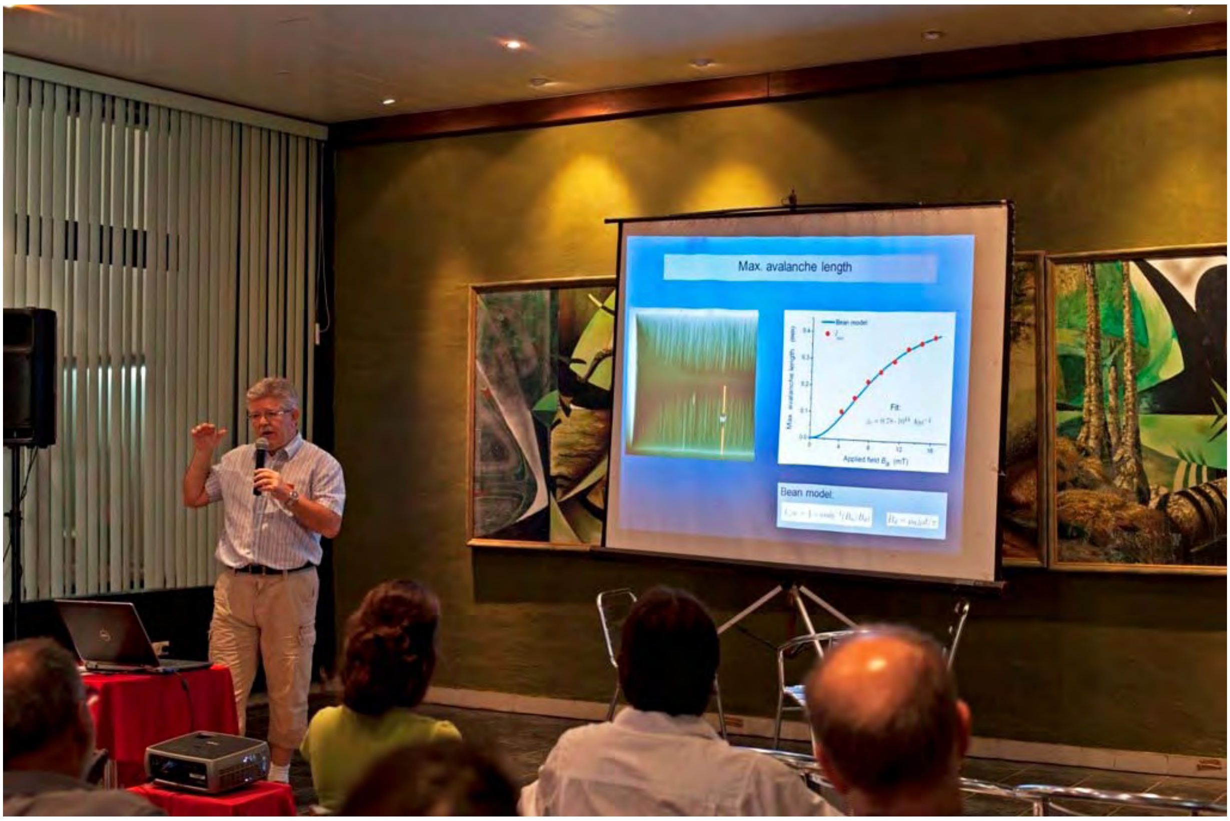
J. I. Vestgården,Department of Physics, University of Oslo, POB 1048, Blindern, 0316 Oslo, Norway
W. A. Ortiz, Departamento de Física, Universidade Federal de São Carlos, 13565-905 São Carlos, SP, Brazil and CAS, Norwegian Academy of Science and Letters, NO-0271, Oslo, Norway
Jo Cuppens, V. V. Moshchalkov and A. V. Silhanek, INPAC -- Institute for Nanoscale Physics and Chemistry, Nanoscale Superconductivity and Magnetism Group, K.U.Leuven, Celestijnenlaan 200D, B-3001 Leuven, Belgium



We have employed magneto-optical imaging to visualize the occurrence of flux avalanches of unexpected morphology in superconducting films of Nb and -MoGe. The specimens are decorated with square antidots arranged in a square lattice. We observed avalanches with the anomalous habit of forming trees where the trunk is perpendicular to the main axis of the square lattice, whereas the branches form angles of 45 degrees. The overall features of the avalanches, and in particular the 45 degree direction of the branches, were confirmed by numerical simulations.



T. H. Johansen

Kenneth D. Knudsen

A new polymer and its temperature-induced transitions (20 min)

Kenneth D. Knudsen
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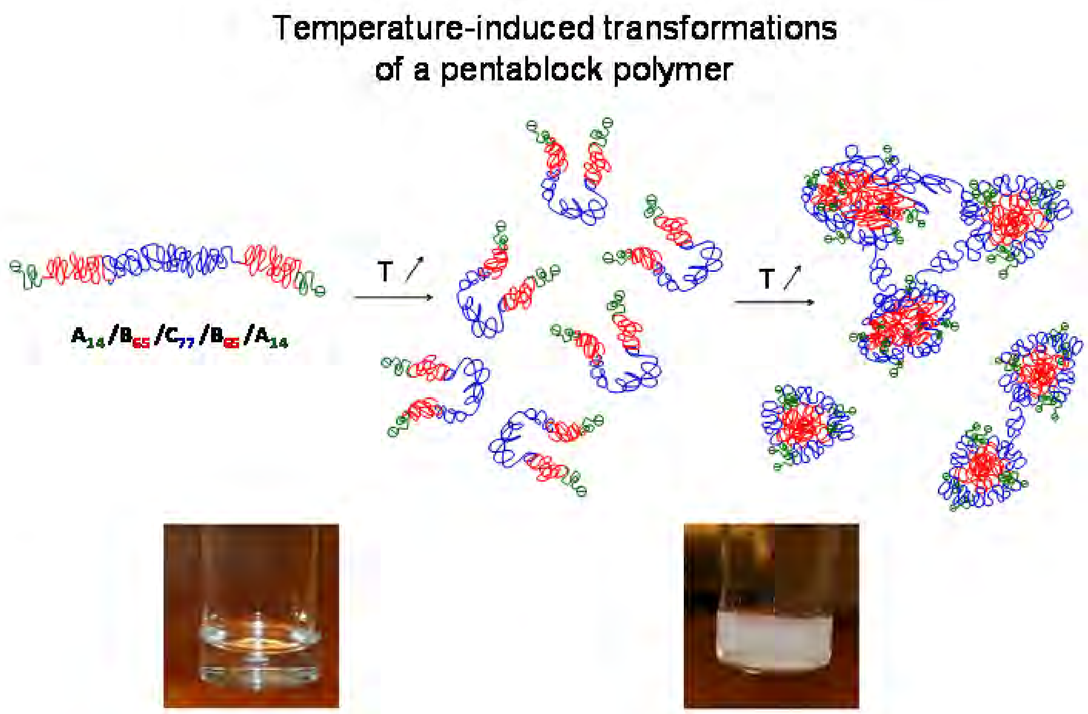
In collaboration with : Neda Beheshti, Kaizheng Zhu, Anna-Lena Kjøniksen, Bo Nystrom
Department of Chemistry, University of Oslo, P.O. Box 1033, Blindern, N-0315 Oslo, Norway

In order to elucidate the interplay between hydrophobic and hydrophilic forces as well as electrostatic interactions for a polymer in an aqueous environment, we have designed a novel pentablock polymer, with the configuration ABCBA. This is a linear chain, where we have attached two hydrophobic blocks (B) to each side of a hydrophilic segment (C), and on the end of the chain we have attached negatively charged groups (A). In this system there will be a competition between the attractive force of the hydrophobic blocks, the repulsion between the charged groups, and the tendency for the hydrophilic group to maximize the interaction with the surrounding water. The polymer has been made in two versions, with different lengths of the hydrophilic block (C), having 34 and 77 C-atoms, respectively. We observe that the physical properties of the system are highly dependent on the length of this C block. A sharp and highly reproducible temperature-induced transition, related to changes in chain conformation, is observed at a temperature around 40 C. The reason for this behavior, as well as the final structures produced in this system will be discussed in the presentation.



Characterizing and Improving Generalized Belief Propagation Algorithms on 2D Edwards-Anderson Model (10 min)

Alejandro Lage
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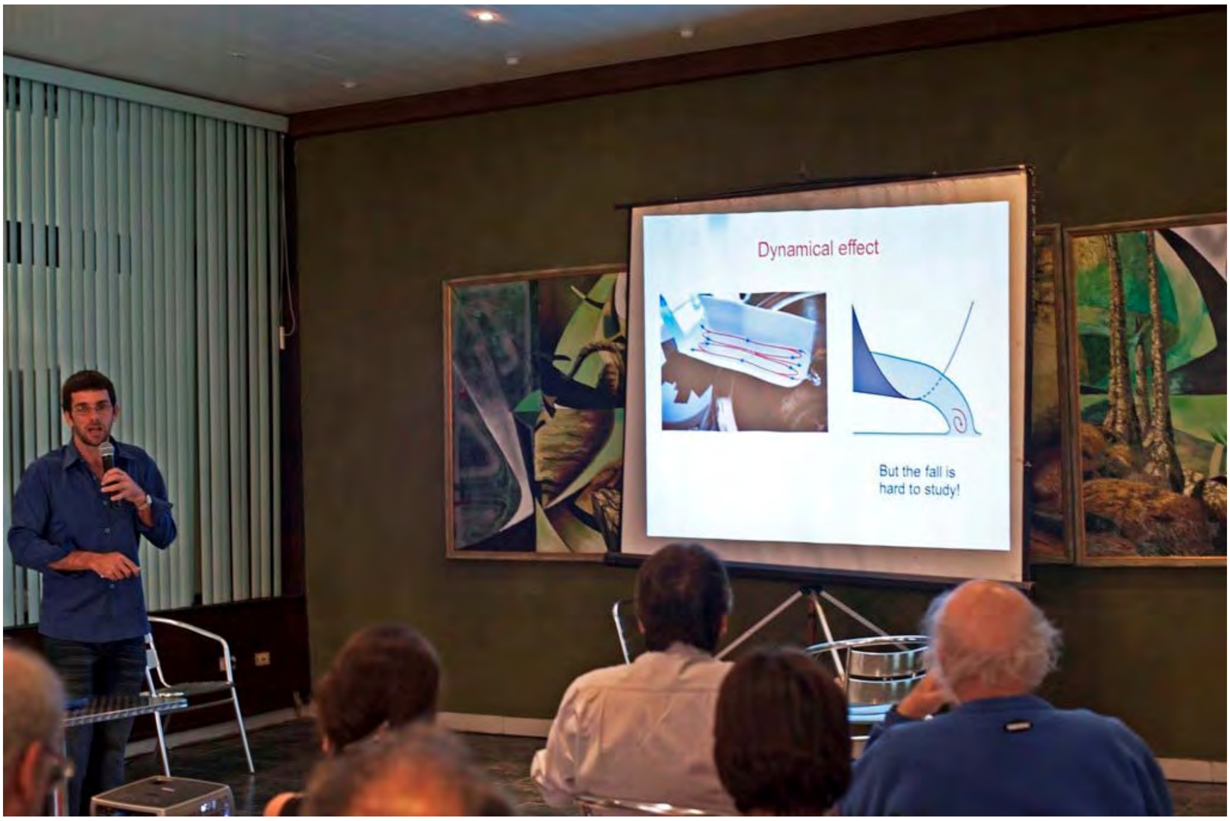
In collaboration with :
Eduardo Dominguez, Roberto Mulet Department of Theoretical Physics and "Henri Poincarè" Group of Complex Systems, Physics Faculty, University of Havana, La Habana, CP 10400, Cuba.
Federico Ricci-Tersenghi Dipartimento di Fisica, INFN – Sezione di Roma 1 and CNR – IPCF, UOS di Roma, Universita La Sapienza, P.le A. Moro 5, 00185 Roma, Italy.
Tommaso Rizzo Dipartimento di Fisica and CNR – IPCF, UOS di Roma, Universita La Sapienza, P.le A. Moro 5, 00185 Roma, Italy.

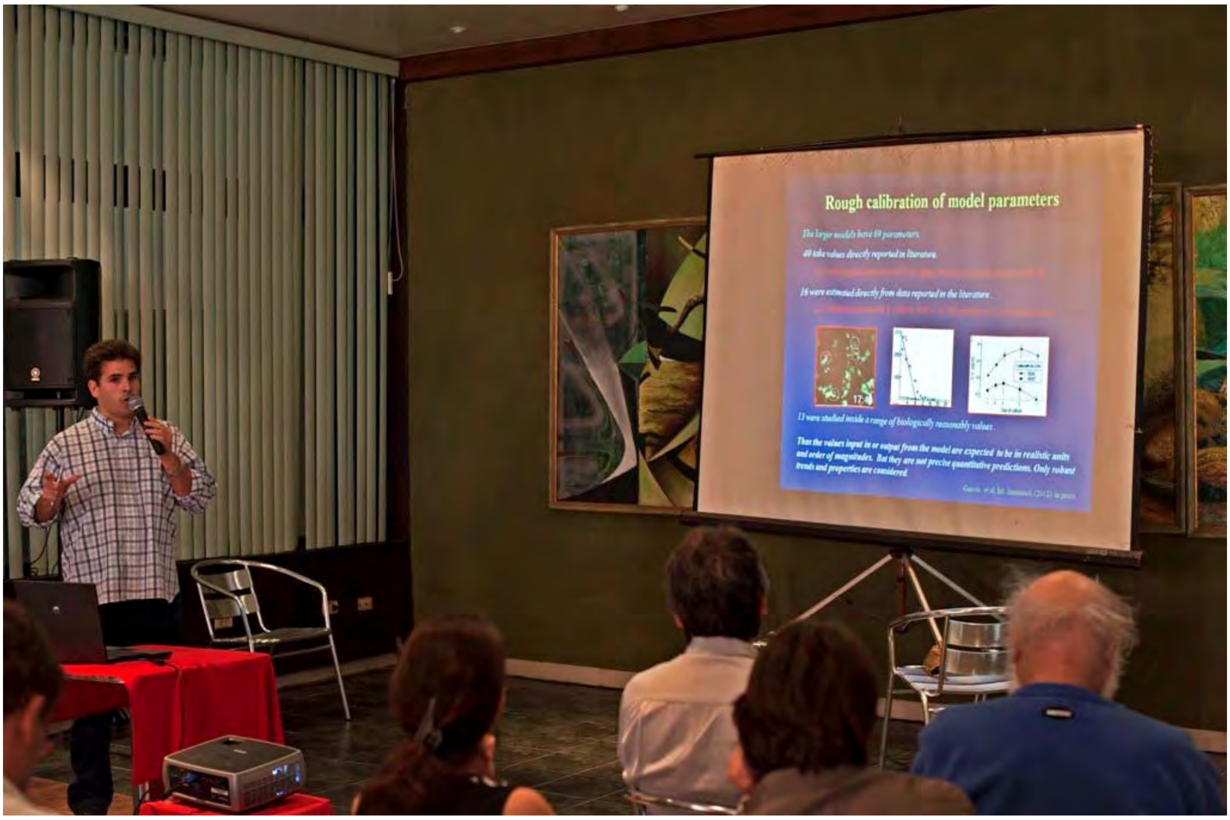
We study the performance of different message passing algorithms in the two dimensional Edwards Anderson model.

We show that the standard Belief Propagation (BP) algorithm converges only at high temperature to a paramagnetic solution. Then, we test a Generalized Belief Propagation (GBP) algorithm, derived from a Cluster Variational Method (CVM) at the plaquette level. We compare its performance with BP and with other algorithms derived under the same approximation: Double Loop (DL) and a two-ways message passing algorithm (HAK). The plaquette-CVM approximation improves BP in at least three ways: the quality of the paramagnetic solution at high temperatures, a better estimate (lower) for the critical temperature, and the fact that the GBP message passing algorithm converges also to non paramagnetic solutions. The lack of convergence of the standard GBP message passing algorithm at low temperatures seems to be related to the implementation details and not to the appearance of long range order.

In fact, we prove that a gauge invariance of the constrained CVM free energy can be exploited to derive a new message passing algorithm which converges at even lower temperatures. In all its region of convergence this new algorithm is faster than HAK and DL by some orders of magnitude.



Alejandro Lage



Kalet León

IL-2 muteins for the therapy of cancer: A success experience of combining dry and wet biology (20 min)

Kalet León
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In collaboration with :
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Introduction:
The CD4+CD25+FoxP3+ regulatory T cells (Tregs) have a central role in the maintenance of natural and peripheral tolerance. Moreover, they have been proof relevant for the natural immune response to some tumours. Interleukin-2 (IL-2), formerly known as a T cells growth factor, is also a key molecule for the homeostasis of Tregs. This fact has recalled the interest in this molecule as a therapeutic agent for cancer and autoimmunity. However this cytokine has a dual role in any immune response. It promotes immunity by expanding the helper/effectors T cells, but it also promotes tolerance by expanding the Tregs. This fact limits any therapeutic manipulation of this molecule. In this work we describe the design, production and preclinical evaluation of two classes of IL-2 muteins.

Materials and Methods:
The non-redundant functions of our muteins were predicted by a mathematical model which describes the dynamics of interactions between effectors and regulatory T cells. Their detailed molecular design was perform using public bioinformatics tools, and the crystal structure of the complex of IL2 with the IL2 receptor (available in the Protein Data Bank PDB). Mutenis were expressed and produced in E.coli. Muteins were designed to include substitution of some of the critical residues for the interaction of IL-2 with the different chains of its receptor. The activity of these muteins was assayed *in vitro* and *in vivo.*

Results:
Two classes of IL2 muteins were obtained: 1) Muteins with agonistic activity of wild type IL2, but with reduced capacity to stimulate Tregs; and 2) Muteins, which are antagonist of wild type IL2, but with a preferential activity over the Tregs. The obtained muteins exhibit the properties expected from their computational design. Particularly, they show significant anti-tumoral effect in mouse models of transplantable tumors, supporting their possible use in the therapy of cancer.

Conclusions:
The muteins developed are promising molecules for the therapy of cancer. The experiences of its design and construction illustrated how the combinations of theoretical and experimental tools could leads to novel drug development.

Strange flow phenomena in Cuban sands (10 min)

Etién Martínez-Román
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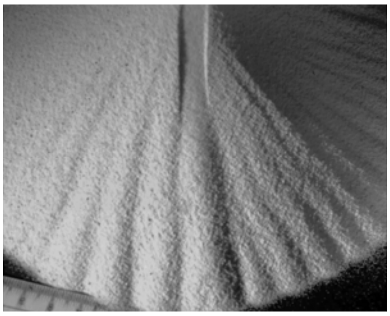
In collaboration with: Osvanny Ramos (Univ. Lyon, France), Alfo JoséBatista-Leyva (Instec, Cuba), Carlos Pérez-Penichet (UH, Cuba), Kevin Bassler (UH, USA), Renaud Toussaint (IPGS, France), Knut Jorgen Måløy (UiO, Norway), Jean Schmittbuhl (IPGS, France), Stephane Douady (ENS-Paris, France), Oscar Sotolongo-Costa (UH, Cuba), and Ernesto Altshuler (UH, Cuba).



We offer an overview of various phenomena observed in silicon sands from "Santa Teresa" (Pinar del Río, Cuba) –only occasionally seen in other sands around the Globe: "revolving rivers" and "uphill bumps". While we have reached a qualitative or semi-quantitave understanding of the observed phenomena, their prediction based on the "microscopic" features of the sands remains as an open question. This work has been made in collaboration of

Etién Martínez-Román

Complex patterns and speciation on the rocks (20 min)

Joachim Mathiesen
Niels Bohr institute, University of Copenhagen, Denmark
(mathies@nbi.dk)

In collaboration with: Namiko Mitarai, Kim Sneppen and Ala Trusina,
Niels Bohr Institute, University of Copenhagen, Denmark

The origin and sustainability of biological diversity is a long-standing problem. Ecological systems comprise an astonishing diversity of species which cooperate or compete with each other forming complex mutual dependencies. The biological requirements to maintain a large species diversity on long time scales are in general unknown. Using sessile plant communities on rocks as an example, we propose a model for the evolution of mutually excluding organisms that compete for space. We suggest that chain-like or cyclic invasions involving three or more species open for the creation of a complex pattern of spatially separated sub-populations that subsequently can lead to increased diversity. Our model predicts robust coexistence of a large number of species, in accordance with observations. It is demonstrated that large species diversity can be obtained on evolutionary time scales, provided that the interactions between species have spatial constraints. In particular, a phase transition to a sustainable state of high diversity is identified when the network of interactions between species becomes sufficiently sparse.

Joachim Mathiesen

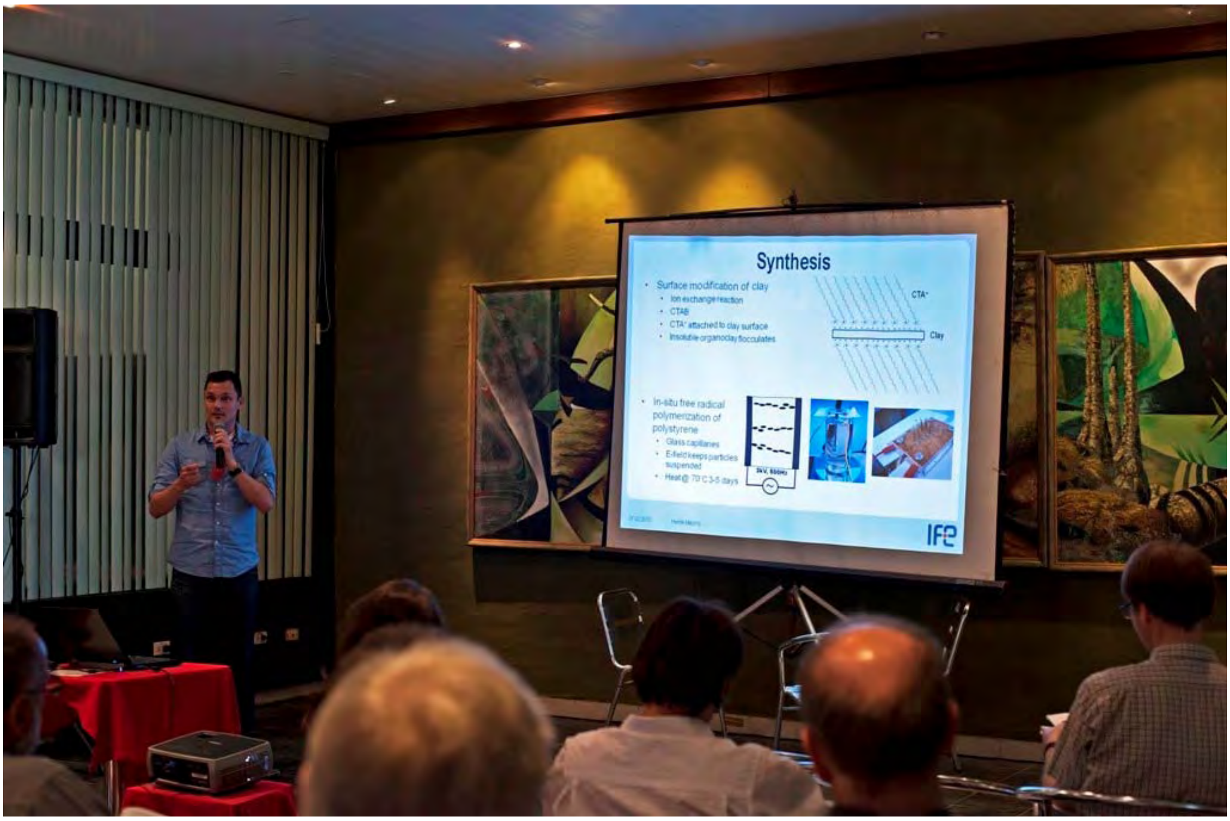
Anisotropy in PS-clay nanocomposites (10 min)

Henrik Mauroy
Physics department, Institute for Energy Technology, Kjeller, Norway
(henrik.mauroy@ife.no)

In collaboration with : Kenneth D. Knudsen[1], J.O. Fossum[2], Z. Rozynek[2]
[1]Physics department, Institute for Energy Technology, Kjeller, Norway
[2]Department of Physics, Norwegian University of Science and Technology, Trondheim, Norway

Recent progress in polymer science has demonstrated that remarkable changes in material properties are achievable by combining polymer systems with miniature particles, where at least one of the particle dimensions is in the nanosize range. Important examples are large increases in melting temperature as well as significantly higher yield stress. Less than 1 wt.% filler can drastically modify the overall system behavior if the surface of the incorporated particles has been made to interact sufficiently with the polymer chains[1]. We have developed a new method of synthesizing polystyrene-clay nanocomposites, where the clay particles are manipulated into chains spanning the whole polymer volume. Synthesis, structure determination, and physical properties of the composites will be discussed.

[1] Haraguchi, K. and T. Takehisa, *Advanced Materials*, 2002. **14**(16): p. 1120-1124.



Henrik Mauroy

Flow-controlled densification of E. Coli through a constriction (10 min)

Gastón Miño
PMMH, UMR 7636 CNRS-ESPCI-Universités Paris 6 and 7, 10, rue Vauquelin - 75231 Paris Cedex 5, France (gaston.lm@gmail.com)

In collaboration with E. Altshuler [2], C. Pérez-Penichet[2,3], L. del Río[2], A. Lindner[1], A. Rousselet[1] and E. Clement[1]
[1]PMMH, UMR 7636 CNRS-ESPCI-Universités Paris 6 and 7, 10, rue Vauquelin - 75231 Paris Cedex 5, France,
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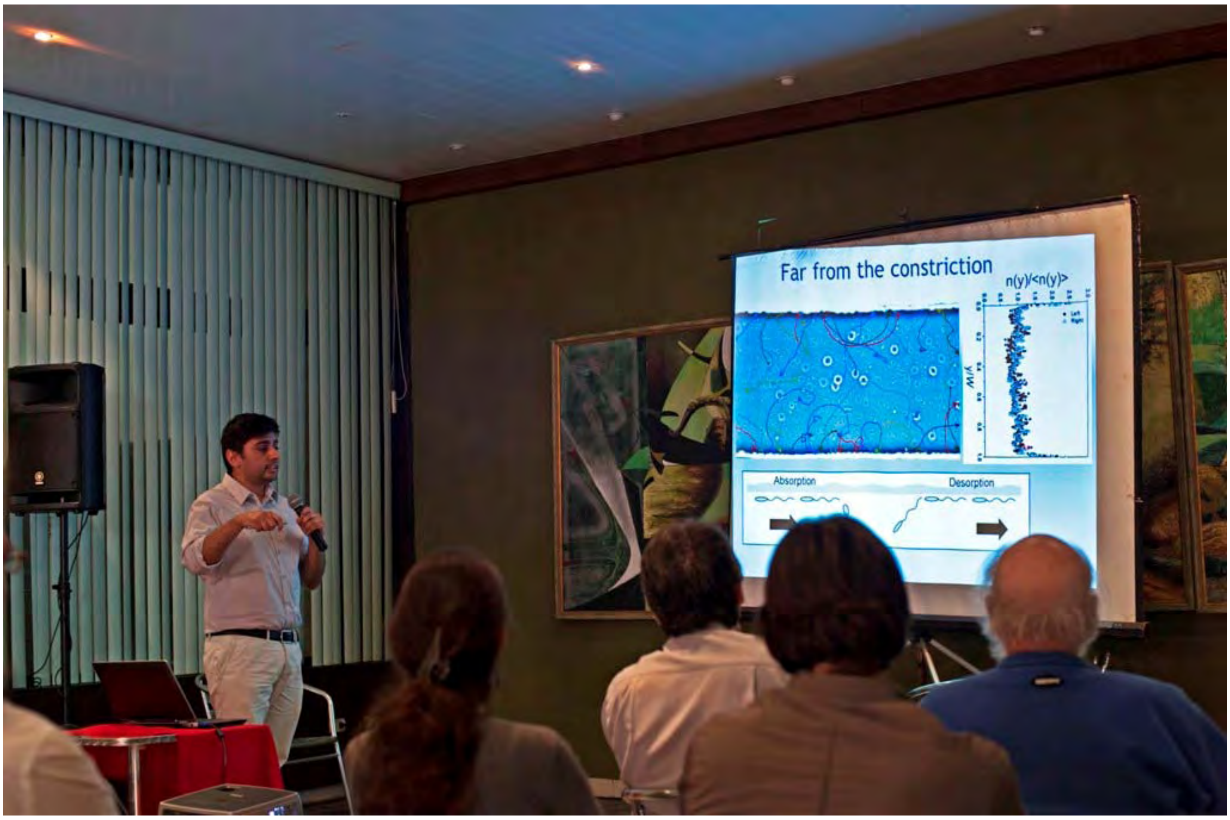
Bacterial suspension can be seen as an interesting example of "active matter". Many works have been done in order to understand how these self-propelled entities can interact hydrodynamically with its environment, including the surrounding "passive" fluid, the boundaries and other bacteria.

In this presentation, we show a new phenomenon concerning *E. Coli* suspensions flowing through a funnel-like constrictions in micro-fluidic channels.

The dynamics of bacterial suspensions flowing in confined spaces is relevant to understand their behavior in scenarios such as porous materials, soil, microbiology, water purification, and biomedical research.

The applied flow induces a counter-intuitive symmetry breaking in the bulk bacteria concentration, which is found to increase past the funnel. The concentration enhancement persists over large distances and its amplitude increases linearly with the flow rate and disappears at large flow values. We show that the effect is reversible when the flow direction is reversed. We explain the observed effects on the interactions between the active bacteria and the channel boundaries. As we know that solid boundaries may act as traps for the bacterial motion and may change drastically the transport properties of the suspension.

This experiment opens the possibility to control the concentration bacterial suspensions in microfluidic channels by simply tuning the flow of liquid.



Gastón Miño

Marcel N. Moura

Vortex dynamics in multiply-connected domains (10 min)
Marcel N. Moura
Universidade Federal de Pernambuco, Departamento de Física,
Recife, Brazil
(marcelmoura@yahoo.com.br)

Incollaboration with: Giovani L. Vasconcelos, Universidade Federal de Pernambuco, Departamento de Física, Recife, Brazil

The dynamics of vortices in a fluid surrounding multiple solid obstacles is of great theoretical interest and practical importance. In particular, the problem of vortex motion past a circular cylinder placed above a plane wall has attracted considerable attention recently. In this case, shown in Fig. 1b, a stationary vortex is formed upstream of the cylinder (Lin et al., Journal of Engineering Mechanics **135**, 697, 2009) in contradistinction to the usual case (Fig. 1a) where a vortex pair is observed behind the cylinder [1].
In the present work, the motion of a point vortex in an ideal fluid past a circular cylinder close to a plane boundary is studied from analytical and numerical standpoints. Using complex analysis techniques devised by Crowdy and Marshall (Proc. R. Soc. A **461**, 2477, 2005) to analyze vortex dynamics in multiply-connected domains in two-dimensional flows, we obtain the complex potential and the Hamiltonian (also called the Kirchhoff-Routh path function) for the problem of one point vortex placed in a uniform stream past a circular cylinder above a plane. The corresponding phase portrait is obtained and all equilibrium points, together with their stability nature, are determined.
We show that this point-vortex model can explain some of the qualitative features observed in the experiments, such as the clockwise circulation around the cylinder and the variation of the stationary position as the gap between cylinder and the plane wall changes. It is also argued that the method can, in principle, be extended to study vortex dynamics around multiple cylinders (with or without a plane wall), although here the mathematical calculations become more involved.

[1] Giovani L. Vasconcelos, Marcel N. Moura, and Adriaan M. J. Schakel, "Vortex motion around a circular cylinder," Physics of Fluids **23**, 123601, 2011.

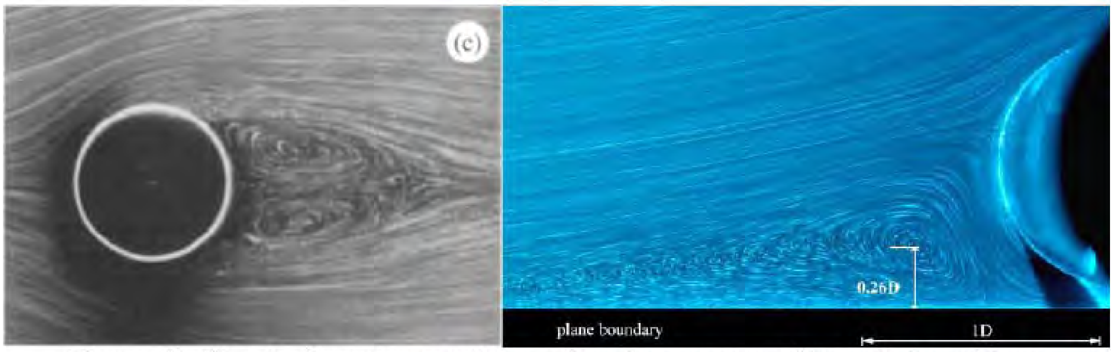


Figure: (Left) pair of counter-rotating vortices downstream of the cylinder without the plane. (Right) single vortex upstream of the cylinder with the plane.

Dynamic aerofracture of dense granular packings (10 min)

Michael J. Niebling
Department of Physics, University of Oslo, Norway, Institut de Physique du Globe de Strasbourg, France, and University of Strasbourg, Strasbourg, France (michael.niebling@fys.uio.no)

In collaboration with: Renaud Toussaint[1,2], Eirik G. Flekkøy[3] and Knut Jørgen Måløy[3]
[1]*Institut de Physique du Globe de Strasbourg, CNRS, France.*
[2]*University of Strasbourg, 5 rue Descartes, 67084 Strasbourg Cedex, France.*
[3]*Department of Physics, University of Oslo, P.O. Box 1048, 0316 Oslo, Norway.*

Hydraulic fractures are a result when diverse materials break under the stress induced by fluids or gases. Understanding how hydraulic fracturing is initiated and progresses is of fundamental importance whenever safe dams are constructed, super-critical CO_2 stored or sustainable wells drilled. Volcanic dikes and sills arise naturally by hydraulic fracturing processes. Just as we learn to protect ourselves from the unwanted effects of hydraulic fractures it has been proven to be a useful technology to fracture the reservoir rock formations around a well-bore to enhance the recovery of mineral oil and natural gas.
In our study a dense but permeable two-dimensional (2D) granular layer is fractured by an imposed pressure gradient of the compressible interstitial gas inside a rectangular Hele-Shaw cell. For this purpose the pressure at the inlet of the cell is increased while at the opposing side a semipermeable boundary only lets the gas-phase pass through. A discrete numerical molecular dynamics model is employed to investigate the dynamics of the fractures and fingers in the granular phase. Systematic variation of the controlling parameters of the interstitial gas reveals a transition of the emerging granular displacement patterns. In the progress we can identify and describe a mechanism which controls the transition of the emerging displacement patterns from fractures and fingers to bubbles as a function of the interstitial gas properties and the characteristics of the granular phase.

Michael J. Niebling

Thermodynamics and complexity (20 min)

José Manuel Nieto-Villar
Physical-Chemistry Departament, Chemistry Faculty and "Henri Poincarè" Group of Complex Systems, Physics Faculty, University of Havana
(nieto@fq.uh.cu)

In collaboration with: E. Izquierdo-Kulich, Physical-Chemistry Departament, Chemistry Faculty and "Henri Poincarè" Group of Complex Systems, Physics Faculty, University of Havana

A link between entropy and information is established. It is discussed the incompatibility between the macroscopic irreversibility and microscopic reversibility, also the entropy production principle and its different and sometimes contradictory statements. The entropy production rate is properly related to aging and cancer.

José Manuel Nieto-Villar

Structural Studies of Mixed Nano-Spheres and Polymers (20 min)

Roger Pynn
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A newly developed neutron scattering technique known as Spin Echo Small Angle Neutron Scattering (SESANS) allows real-space density correlations to be probed in bulk samples over distances ranging from ~ 20 nm to ~ 2000 nm. We have applied this technique to study correlations between surfactant-stabilized poly(methyl methacrylate) (PMMA) spheres suspended in either dodecane or decalin, both of which are good solvents for PMMA. As expected, the data show that for colloid concentrations below ~30%, correlations between PMMA spheres are accurately described by Percus-Yevick hard-sphere behavior. When a small amount of low molecular weight polymer is added to the colloidal suspension and when the carrier fluid is a good solvent for the polymer, the measured correlations between PMMA spheres are as expected from Monte Carlo simulations: short-range correlations between colloidal particles are increased by the presence of the polymer depletant. When higher concentrations of polymers are added or when the molecular weight of the polymers is large, we find that long-range, fractal-like correlations develop between spheres, even though the sample still appears to be a viscous liquid rather than a gel. When the solvent is not a good solvent for the polymer depletant, correlations between PMMA spheres are unaffected by the addition of small quantities of polymer.

Roger Pynn

Growth of metal nanostructures on graphite and their chemical properties (20 min)

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It has been long known that systems that consists of metal nanoparticles that have been dispersed in a non-metal matrix have enhanced catalytic properties as compared to a catalysts made from larger metal grain sizes [1].One key example is that gold nanoparticles are catalytic active in contrast to low-index gold surfaces [2]. It has been found that chemical properties were markedly altered for particle sizes below 6 to 10 nm [3].

Presently, metal nanostructures on pyrolytic graphite have been studied by photoelectron spectroscopy (PES), temperature programmed desorption (TPD) spectroscopy, and scanning electron microscopy (SEM). Preparation of the structures was done by thermal evaporation of small amounts of metal onto the substrate surface. The structures could subsequently be modified by Ar-sputtering.We find that metal core level shifts may be used to define an effective size of the nanostructures. Desorption of carbon monoxide was seen to depend on the size of the structures in the size range below 10 nm [4]. The modified reactivity of the nanostructures may be consistent with an increasing number of corner atoms for smaller structures [3], and is also consistent with a model in which "hot electrons" are flowing from the nanostructures to the substrate and thus modifying the electrostatic potential of the metal particles [4,5].

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Zbigniew Rozynek

Scale invariant avalanches: a critical confusion (20 min)
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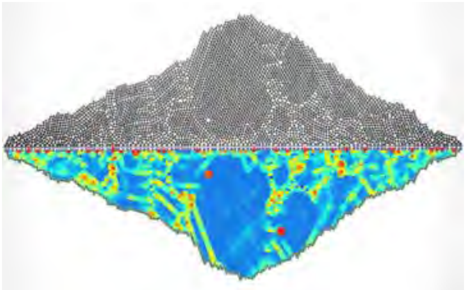

In the last decades considerable efforts have been devoted to understanding single events related to friction, fracture and unjamming transition, commonly denominated avalanches. However, in many different natural scenarios -from subcritical fracture to earthquake dynamics- these events are of all scales; a situation that has often been interpreted within the formalism of critical phenomena, and having as a relevant consequence the inherently unpredictability of scale-invariant avalanches. A revision of this interpretation which departs from standard ideas is presented here, resulting in [1]: (i) critical systems are not necessarily unpredictable; (ii) slowly driven systems evolving through power-law distributed avalanches are not necessarily critical; and (iii) scale-invariant avalanches are not necessarily unpredictable. Simple simulations [2] and granular experiments [3] confirm the findings.

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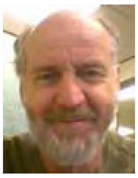
Osvanny Ramos



Water as a complex quantum network (20 min)

George Reiter
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Using Deep Inelastic Neutron Scattering to measure the momentum distribution of protons in water, we have demonstrated that the model of water as isolated molecules interacting electrostatically is inadequate to explain the rich variation in the momentum distribution with different conditions that is observed, and indeed, is even quantitatively inadequate in bulk water at room temperature. We find that in water confined on scales of 20 Å, the protons experience a strongly anharmonic local potential, and show evidence in some cases of coherent delocalization in double wells. There are changes in the zero point kinetic energy of the protons from -40 to +120 meV from that of bulk water at room temperature (148 meV). In bulk water supercooled by a few degrees, the momentum distribution also shows coherent delocalization of protons in double wells, with kinetic energy increases of 80meV. We attribute these changes to the electronic system being a connected network, through the hydrogen bonds, and able to respond as a network to global constraints. We provide another example, KDP, of this sort of behavior in a hydrogen bonded system that satisfies the same "ice rules".

George Reiter

Self-organization from Electrically Polarized Clay Particles (10 min)

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This is an overview on the subject of electric field induced self-organization from clay particles. It is known that the application of an electric field induces polarization of the suspended dielectric particles. As a result they re-orient and aggregate, which results in the formation of a columnar structure parallel to the electric field direction [1].

The formation of a column-like structure consists of four stages/steps and these are considered separately in order to describe different physical processed that lead to the final particle assembly.

(i) The electric field induces particle polarization is a very rapid process (τ_1<10^{-6}s). The clay particles polarise along their silica sheets, i.e. their stacking direction in normal to the polarisation direction. It is suggested that the intercalated ions and water, which are movable, could play a central role in particle electrical polarisation [2].

(ii) The resulting induced dipole is attached structurally to the clay particle, and this causes clay particles to reorient. The particle alignment has been studied by means of fast speed camera imaging. The time it takes the particle to rotate is measured. The rotation time is proportional to the carrier fluid viscosity and inversely proportional to: firstly the difference in the dielectric constants between particle and medium; and secondly the electric field squared. The time scale τ_2 for particle rotation is in a range of 10^{-3} to 10^{1} s, for *E*-field strengths between 50 and 2000 V/mm and viscosity of silicone oil between 100 and 500 mPa.s [3].

(iii) If particle concentration is high enough and a minimum critical *E*-field is applied a chain formation occurs via a particle dipole-dipole interaction. As a consequence the chain-like structure is formed that changes the suspension parameters (electro-rheological effect) [4,5]. The time scale for particle bridging is between 10^{-1}-10^{1} s (when parameters mentioned above are used).

(iv) When time passes the structure may coarsen into thicker (column-like) assemblies. It has been suggested that in some systems, this process may be driven by thermal motions of particles that induces dipolar chain fluctuations [6,7].

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The morphology of impact craters: Grains vs grains (20 min)

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In 1609 Galileo challenged the Aristotelian philosophy that for almost two thousand years imposed the idea that celestial bodies were perfectly spherical. He showed that the surface of the moon was not perfect but had circular large depressions. More than 350 years needed to pass to accept the idea that those depressions, now called craters, were caused by asteroid collisions[1]. However, a question remained: why some craters have central peaks? Nowadays, well elaborated models explain that central peaks arise due to the surface fluidization produced by the impact[2]. It has also been proposed that those peaks were formed by expelled jets[3]. Based on a recent report suggesting that asteroids have a granular composition[4], we developed impact experiments of “granular projectiles” in sand, obtaining similar morphologies to those observed in celestial bodies[5]. So we claim that the crater morphology is due to the granularity of the projectile: low-packed projectiles completely spread after collision producing bowl- shaped craters, high-packed projectiles confine the internal material during the impact giving rise to central peaks.

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Carlos Ruiz-Suárez

From fingering to fracture in complex fluids (10 min)
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We present a novel experiment - a specific Hele-Shaw cell with mobile sides – with which both liquids and solids can be loaded with the same boundary conditions, beyond the small deformation regime. With such a system, one can examine quantitatively the response of a viscoelastic material when the loading rate is varied. On the liquid side, a bubble grows in the material and destabilizes in a Saffman-Taylor manner, forming an elongated finger, while on the solid side, a crack develops. Thus, a study of the morphologies of the pattern formed in the fluid allows for a quantitative analysis of the liquid to solid behavior. Furthermore, in our geometry, the two kinds of patterns have inverse aspect ratios. This study could hence give some new insight on liquid to solid phase transitions such as the sol-gel and the glass transition. We present firstly a set of experiments obtained on Newtonian fluids of different viscosities. Then we show some experiments in different viscoelastic materials. We perform an analysis of the morphologies pattern and the displacement field through the transition.

Baudouin Saintyves

"Here be dragons". A tentative phase map for granular mixtures (20 min)

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In collaboration with: E. G. Flekkøy[2], H. A. Knudsen[2], K. J. Måløy[2] and Howard See[3]
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Mythical creatures were once believed to roam beyond the horizons of the known lands. Cartographers at the time filled in the white spaces with sea serpents and other fanciful creatures and posted ominous warnings for the explorers: "Here be Dragons". In this talk we shall explore an altogether different and much less dangerous world – pattern formation in granular mixtures. However, also we find that strange and wondrous creatures abound. The system is simple: air is injected into a granular mixture confined between two glass plates. The displacement structures that emerge are governed by the contending forces and interactions at play, including pressure, friction, viscous and capillary forces. We start by exploring the domain of "frictional fingering", and then map the phase boundary to "stick slip bubbles". As we increase the rate, viscous forces start to dominate the dynamics yielding new types of patterns. Finally, we investigate what kind of displacement structures develop when the filling fraction of granular material is increased, ultimately resulting in a fixed porous medium. The diversity of pattern formation dynamics is surprising, and maps are needed to navigate this new world. Based on our results, and those of fellow explorers, we draft tentative maps, or phase diagrams, of the different pattern formation modes and the phase boundaries between them.

Bjørnar Sandnes

Avalanche dynamics of imbibition fronts (20 min)

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In collaboration with : R. Planet[1,3], K. Jørgen Måløy[2] and J. Ortín[3]
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[3] Departament d'Estructura i Constituents de la Matèria, Universitat de Barcelona - Martí i Franquès 1, 08028 Barcelona, Catalonia, Spain, EU

We address here the problem of forced-flow imbibition in a disordered medium where a fluid (oil) that preferentially wets the medium displaces a resident fluid (air) at a constant flow rate. Using a high-resolution fast camera, we follow the propagation of the fluid-air interface invading a disordered Hele-Shaw cell. Measuring the local waiting time fluctuations along the front during its propagation, we show that the fluid interface displays an intermittent behavior signature of an avalanche-like dynamics. First, we will discuss the Non-Gaussian fluctuations of the global (spatially averaged) velocity V(t) of the interface. Then, we will focus on the various scaling behavior of the local avalanches defined as spatial clusters of large local velocity. Our experimental results underline the critical behavior of the imbibition dynamics, suggesting the existence of a critical depinning transition for this process at V=0

Stéphane Santucci

Electrical precursors to granular slip events (20 min)

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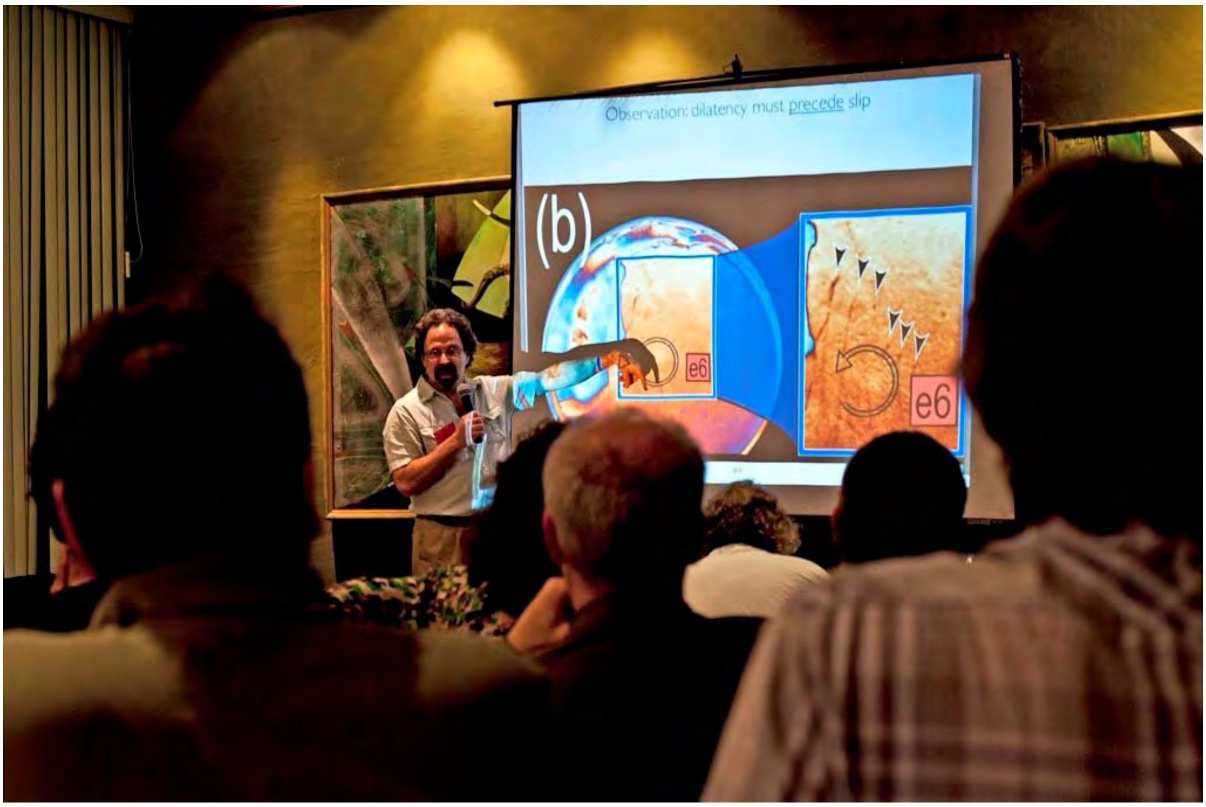
It has been known for many years that electrical signals are produced by material failure, for example during crack formation of solid crystals, glasses, and rocks, peeling of plastic tape from a roll, and stick-slip motion of liquid mercury on glass. New experiments in our group reveal that slip events in cohesive powders also produce electrical signals, and remarkably our data reveal that <u>these signals appear in advance of slip events</u>, creating the possibility that reliable predictions of granular avalanches may be made for the first time. We have confirmed the precursor effect over a period of over a year in *two different experimental systems* using entirely *different materials*, with four *different experimenters*, *different measurement methods*, and with and without controls. The mechanism underlying these precursors is, however, not understood: we speculate that the effects seen may be associated with a need for granular beds to dilate before they can slip.



Troy Shinbrot

Tsallis’ formalism in radiobiology (20 min)

Oscar Sotolongo
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I describe how Tsallis’ formalism can be applied to the cell survival factor of cells under radiation. Some universal characteristics become revealed with this treatment. This viewpoint has potential applications in clinical radiotherapy.

Oscar Sotolongo

Experiments on droplet baed microfluidics (20 min)

Patrick Tabeling
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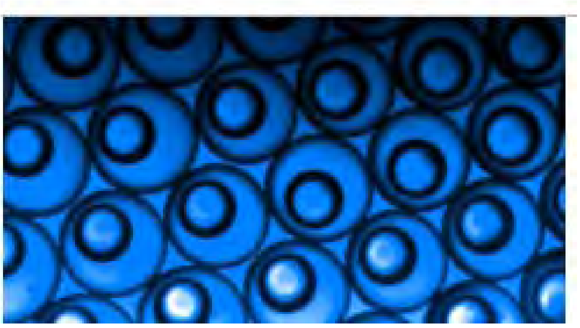
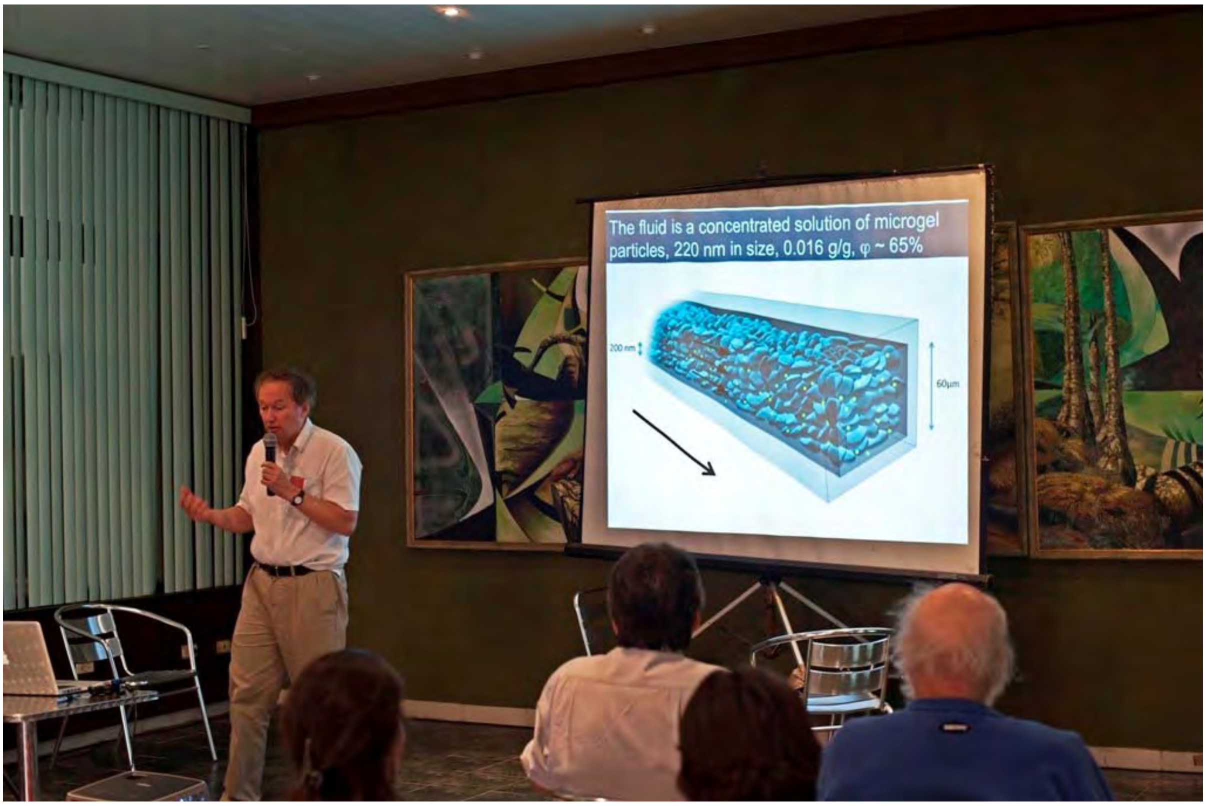
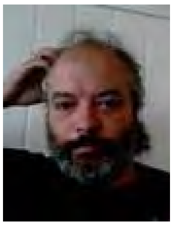


Developing biochemical and chemical processes in microdroplets rather than in microchannels or microchambers is an idea that has been promoted over the last few years by several groups. Among the main advantages of microdroplet approach, one may mention the absence of contact between the chemical species and the walls, the possibility of varying, in each droplet, the physico-chemical conditions under which chemical or biochemical processes develop (opening the way to screening), and the fast mixing that takes place in each droplet. This approach naturally leads to envision microfluidic systems with mazes of microchannels along which droplets conveying solutes, materials, particles, undergo transformations, reactions and processes. We are still far from this stage, but progress reported recently in the literature point in that direction. I will describe the experimental effort we developed in this domain, over the last couple of years, in the Microfluidic Group of ESPCI. The talk will focus on droplet breakup in simple microfluidic geometries, generation of colloidal droplets, expression profiling at the single cell level (using droplet based microfluidics) and localized drug delivery using micrometric droplets as vectors.



Patrick Tabeling



Flow of dense mixed suspensions: liquefaction, avalanches and fluidofracture (20 min)

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d Hebrew university of Jerusalem, Israel
d University of Texas A&M, USA)

When fluid pressure gradients rises to sufficiently high levels in porous media, seepage forces can lead to irreversible flow of the solid matrix. This process is unstable, and leads to high permeability channel formation. We will present here experimental and numerical results on this channel formation and the characterization of their dynamics.
We will address the following situations:
a) Friction in a sheared dense fluid/granular mixture: The impact of lubrication effects in avalanches with long runoff and liquefaction is urging for models, as those tested on the simple flows presented here. We will present some results on the influence of intersticial fluids on sheared granular layers, and show that pore pressurization and liquefaction can also occur in drained soils initially compacted.
b) Saffman Taylor like instability: Transition from fingering to fracture during fluid injection in dense grain packing. We show how depending on the diffusion of the overpressure versus the propagation of solid stress transfer in a medium, one transits from a bubble like pattern to a fracturing pattern during the injection of fluid in the packing. We also study the pattern formation in the decompaction process starting from free boundaries during fluid extraction, and the formation of channels and fractures around injection chambers or gravitationally pressurized chambers. Thresholds of pressures are determined for the formation of these preferential paths. The geometry of these channels, their fractal dimension and other characteristics, are extracted from experiments and simulations. This allows to study a granular/fluid analog of the Saffman Taylor instability.
c) Rayleigh Taylor like instability: mixing and front growth during sedimentation. This granular fluid analog of the Rayleigh Taylor instability is studied: for fluids of various compressibility and viscosities, we look at the development of a decompaction front at the bottom of dense grains falling in a clear fluid. This corresponds to a granular analog to the Rayleigh Taylor instability. The analyses of the granular density profile under the packing reveals that it follows a Family Vicsek scaling with an anomalous diffusion exponent around 0.75, a Hurst exponent around 0.75 and a dynamic exponent around 1.

Renaud Toussaint

Giovani L. Vasconcelos

On the origin of power law distributions (20 min)

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A general theoretical framework is presented where probability distributions with power-law tails and finite variance naturally arises as a consequence of the existence of distinct characteristic time scales in the underlying dynamics governing the fluctuations of the relevant physical quantity.

Our model is based on a few reasonable assumptions:

(i) at large scales the distributions should approach a Gaussian;
(ii) at short scales the distribution can be represented as a Gaussian but where the variance—which can be viewed as the mean energy in a given scale or, alternatively, a scale-dependent temperature—is itself a fluctuating quantity;
(iii) the fluctuating dynamics of the variance is described in terms of an intermittent "cascade" process, meaning a hierarchy of linear coupled stochastic differential equations; and
(iv) the characteristic times for the dynamics at the different scales of the cascade are well separated.

From these assumptions it is possible to derive an analytic expression for the resulting probability distribution function (pdf) in terms of generalized hypergeometric functions of the type nF0. It is argued that the pdf's based on the functions nF0 form the most general family of probability distributions with finite variance and power law tails. The parameter n indicates the number of time scales present in the system. This quantity, however, and is not known a priori, in general, and must be estimated from the data.

Several applications of our model to velocity fluctuations in turbulence, financial asset price fluctuations, and fluctuating processes in other complex systems will be discussed.

Exotic Behavior Of Hexagons In Faraday Waves (20 min)

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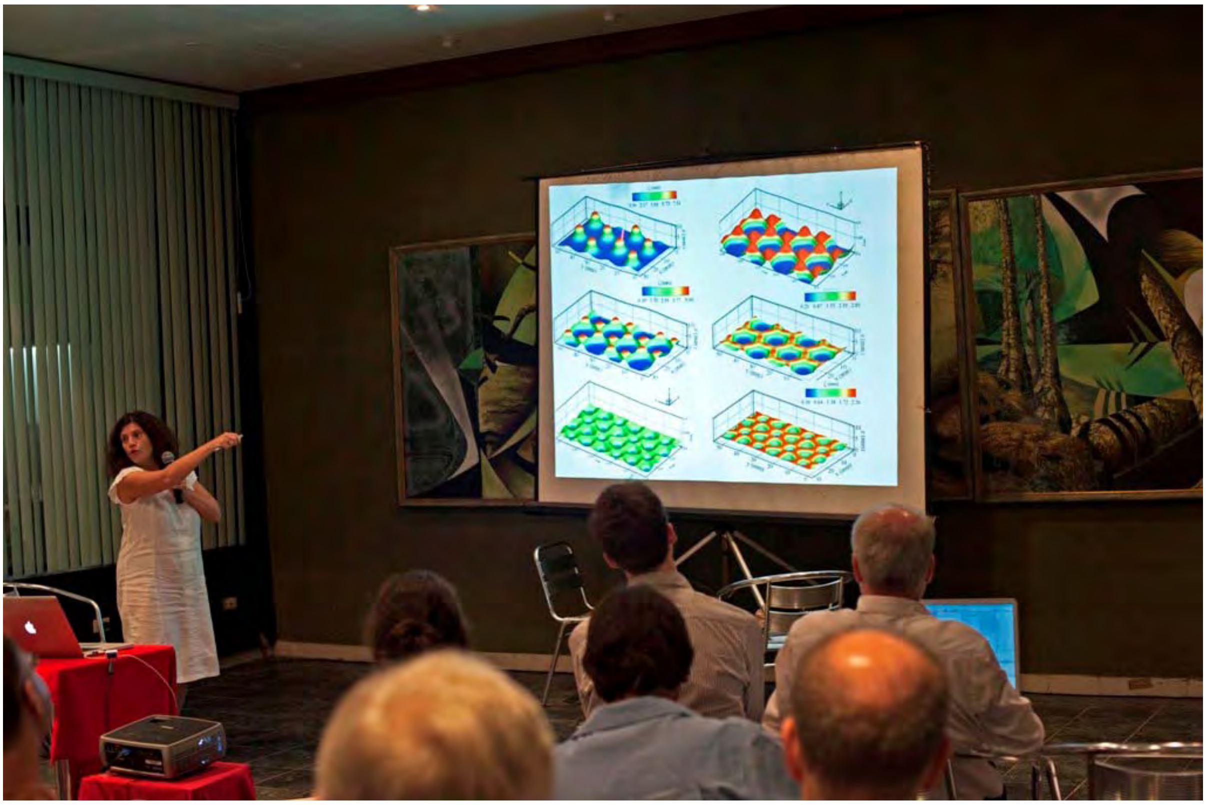
Three-dimensional numerical simulations of hexagonal patterns in Faraday waves are presented, including details of the velocity field and interface motion. The pattern does not remain hexagonal, but is succeeded by alternation of patterns we call quasi-hexagons and beaded stripes.



Laurette Tuckerman

Micro- and macro-avalanches in superconductors (10 min)

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In collaboration with: Daniil Shantsev, Yuri Galperin, Tom Henning Johansen Department of Physics, University of Oslo, Norway

Magnetic field does not always enter superconducting films in a smooth manner and often the penetration happens in form of avalanche. The macro-avalanches create spectacular, complex, dendritic flux structures and they have been well studied for decades. However, less attention has been paid to micro-avalanches, also present in superconducting films. The micro-avalanches can be detected as localized jumps in the flux penetration, with sizes ranging from one two tens of thousands of magnetic vortices. Several studies have reported that the number of avalanches distributes as a power law with regards to size, but it is not clear if this is a general feature of micro-avalanches. Neither is it clear what is the origin of the avalanches. In the presentation, I will show that disorder combined with strongly nonlinear material characteristics will give flux penetration in form of small avalanches. The sizes of the avalanches tend to be larger if the material is thermomagnetically unstable. In this way, the micro-avalanches are also potential triggers for dendritic flux avalanches.

Jørn Inge Vestgården

Why you can walk on a suspension of cornstarch and water (20 min)

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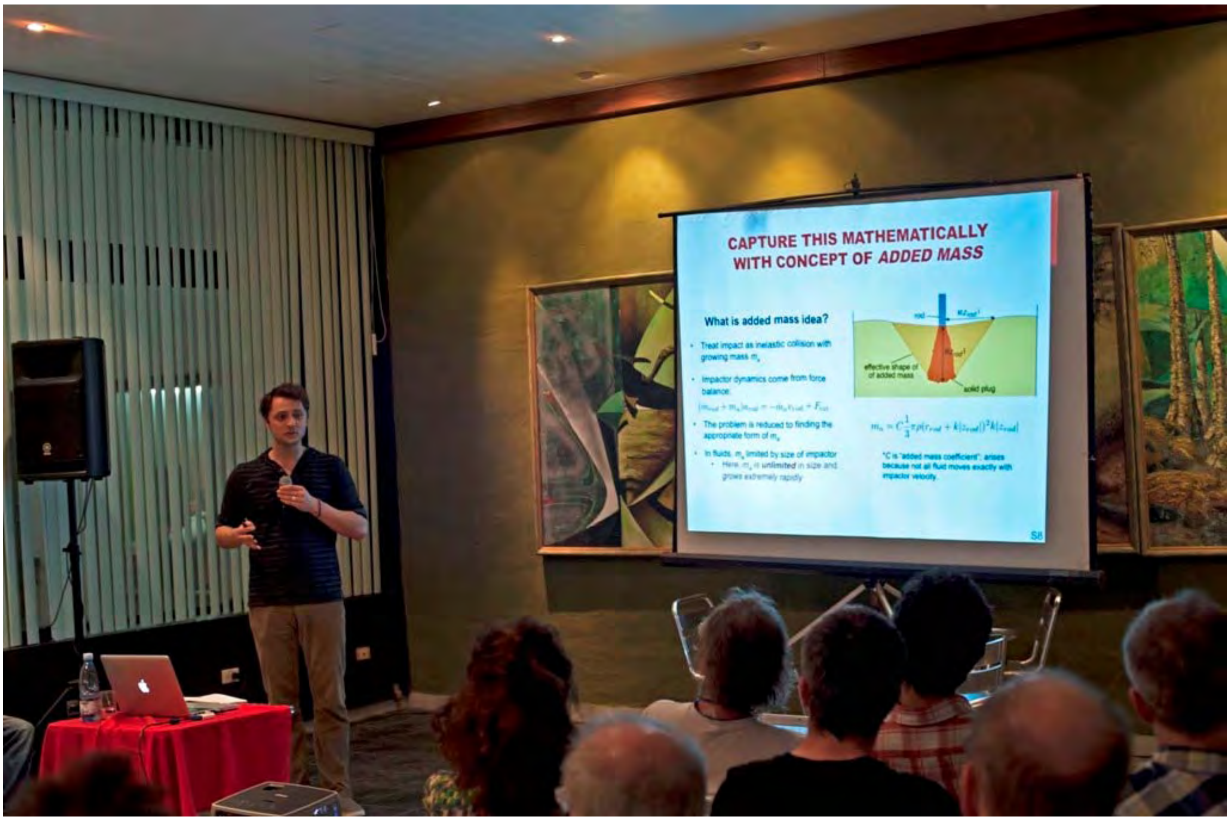
In collaboration with: Heinrich Jaeger

Dense suspensions of corn starch and water exhibit many unique and fascinating behaviors. Perhaps the most well-known and and striking example is the ability for the free surface of such a suspension to provide remarkably large impact stresses. As can be confirmed by a short search on YouTube, these stresses can easily be large enough to allow an ordinary sized person to run across the surface of the fluid. Despite the inherent uniqueness and obvious technological usefulness exhibited by this strange material, surprisingly little is known regarding how this response is generated. We address this question directly through a combined experimental approach utilizing high speed cameras, embedded force and acceleration sensors, and x-ray videography. Our experimental results paint a picture in which the generated response arises from the solidification of the suspension below the impact site. Following this idea, we develop a simple model that explains why you can walk on a suspension of cornstarch and water.



Scott Waitukaitis

Formation of quasi-1D clusters in vortex matter and their role in thermo-magnetic instability of superconductors. (10 min)

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In collaboration with: A.J. Qviller, P. Mikheenko, Yu. Galperin and T.H. Johansen
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Performance of most superconductor (SC) applications strongly depends on their behavior in magnetic field. Since almost all practically useful SCs belong to type-II, the field penetrates them in a quantized manner in the form of vortices. The vortices propagate from the edges of a sample and interact with structural disorder. Due to this interaction, called pinning, according to the original concept of Ch. Bean, a critical gradient of magnetic flux density is formed. This gradient corresponds to the maximum lossless current that a SC can sustain. The critical state is metastable and can be destructed either by flux creep or by abrupt massive flux avalanches. The latter ones may have a very dramatic consequences including loss of superconductivity and physical damage to the sample or a device.

The avalanches are associated with thermo-magnetic instability (TMI) of superconductors, which appears when the heat generated by the moving vortices is greater than the heat released into an environment, e.g. substrate in case of films. In that sense NbN films are known to be unstable, i.e. even the smallest increase of the external field may trigger a massive flux avalanche. Most theories developed to formulate the criteria for the appearance of the avalanches operate in terms of intrinsic parameters of SC, such as heat capacity, critical current etc., and basically disregard the origins and the nature of the triggering mechanisms that cause the instability.

We would like to present the most recent results of magneto-optical imaging (MOI) of flux dynamics in a series of NbN with well controlled nano-granular structure. The MOI shows that nano-scale irregularities, that inevitably appear under certain deposition conditions, not only stipulate increase of the critical current but also promote self-organization and correlated motion of large vortex clusters, which in turn trigger the avalanches.

Vitaliy V. Yurchenko

Round Table "Complex Systems: Doing cutting-edge experimental Physics on a small budget:

Ernesto Altshuler:

Elisabeth Bouchaud:

Patrick Tabeling:

Knut Jørgen Måløy & Jon Otto Fossum:

Irene Ippolito:

Oscar Sotolongo:

POSTERS

Best poster award (1 bottle Norwegian Aquavite + diploma above) received by Anier Hernandez Garcia:

1st Rhumer-up poster award (1 bottle Santiago rhum + diplome) received by Joakim Bergli:

2nd Rhumer-up poster award (1 bottle Santiago rhum + diploma) received by Angélica Castro:

Discharge of a granular material through an aperture: independence of flow rate with pressure.

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We experimentally demonstrate that the flow rate of granular material through an aperture is controlled by the exit velocity imposed on the particles and not by the pressure at the base, contrary to what is often assumed in previous work. This result is achieved by studying the discharge process of a dense packing of monosized disks through an orifice. A conveyor belt drives the flow. This two-dimensional horizontal setup allows us to independently control the velocity at which the disks escape the horizontal silo and the pressure in the vicinity of the aperture. The flow rate is found to be proportional to the belt velocity, independent of the amount of disks in the container and, thus, independent of the pressure in the outlet region. In addition, this specific configuration makes it possible to get information on the system dynamics from a single image of the disks that rest on the conveyor belt after the discharge.

Hydrodynamic correlations between confined colloidal particles

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The two-body hydrodynamic correlations between colloidal particles in a quasi-two-dimensional geometry are measured by optical microscopy. The correlation of the short-time motion of pairs of polystyrene spheres, suspended in water and confined between two parallel plates, is determined as a function of the interparticle distance and particles concentration. Such correlations, reported here in terms of diffusion coefficients of the normal diffusion modes, are found to depend more strongly on the particles concentration at short distances, less than three particles diameters.

However, at larger distances the decay of the correlation is inversely proportional to the interpaticle distance independently of the particles concentration. In our system the long-range electrostatic interaction is screened and the interparticle direct interaction becomes effectively only that of excluded volume. Thus, the observed long-range correlations, between pairs of particles, are due to the solvent mediated hydrodynamic interactions.

Here we present results for the diffusion coefficients for the normal modes, collective and relative, for a wide range of particle concentrations.

Dynamics and pattern formation of self-sustained fronts in disordered flow

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We generate propagation fronts resulting from a balance between molecular diffusion and non-linear chemical reaction. These fronts behave as solitary waves with a constant velocity and a stationary concentration profile. The interaction between this self-sustained system and a disordered flow leads to complex front formation. We have performed experiments of the front propagation over a wide range of stochastic flow rates and we have studied the spatial structures and the velocity fluctuations along these fronts. These structures depend not only on the intensity of the flow but of its direction relative to the chemical wave, leading to upstream, down-stream stationary front and, more surprisingly, to steady fronts. This pseudo-interface displays morphological features such as roughness that are analyzed in the frame work of front in disordered system. At flow rates close to the wave velocity but in the opposite direction, the front dynamics exhibits an intermittent behavior revealing the existence of local avalanches.

Roughness and fractality in the study of some geophysical and atmospheric phenomena

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Firstly, we use the roughness as a parameter to characterize the surface of granular heaps formed by different phenomena: continuous or intermittent flows. Only certain regimes could be differentiated, so the scaling-up to geological scenarios is not a trivial task. Secondly, we measure the fractal dimension of cloud images in the Cuban territory, under the hypothesis that they may constitute an indicator of rain and other meteorological phenomena. This work is presently under progress.

Upstream contamination in water pouring

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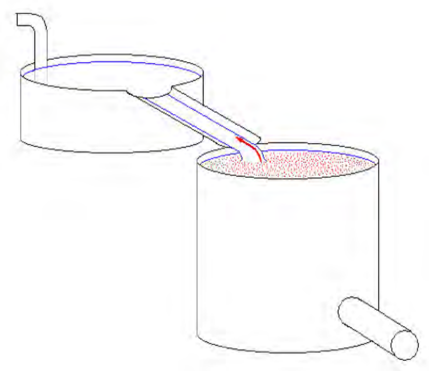

We report the observation of upstream transport of floating particles when clear water is poured on the surface of a flat water surface on which mate or chalk particles are sprinkled. As a result, particles originally located only at the surface of the lower container can contaminate the upper water source by "riding" on vorticial water currents. We speculate that Marangoni forces in combination with geometry-induced vortices may explain the observed phenomenon.

Transversal conduction through multi-filamentary superconducting tapes

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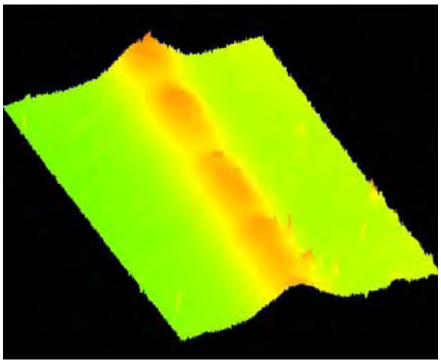

We have performed systematic transport experiments on transversal, Laser-cut bridges from multi-filamentary BSCCO-Ag superconducting composites. Our results, combined with magneto-optical images, show that the inter-filament conduction is always dissipative, contrary to some previous reports. We model the system in a "deterministic" way using a parallel-series set of resistive and superconducting elements. We also show some preliminary results from a percolative model of the composite.

Electric field induced rotation of Clay particles

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The electric field induced structuring of Sodium Flourohectorite clay particles suspended in silicone oil have been studied using WAXS and a high speed camera. This allows us to study the behavior from the microsecond regime to several minutes. The WAXS experients give us information of the distribution of particle orientation during the chain formation. Using a simple model and the data from the Highspeed camera gives some insight into the effect of the electric field, shape of the particles and viscosity of the oil on the rotation rate of the particles.

Aggregation forces measurement of levitating particles and cells in an ultrasonic resonator

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Aggregation of micron-sized particles and cells can be obtained by using ultrasonic standing waves field in fluidic resonators. This method is becoming very appealing for tissue engineering and bioassays but the comprehension of the aggregation dynamics is not still complete. In this work we present a way for determining the acoustic forces implied in the aggregation process. The ultrasonic resonator is composed of parallel pates separated by a distance w. The number of nodes$n$ generated by the standing wave of wavelength λ is given by the relationship: $w = n\lambda/2$. The primary radiation force generated by the standing waves induces levitation of particles toward pressure nodes. If gravity is considered, and if $n = 1$, an equilibrium position of particles occurs slightly underneath the pressure node at the middle of the cavity thickness. Once in equilibrium, acoustic transversal forces pouch particles toward the center of the resonator generating an aggregate in levitation. The dynamics of the aggregation is a complex process that depends on suspension concentration, elastic properties of particles as well as on the resonator geometry. The resonator used was a cylindrical chamber of 1cm diameter and 250µm height. Resonance frequency was 2.85 MHz. Long-range aggregation is generated by pressure gradients at the nodal plane while short-range aggregation is caused by Bjerknes force that is the result of the acoustic scattering generated by particles. We shall present a study of Bjerknes forces, which are predominant when particles are found at a few particle sizes from each other. Forces have been obtained by measuring particle velocities and distances during the aggregation process. We show the order of magnitude of all the forces implied in the process and we experimentally determined Bjernes forces of 5, 10 and 15 µm particles and colon cancer cells. The order of magnitude of acoustic forces 10^{-12}N, are in agreement with the theory.

On the role of the intrinsic noise on the response of the p53-Mdm2 module

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The p53 has a well established role in protecting genomic integrity in human cells. In particular, the p53-Mdm2 feedback loop seems to be the key circuit in the response of cells to damage. For many years, based on measurements over populations of cells it was believed that the p53-Mdm2 feedback loop was the responsible for the existence of damped oscillations in the culture.

However, recent measurements in individual human cells have shown that p53 and its regulator Mdm2 develop sustained oscillations over long periods of time, with essentially _xed frequency but variable amplitudes. These results have attracted a lot of interest because they challenge years of mathematical models with new and accurate data on single cells. Inspired by these experiments standard models of the p53-Mdm2 circuit were modi_ed mainly introducing some biologically motivated noise that becomes responsible for the stability of the oscillations.

We follow an alternative approach, the noise that stabilizes the _uctuations is the intrinsic noise due to the _nite nature of the populations of p53 and Mdm2 in a single cell. We study three stochastic models of the p53-Mdm2 circuit. These models are studied using Gillespie's simulations, mean _eld methods and the Linear Noise Approximation. The models intend to capture the response of the p53-Mdm2 circuit in the presence of DNA damage, in its basal state, and under oncogenic signals. For the _rst two cases our results compare quantitatively well with existing experimental data in single cells. While we can not discard that other sources of noise in the cells may also be important, our results strongly support the relevance of the intrinsic noise in this kind of systems. The literature of stochastic processes gives us already standard tools to study this kind of noise. In many cases one can predict analytically whether this noise will be relevant and how much. As far as we know, none of the sources of noises proposed previously can be studied so accurately from the analytically point of view.

The study of the response of the p53-Mdm2 circuit under oncogenic signals is presented as a an example of a process for which we do not have any experimental evidence, but can still be modeled looking for experimental veri_able results. We suggest that the intrinsic noise is the main responsible for the existence of sustained oscillations in the response of the p53-Mdm2 circuit. This noise alone can explain most of the experimental results obtained studying the dynamics of the p53-Mdm2 circuit in individual cells.

Understanding the dynamics at the Spin Reorientation Transition

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The dynamical properties of a 2D frustrated Heisenberg model with dipolar interactions and perpendicular anisotropy are studied using Monte Carlo simulations around the Spin Reorientation Transition. We explore a temperature defining a dynamical transition below which the relaxation suddenly slows down and the system apart from the typical Arrhenius relaxation. This anomalous behaviour is observed in the scaling of the magnetic relaxation and may eventually lead to a freezing of the system as has been reported in early experimental observations.

On the equilibrium structures of the Ginzburg-Landau Hamiltonian with competing interactions.

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The equilibrium features of a GL model with competing interactions are explored through a novel numerical scheme that ensures the isotropic nature of the fluctuation spectrum. Under these conditions it is possible to identify the phase boundaries in the H-T plane and describe the connection of the Hamiltonian parameters with the appearance of the inverse transition observed recently in Fe thin films. Furthermore, several new features emerges enriching the known phenomenology of this kind of frustrated systems.

A Numerical Approach to Stick-Slip dynamics in Granular Fluids

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Henning Arendt Knudsen[1] and Bjørnar Sandnes[2]

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Pattern formation in granular materials is a curious result ofdissipative interactions between grains. A recent study by B. Sandes [1] points to an extraordinary diversity in the dynamics of the flow of wet granular materials displaced by air in a Hele-Shaw cell. By varying the air injection rate and the granular filling fractionseveral distinct morphologies were observed, and the study maps out a tentative dynamical phase diagram. We investigate a transition in thatphase diagram, from frictional fingering to Stick-slip bubbles. By integrating the surface tension, pressure and frictional forces, we trace the displacement of the interface, and reproduce the experimentally observed patterns. The numerical scheme offers a method to study the transition in detail, complimentary to the experimental observations. The simulation use a dynamical version of a quasi static algorithm developed by H.A. Knudsen and others [2], developed to simulate labyrinth patterns in granular fluids.

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[2] H.A. Knudsen, B. Sandnes, E.G. Flekkøy and K.J. Måløy. Granular labyrinth structures in connfined geometries. Phys. Rev. E. 77,
021301. doi:10.1103/PhysRevE.77.021301 (2008)

Quantifying ant's traffic

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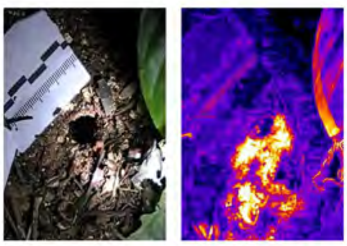
We measure the traffic ("activity") during ant foraging in wild conditions. Our measurements indicate a cyclic evolution of the activity, correlated to the environmental temperature cycles –a reasonable result from the "adaptational" point of view. However, the activity during each day increases rapidly and decreases in a slower fashion. We also measure temporal correlations in the activity fluctuations, eventually indicating "long" correlations. We are able to reproduce the main features of the temporal evolution of the activity using a differential equations model, which suggests that the "characteristic frequency" of the swarm "resonates" with the external frequency of the environmental temperature.



Study of the mechanisms of counterstream penetration of blood in vascular catheters

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Vascular catheters are irreplaceable elements for the care of critically ill patients. They are excellent tools for controlled administration of fluids. But they are also indissolubly bounded to bloodstream infections, mainly given by the catheter bacterial colonization that occurs very often in a few hours after,its insertion, even when a perfusion fluid is injected constantly in the circulatory system, through the catheter. Previous to, microorganism colonization it has been observed the existence of a protein slim layer where populations find a favorable substrate. In order to explain the counterstream migration of this nonselfpropelled material that form the blood, we have developed a hydrodynamic model based in the flowlimited diffusion of molecules against the perfusion fluid. According to this, the counterstream diffusion occurs in a very narrow corridor next to the inner tube wall. We have also made experiments where the same physical mechanisms that produce the studied phenomenon are observed under very controlled conditions, through the use of microchanels. Our preliminar experiments seem to corroborate the main theoretical results.

Modeling the role of IL-2 in the interplay between CD4+ helper and regulatory T-cells: Studying the impact of IL-2 modulation therapies

Karina García-Martínez and Kalet León,

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Several reports have drawn a complex picture of the effect of IL-2 modulating treatments. They seem to promote indistinctly immunity or tolerance. Such complexity might derives from the dual role of IL-2 on T cell dynamics. To theoretically address the latter possibility, we develop a mathematical model for T cells dynamics, and their relationship with IL-2. We simulate the effect of IL-2 injections, IL-2 depletion using anti-IL-2 antibodies, and IL-2/anti-IL-2 immune-complexes injection. We focus in the qualitative and quantitative conditions of dose and timing for treatments which allow them to potentate either immunity or tolerance. Our results provide reasonable explanations for the existent pre-clinical and clinical data, and further provide interesting practical guidelines to optimize the future application of these types of treatments. Our results predict that: a) Immune-complexes IL-2/Anti-IL-2 mAbs, using mAbs which block the interaction of IL-2 and CD25 (alpha chain of IL-2 receptor), is the best option to potentate immunity; b) Immune-complexes IL-2/Anti-IL-2 mAbs, using mAbs which block the interaction of IL-2 and CD122 (beta chain of IL-2 receptor), are the best option to reinforce preexistent natural tolerance; c) mAbs anti-IL-2 can be successfully used alone to treat an ongoing autoimmune disorder, promoting the re-induction of tolerance.

The FABULAB project: low-budget experiments in the Solar System

Alberto González, Harold Torres, C. Pérez-Penichet, Gustavo Sánchez-Colina, Johan Carlos Santana, M. A. Carvajal and E. Altshuler

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We present the conception and instrumentation of a FAlling BUcket LABoratory (FABULAB). The bucket, as part of a 12-meter-long Atwood machine, contains sand and an array of inexpensive instruments controlled from ground using wireless technology. Simple and, above all, FAST experiments in granular matter can be performed at different acceleration environments into the bucket while it falls (or rises), eventually resembling the situation in some planets of the solar system. Amongst these experiments there is the study of crater formation.

X-ray studies of interlayer water absorption and mesoporous water transport in a weakly hydrated clay

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The swelling of layered smectite clay particles causes changes in the interlayer repetition distance (d-spacing) as a function of temperature and humidity. For the synthetic clay sodium fluorohectorite, hydrodynamically stable hydration states with zero, one and two intercalated monolayers of water have previously been reported, with discrete jumps in d-spacing at the transitions between the hydration states. Keeping the temperature fixed and varying the ambient relative humidity, we find small reproducible d-spacing changes also within the hydration states. These changes are monotonous as a function of relative humidity, and one order of magnitude smaller than the shift in d-spacing that is typical of the transition between two hydration states. The reproducibility and reliability of this relative humidity controlled d-shift enables us to use the interlayer repetition distance d as a measure of the local humidity surrounding the clay particles. We provide an example of application of this observation: imposing a humidity gradient over a quasi one-dimensional temperature-controlled sample, and using x-ray diffraction to record the d-spacing, we are able to extract profiles of the relative humidity along the sample length. Their time evolution describes the transport of water through the mesoporous space inside the clay powder. An analysis of the measured humidity profiles based on the Boltzmann transformation, under certain simplifying assumptions, yields a diffusive behavior that is either normal or possibly weakly anomalous.

H. Hemmen, L.R. Alme, J.O. Fossum and Y. Meheust. Phys.Rev. E 82, 036315 (2010).

Electromagnetic characterization of metal foams by means of low frequency induced currents

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Metal foams are one of the most interesting new materials used in several emerging technologies such as aeronautic, spatial research, auto-motion or heat exchanger. The manufacturing process of metal foam is very sensitive to a lot of parameters during the process in such a manner that the size and distribution of pores is clearly affected, and there is not enough information concerning their predictable thermal, electrical or structural properties. Among the techniques we can use to characterize the samples, one of the most promising alternatives corresponds to the analysis of electric conductivity by means of non-contact procedures. It is to note that the measurement of conductivity with four-probes techniques is very tedious and usually demands destructive tests. By contrary, eddy currents analysis is intrinsically non-invasive and can attain a high grade of accurateness.

In this work we show a detailed study of the electromagnetic field in tubes, rods and slabs of non-ferromagnetic materials. With the help of a primary solenoid the samples were submitted to an axial harmonic magnetic field and the induced currents were carefully checked via the information we obtain trough the measurements of the induced voltage on a secondary coil. The phase difference between the primary magnetic field and the induced signal allows us to obtain very precise results of the electric conductivity of the sample under test. In metal foams, the microstructure of pores (size, type, and distribution) affects significantly to the effective conductivity and hence to the induced eddy currents. The porosity as well as the isotropy of the metal foam constitutes two relevant parameters which must be considered to explain the measurement of electric conductivity. Therefore, by measuring the induced voltage in the probe test, the nature of the material may be inferred by correlating the measurement when operating with massive materials with the same composition.
Here we present our preliminary results for a set of porous samples with composition CuZn5% with a notable isotropic behavior.

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Experimental Demonstration of Snell's Law for Shear Zone Refraction in Granular Materials

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We present experiments on slow shear flow in granular materials. Under appropriate conditions shear localizes in narrow shear zones. We demonstrate that when the shear zone crosses a material boundary, it refracts in accordance with Snell's law in optics - an effect first found in simulations [Phys. Rev. Lett. 98, 018301 (2007)]. The shear zone is the one that minimizes the dissipation rate upon shearing, i.e., a manifestation of the principle of least dissipation. We have prepared the materials as to form a granular lens. Shearing through the lens is shown to give a very broad shear zone, which corresponds to fulfilling Snell's law for a continuous range of paths through the cell.

Characterizing and Improving Generalized Belief Propagation Algorithms on 2D Edwards-Anderson Model

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We study the performance of different message passing algorithms in the two dimensional Edwards Anderson model. We show that the standard Belief Propagation (BP) algorithm converges only at high temperature to a paramagnetic solution. Then, we test a Generalized Belief Propagation (GBP) algorithm, derived from a Cluster Variational Method (CVM) at the plaquette level. We compare its performance with BP and with other algorithms derived under the same approximation: Double Loop (DL) and a two-ways message passing algorithm (HAK). The plaquette-CVM approximation improves BP in at least three ways: the quality of the paramagnetic solution at high temperatures, a better estimate (lower) for the critical temperature, and the fact that the GBP message passing algorithm converges also to non paramagnetic solutions. The lack of convergence of the standard GBP message passing algorithm at low temperatures seems to be related to the implementation details and not to the appearance of long range order. In fact, we prove that a gauge invariance of the constrained CVM free energy can be exploited to derive a new message passing algorithm which converges at even lower temperatures. In all its region of convergence this new algorithm is faster than HAK and DL by some orders of magnitude.

Mesoscopic simulations of micelles formation and drugs encapsulation

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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 spherical and the size changes in dependence of the initial surfactant concentration. Also, we can observe that less polar drugs are encapsulated by the micelles.

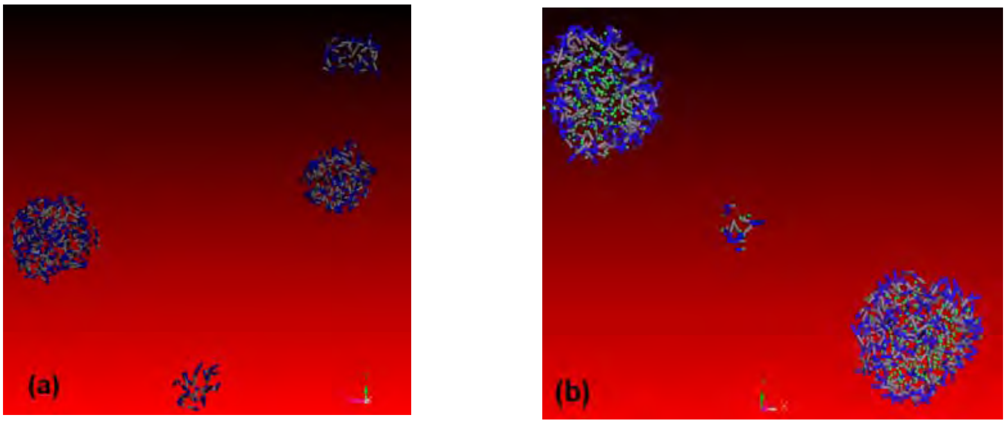

Figure 1 (a) BC micelles formed at concentration above cmc (b) Drugs encapsulation inside micelles. In the figure water molecules are not included and the gray-blue sticks are the CB molecules and the green points are the sulfamethoxazole molecules.

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Evaporation induced order in aqueous phases of clays

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We demonstrate experimentally the possibility for promoting uniaxial orientational order in initially isotropic, soft solid dispersions of the synthetic clays Na-fluorohectorite and Laponite RD. We observe that strong orientational order can emerge from initially isotropic states when the samples are subjected to a slow concentration increase through evaporation of the dispersion water. The development of orientational order is not counterindicated by the viscoelastic nature of the samples, and although the translational and likely also rotational diffusion of the particles is restricted in the soft solid state, the orientational degree of freedom can undergo a transition from a collectively random to an ordered state.

The effects of temperature on the rheology and structure of clay suspensions

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The fact that aqueous clay dispersions can form colloidal gels and glasses even at very low solid fractions has inspired several investigations on the emergence of arrested states in these systems. Studies conducted in particular on suspensions of synthetic Laponite RD argue that complex aging dynamics here promote either the formation of gelled states whose dynamics are characterized by the growing in size with time of percolated particle clusters, or glassy states dominated by the cooperative electrostatic trapping of particles in the potential 'cages' formed by their neighbors [1].
In the present study, we focus on aqueous dispersions of high-charge synthetic Na-fluorohectorite clay platelets, similar to natural hectorites, and investigate how heating affects the nanoscale structure of the dispersions and their rheological properties. We show that heating to temperatures exceeding roughly 40 ^{o}C favors delamination of particles that are stacked at room temperature, and that the increased effective volume fraction after delamination leads to a growth of the viscosity and the appearance of an (increased) yield stress.

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Strange flow phenomena in Cuban sands

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We offer an overview of various phenomena observed in silicon sands from "Santa Teresa" (Pinar del Río, Cuba) –only occasionally seen in other sands around the Globe: "revolving rivers" and "uphill bumps". While we have reached a qualitative or semi-quantitave understanding of the observed phenomena, their prediction based on the "microscopic" features of the sands remains as an open question.

Pattern formation in stressed multiphase systems

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The formation of complex patterns in stressed multiphase systems is a well-known phenomenon. The patterns formed at stressed surfaces in contact with their melts or solutions, in particular, have been intensively studied – examples include defect nucleation and island growth in thin films and solidification. In the absence of surface tension, small perturbations of the surface increase in amplitude due to material transport from regions of high stress, where chemical potential is high, to surrounding regions where the stress and chemical potential is low. Here we consider the patterns formed at the interface of reactive solids in contact. We present conditions for the stability of a stressed interface in terms of external loading conditions and material properties and discuss the possible consequences for the roughness of faults surfaces and grain boundaries.

Phase separations in PNIPA-Laponite Nanocomposites

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Poly-N-isopropylacrylamide-Laponite nanocomposites hydrogels (NC-gels) have recently been synthesized by Haraguchi et al [1], and the mechanisms during formation of the three-dimensionally cross linked polymer have been presented in several papers [2-4]. These gels exhibit superior mechanical properties compared to organically cross linked hydrogels, and they are also transparent, in contrast to their organic counterparts.

Formation of a visible ring in the transparent PNIPA-Laponite NC-gel during polymerization was observed by our group, and it was recognized that this was due to oxygen contamination during sample preparation. The ring was found out to be the end of the three-dimensionally cross linked polymer, and acted as a kind of barrier between the polymer rich phase at the bottom and the water-rich phase at the top. The top layer mainly consists of unreacted monomer and clay-brush particles suspended in the water. The depth of the top layer is influenced by both the oxygen content in the sample vial, and the concentration of Laponite in the initial solution before polymerization. Samples with different clay content were monitored with a movie recorder during polymerization. The movies showed a clear correlation between the amount of clay and the thickness of the polymer rich phase, and also the time for the polymerization reactions to finish. More clay led to thicker polymer phases and longer polymerization times. None of the phenomena mentioned above occurred if the samples were kept under oxygen-free environment during preparation and polymerization.

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Flow-controlled densification of E. Coli through a constriction

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Bacterial suspension can be seen as an interesting example of "active matter". Many works have been done in order to understand how these self-propelled entities can interact hydrodynamically with its environment, including the surrounding "passive" fluid, the boundaries and other bacteria.
In this presentation, we show a new phenomenon concerning *E. Coli* suspensions flowing through a funnel-like constrictions in micro-fluidic channels.
The dynamics of bacterial suspensions flowing in confined spaces is relevant to understand their behavior in scenarios such as porous materials, soil, microbiology, water purification, and biomedical research.
The applied flow induces a counter-intuitive symmetry breaking in the bulk bacteria concentration, which is found to increase past the funnel. The concentration enhancement persists over large distances and its amplitude increases linearly with the flow rate and disappears at large flow values. We show that the effect is reversible when the flow direction is reversed. We explain the observed effects on the interactions between the active bacteria and the channel boundaries. As we know that solid boundaries may act as traps for the bacterial motion and may change drastically the transport properties of the suspension.
This experiment opens the possibility to control the concentration bacterial suspensions in microfluidic channels by simply tuning the flow of liquid.

Vortex motion around multiple obstacles

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The dynamics of vortices in a fluid surrounding multiple solid obstacles is of great theoretical interest and practical importance. In particular, the problem of vortex motion past a circular cylinder placed above a plane wall has attracted considerable attention recently. In this case, shown in Fig. 1b, a stationary vortex is formed upstream of the cylinder (Lin et al., Journal of Engineering Mechanics **135**, 697, 2009) in contradistinction to the usual case (Fig. 1a) where a vortex pair is observed behind the cylinder [1].

In the present work, the motion of a point vortex in an ideal fluid past a circular cylinder close to a plane boundary is studied from analytical and numerical standpoints. Using complex analysis techniques devised by Crowdy and Marshall (Proc. R. Soc. A **461**, 2477, 2005) to analyze vortex dynamics in multiply-connected domains in two-dimensional flows, we obtain the complex potential and the Hamiltonian (also called the Kirchhoff-Routh path function) for the problem of one point vortex placed in a uniform stream past a circular cylinder above a plane. The corresponding phase portrait is obtained and all equilibrium points, together with their stability nature, are determined.

We show that this point-vortex model can explain some of the qualitative features observed in the experiments, such as the clockwise circulation around the cylinder and the variation of the stationary position as the gap between cylinder and the plane wall changes. It is also argued that the method can, in principle, be extended to study vortex dynamics around multiple cylinders (with or without a plane wall), although here the mathematical calculations become more involved.

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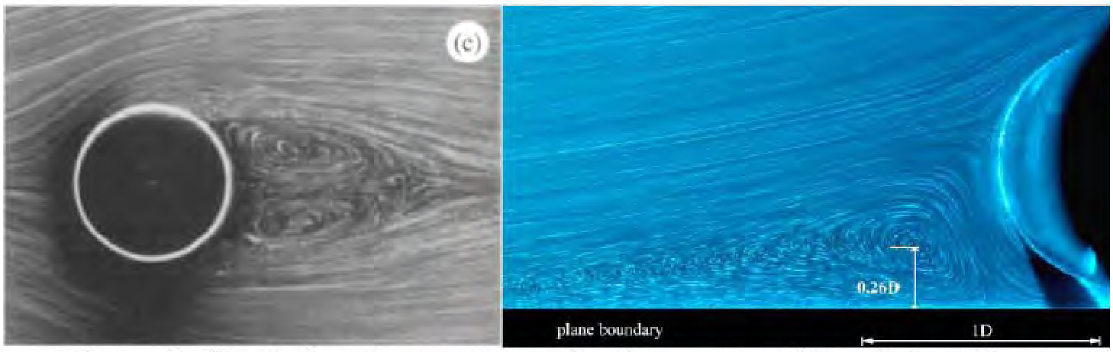

Figure: (Left) pair of counter-rotating vortices downstream of the cylinder without the plane. (Right) single vortex upstream of the cylinder with the plane.

Numerical simulations of hydraulic fractures

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A permeable two-dimensional (2D) granular layer is fractured by an imposed pressure gradient of the compressible interstitial gas inside a rectangular Hele-Shaw cell. For this purpose the pressure at the inlet of the cell is increased while at the opposing side a semipermeable boundary only lets the gas-phase pass through. A discrete numerical molecular dynamics model is employed to investigate the dynamics of the fractures and fingers in the granular phase. Systematic variation of the controlling parameters of the interstitial gas reveals a transition of the emerging granular displacement patterns. In the progress we can identify and describe a mechanism which controls the transition of the emerging displacement patterns from fractures and fingers to bubbles as a function of the interstitial gas properties and the characteristics of the granular phase.

Clay-based composites for drug delivery: preliminary studies

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Controlled drug delivery systems have been introduced in pharmacotherapy, showing several advantages over conventional dosage forms, besides the possibility to manipulate the release rate. In the last years different porous materials have been used as hosts for drug molecules [1]. Recently, clays have been incorporated to the list of host materials, with the use of synthetic hectorites. When compared to natural smectites, synthetic hectorites show a number of advantages, such as a controllable pore size distribution, purity and composition. In addition, these materials have been shown to be non-toxic for trans-dermal application and oral administration [2,3].

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Clay-oil droplet suspensions in electric field

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Silicone oil droplets containing synthetic smectite clay submerged in immiscible organic oil have been studied by observing clay particle movement and oil circulation when an electric field is applied. Results show how electric field strength, dielectric and electrorheological properties as well as electrohydrodynamics determine the fluid flow and clay particle formation. In a presence of the DC electric fields the clay particles formed a ribbon-like structure onto the inner surface of the droplet. The structure consists of short chain-like clay elements orienting parallel to the electric field direction. It is suggested that a combination of two phenomena, namely the induced viscous flow (electrohydrodynamic effect) and the polarization of the clay particles (dielectric effect), contribute to the ribbon-like structure formation.

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From fingering to fracture in complex fluids

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We present a novel experiment - a specific Hele-Shaw cell with mobile sides – with which both liquids and solids can be loaded with the same boundary conditions, beyond the small deformation regime. With such a system, one can examine quantitatively the response of a viscoelastic material when the loading rate is varied. On the liquid side, a bubble grows in the material and destabilizes in a Saffman-Taylor manner, forming an elongated finger, while on the solid side, a crack develops. Thus, a study of the morphologies of the pattern formed in the fluid allows for a quantitative analysis of the liquid to solid behavior. Furthermore, in our geometry, the two kinds of patterns have inverse aspect ratios. This study could hence give some new insight on liquid to solid phase transitions such as the sol-gel and the glass transition. We present firstly a set of experiments obtained on Newtonian fluids of different viscosities. Then we show some experiments in different viscoelastic materials. We perform an analysis of the morphologies pattern and the displacement field through the transition.

Avalanches in superconducting films

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Magnetic field does not always enter superconducting films in a smooth manner and often the penetration happens in form of avalanche. The macro-avalanches create spectacular, complex, dendritic flux structures, but there is also a class of less studied micro-avalanches, with sizes varying from one to several tens of thousands of vortices. The poster will show simulation results based on continuum electrodynamics with extremely nonlinear material characteristics, where both kinds of avalanches appear. The appearance of the micro-avalanches is strongly linked with the material disorder and it turns out that the micro-avalanches, when they get large enough, can escalate into dendritic avalanches, and in this way the understanding of micro-avalanches is essential also for understanding the mechanism behind nucleation of the dendritic flux avalanches.

Formation of quasi-1D clusters in vortex matter and their role in thermo-magnetic instability of superconductors

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Performance of most superconductor (SC) applications strongly depends on their behavior in magnetic field. Since almost all practically useful SCs belong to type-II, the field penetrates them in a quantized manner in the form of vortices. The vortices propagate from the edges of a sample and interact with structural disorder. Due to this interaction, called pinning, according to the original concept of Ch. Bean, a critical gradient of magnetic flux density is formed. This gradient corresponds to the maximum lossless current that a SC can sustain. The critical state is metastable and can be destructed either by flux creep or by abrupt massive flux avalanches. The latter ones may have a very dramatic consequences including loss of superconductivity and physical damage to the sample or a device.

The avalanches are associated with thermo-magnetic instability (TMI) of superconductors, which appears when the heat generated by the moving vortices is greater than the heat released into an environment, e.g. substrate in case of films. In that sense NbN films are known to be unstable, i.e. even the smallest increase of the external field may trigger a massive flux avalanche. Most theories developed to formulate the criteria for the appearance of the avalanches operate in terms of intrinsic parameters of SC, such as heat capacity, critical current etc., and basically disregard the origins and the nature of the triggering mechanisms that cause the instability.

We would like to present the most recent results of magneto-optical imaging (MOI) of flux dynamics in a series of NbN with well controlled nano-granular structure. The MOI shows that nano-scale irregularities, that inevitably appear under certain deposition conditions, not only stipulate increase of the critical current but also promote self-organization and correlated motion of large vortex clusters, which in turn trigger the avalanches.

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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]. 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 down to 3 - 4 CUC or something like that. 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 used the whole day, at any bus stop. A popular stop if at Parque Central, just facing hotel "Inglaterra". The first bus departs to Playas del Este at 9 AM.

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 only 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). However, it basically spreads in the summer months, and with low probability due to systematic sanitary measures. Much more probable is to get sunburn, to which you are exposed particularly from 11 to 15 hours.

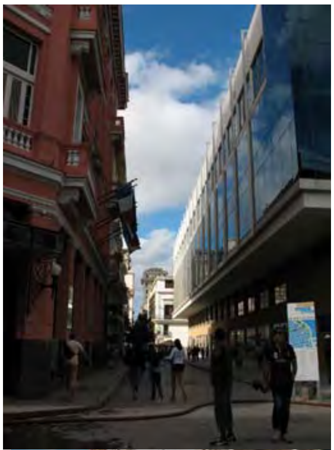
Physical Contact

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.

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!.

Maps and locations:



Colegio San Gerónimo de La Habana (right) and "Ambos Mundos" hotel (left). ←

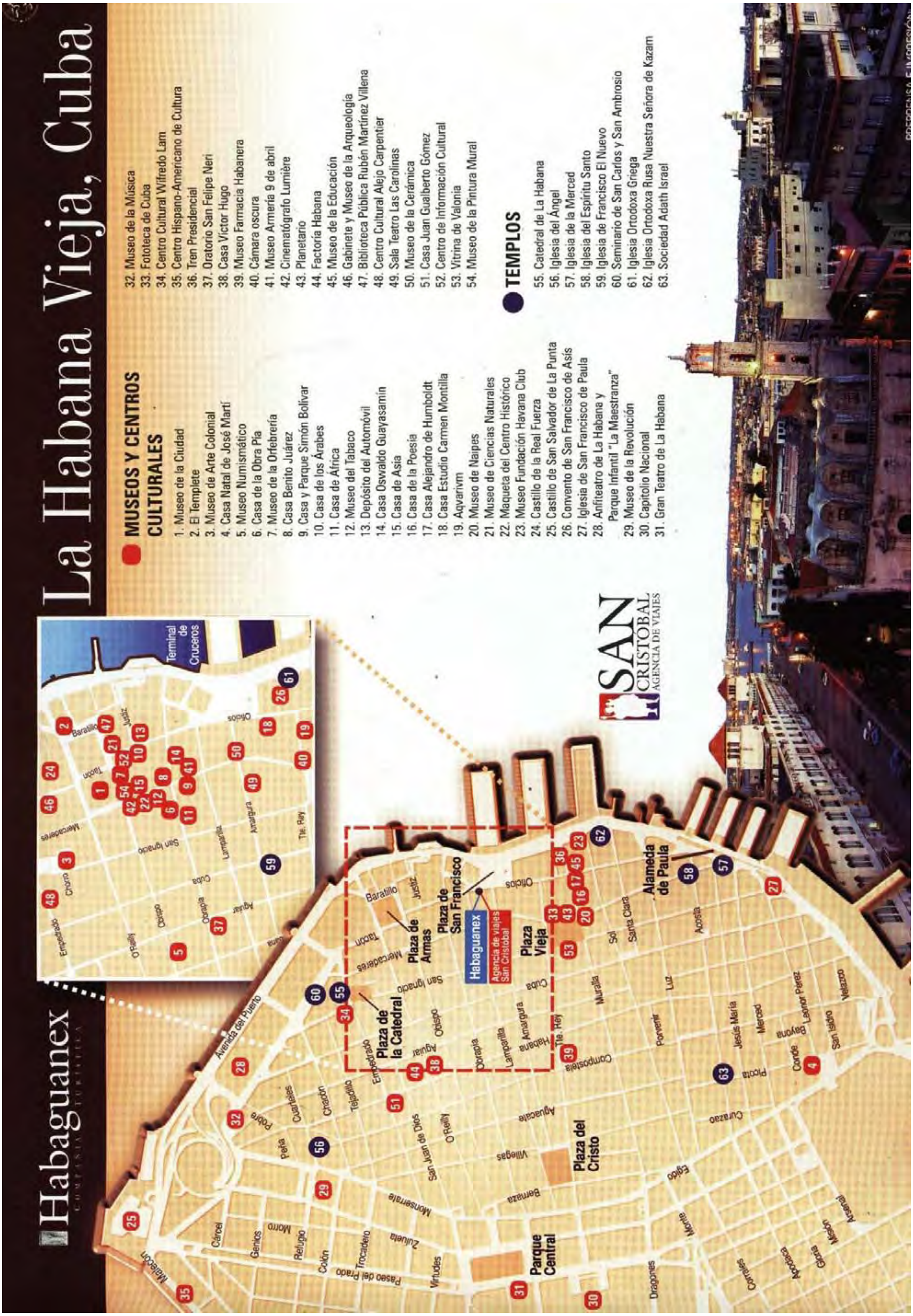
Lobby of "Ambos Mundos" hotel ←

"Florida" hotel ←

One of the inner areas, "Florida" hotel ←

"Caribbean" hotel ←

"La Torre de Marfil" restaurant ←



Habaguanex
COMPAÑÍA TURÍSTICA
La Habana Vieja, Cuba
MUSEOS Y CENTROS CULTURALES
1. Museo de la Ciudad
2. El Templete
3. Museo de Arte Colonial
4. Casa Natal de José Martí
5. Museo Numismático
6. Casa de la Obra Pía
7. Museo de la Orfebrería
8. Casa Benito Juárez
9. Casa y Parque Simón Bolívar
10. Casa de los Árabes
11. Casa de África
12. Museo del Tabaco
13. Depósito del Automóvil
14. Casa Oswaldo Guayasamín
15. Casa de Asia
16. Casa de la Poesía
17. Casa Alejandro de Humboldt
18. Casa Estudio Carmen Montilla
19. Aqvarivm
20. Museo de Naipes
21. Museo de Ciencias Naturales
22. Maqueta del Centro Histórico
23. Museo Fundación Havana Club
24. Castillo de la Real Fuerza
25. Castillo de San Salvador de La Punta
26. Convento de San Francisco de Asís
27. Iglesia de San Francisco de Paula
28. Anfiteatro de La Habana y Parque Infantil "La Maestranza"
29. Museo de la Revolución
30. Capitolio Nacional
31. Gran Teatro de La Habana
32. Museo de la Música
33. Fototeca de Cuba
34. Centro Cultural Wifredo Lam
35. Centro Hispano-Americano de Cultura
36. Tren Presidencial
37. Oratorio San Felipe Neri
38. Casa Víctor Hugo
39. Museo Farmacia Habanera
40. Cámara oscura
41. Museo Armería 9 de abril
42. Cinematógrafo Lumière
43. Planetario
44. Factoría Habana
45. Museo de la Educación
46. Gabinete y Museo de la Arqueología
47. Biblioteca Pública Rubén Martínez Villena
48. Centro Cultural Alejo Carpentier
49. Sala Teatro Las Carolinas
50. Museo de la Cerámica
51. Casa Juan Gualberto Gómez
52. Centro de Información Cultural
53. Vitrina de Valonia
54. Museo de la Pintura Mural
TEMPLOS
55. Catedral de La Habana
56. Iglesia del Ángel
57. Iglesia de la Merced
58. Iglesia del Espíritu Santo
59. Iglesia de Francisco El Nuevo
60. Seminario de San Carlos y San Ambrosio
61. Iglesia Ortodoxa Griega
62. Iglesia Ortodoxa Rusa Nuestra Señora de Kazam
63. Sociedad Adath Israel
SAN CRISTÓBAL
AGENCIA DE VIAJES
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Plaza de la Catedral
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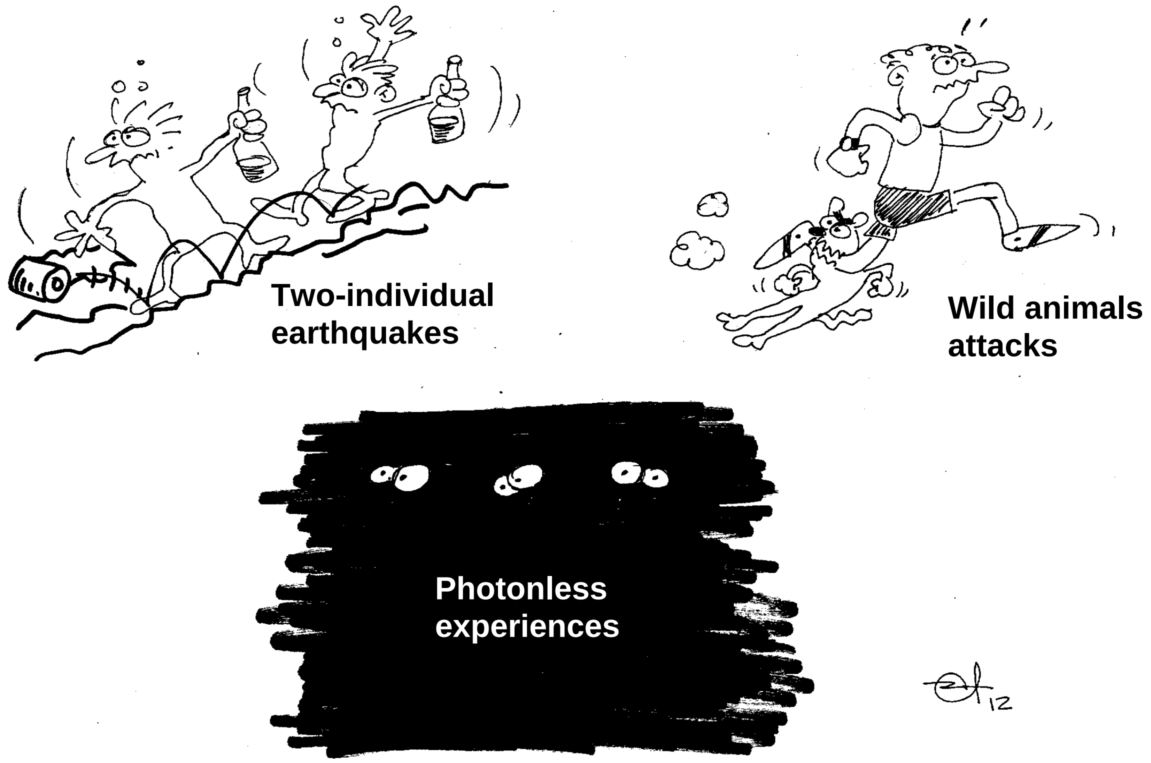
Plaza Vieja
Parque Central
Plaza del Cristo
Alameda de Paula
Avenida del Puerto
Malecón

Some paranormal experiences that happened during the workshop:



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