Mini-Workshop on Complex Matter Physics: September 20-21, 2010: Abstracts for invited talks, including short descriptions of the speakers:

A macroscopic type of wave-particle duality: The role of a "path memory" in the motion of bouncing droplets

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We have shown recently that a droplet bouncing on a vertically vibrated liquid interface can become dynamically coupled to the surface waves it excites. It thus becomes a self-propelled "walker", a symbiotic object formed by the droplet and its associated wave.
Through several experiments we will address one central question. How can a continuous and spatially extended wave have a common dynamics with a localized and discrete droplet? We will show that in all cases (diffraction, interference, tunneling etc…) where the wave is split, a single droplet has an apparently random response but that a deterministic behaviour is statistically recovered when the experiment is repeated. The truncation of the wave is thus shown to generate an uncertainty in the drop's motion.
We will show that these properties are linked to the complex structure of the wave field generated by the bouncing. It is not instantaneous but results from the superposition of waves generated in the points visited by the droplet in the recent past. The wave field thus contains what we have called the walker's "path-memory"
A remarkable effect of this path memory is observed when the walker is submitted to a transverse force and follows an orbiting motion. The measured orbit radius, instead of varying continuously with the force can only take quantized values.
The limits in which these results can be compared to those at quantum scale will be discussed.

Yves Couder plays a major role in several scientific domains, from non-linear physics to vegetal biology: Turbulence, instabilities, singularities, mechanics of morphogenesis, interfacial flow... By developping clever, elegant, and relatively simple experiments, he was able to open several new fields and inspired many physicists in France and abroad. He was awarded the Academy of Science-IFP (French Petroleum Research Institute) Prize in 1993, the Gentler-Kastler Prize (German Deutsche Physikalische Gesellschaft and Société Française de Physique) in 2007, and the Three Physicists Prize in 2007.

Mechanics of Cellular Aggregates

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Embryonic morphogenesis, wound healing, cancer growth, and metastasis are all examples where the mechanical properties play an important role in the functioning of a tissue. It has been suggested that certain embryonic tissues mimic the behavior of viscous fluids. However, due to the immense variety of tissues ranging from very soft (brain) to very hard (bone), such an analogy between tissues and fluids remains not well understood. We shall describe aspiration and compression experiments performed on cell aggregates, which provide a convenient laboratory model to characterize the mechanical properties of tissue. Using this characterization, we study the spreading of cell aggregates on a coated substrate, as well as their deformation and detachment under flow. In addition, we perform analogous experiments on viscous pastes, which provide a comparison with an inert system. Our results should yield insights in the understanding of pathologies related to artery obstruction, such as atherosclerosis or thrombosis.

Françoise Brochard-Wyart is a Professor at Paris VI University. Her leading theoretical work in soft matter physics has covered several topics of importance: dynamics of liquid crystals, dynamics of polymer chains, polymers at interfaces, colloids, fluctuations of membranes - with an extension to red blood cells -, wetting... More recently her interests focused on biophysics - cell adhesion, membrane mechanics, cellular nanotubes, artificial cells and tissue rehology -. She created the "Soft surfaces" group at the Institut Curie in 1994.
In 1997, Françoise Brochard-Wyart was the first woman to be awarded the prestigious Jean Ricard Prize by the French Physical Society. In 1999, she received the Légion d'honneur - the highest honour awarded by the French government - and she obtained the Roberval Prize in 2007 for the book she wrote with P.-G. de Gennes and D. Quéré "Drops, bubbles, pearls and waves".

Complex rupture dynamics in biological membranes

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All cells are covered by a thin membrane consisting of a lipid bilayer and protein inclusions. Cell membranes frequently rupture, however active cell repair mechanisms quickly seal the membrane. According to common understanding cell membranes rupture by formation of circular pores.
Here we present experiments showing complex rupture dynamics in both synthetic bilayer membranes and cell membranes, including fractal rupture morphology, burst dynamics and intermittency. The results are discussed in relation to hydrodynamic instabilities and critical dynamics.

Paul Dommersnes is Norwegian and he is currently Assisant Professor at Matière et Systèmes Complexes, Université Paris Diderot (Paris 7). He studied physics at NTNU, and graduated as M.Sc. in Physics at NTNU in 1996 after doing his thesis work at ESPCI in Paris. He received his PhD from Universite Paris 6, highest honors (tres honorable avec felicitations) in 1999, and worked after that as at Nordita in Copenhagen, at MIT, at NTNU, as well as at Insititue Curie in Paris. Since 2005 Paul Dommersnes has been Assisant Professor at Matière et Systèmes Complexes, Université Paris Diderot (Paris 7) and recently he has been a visiting scientist at Chemistry and Bioscience, Chalmers University, Gothenborg, Sweden. Paul Dommersnes current research interestes include: - Physical processes in surfactant membranes, interfaces and nanotubes including nanofluidic, electrophoretic and networking phenomena in such systems. In collaboration with the Lab. for Soft and Complex Matter Studies at NTNU he studies - Capillary imbibition in nanoporous materials, - Clays acting as surfactants at oil water interfaces, and - Polarized clay-oil droplets.