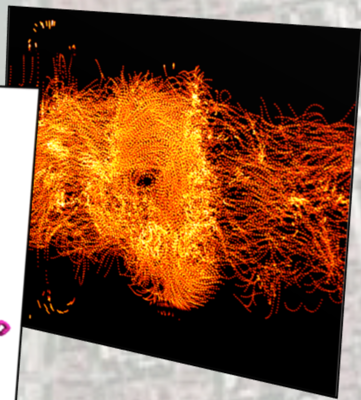

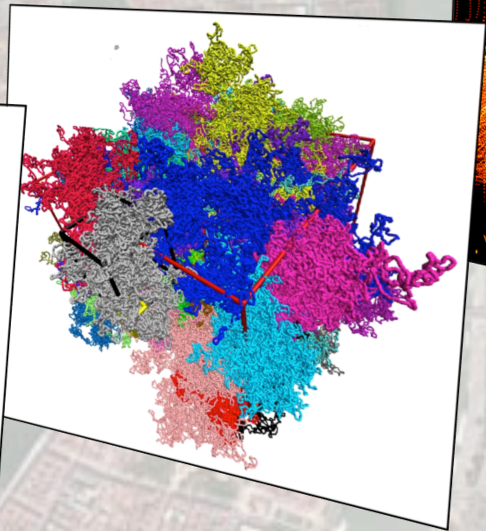

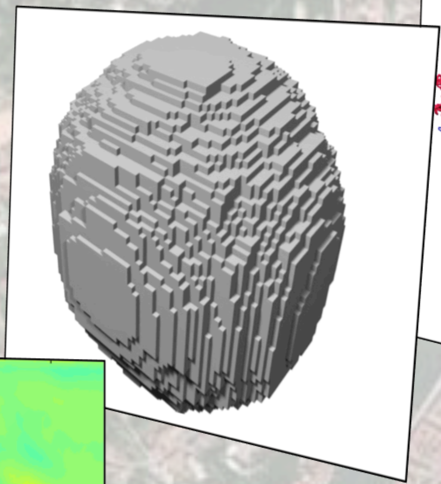

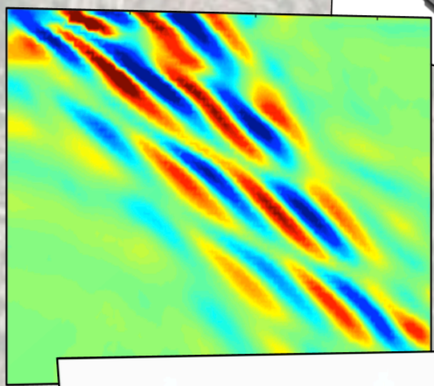

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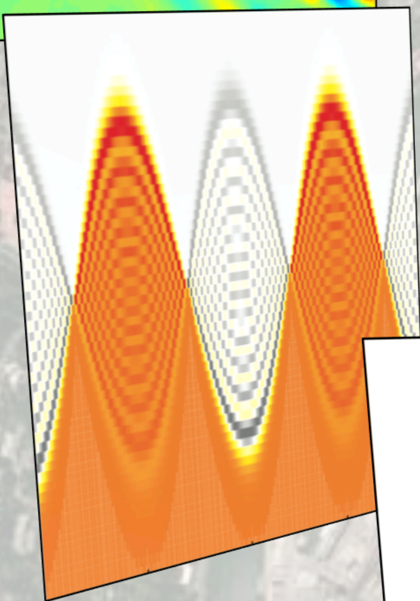

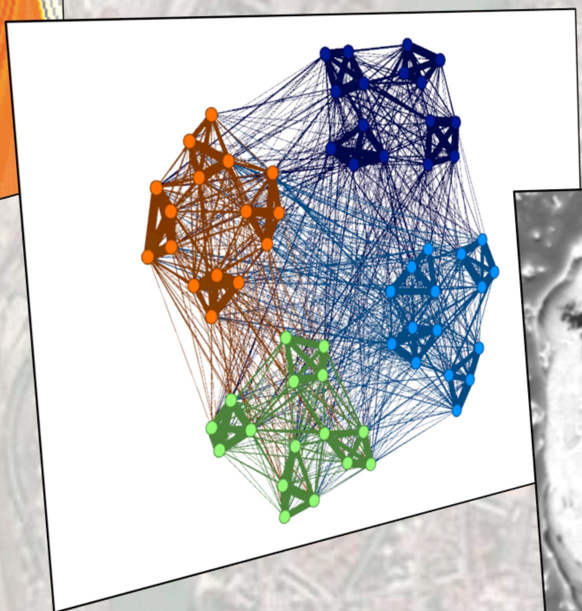

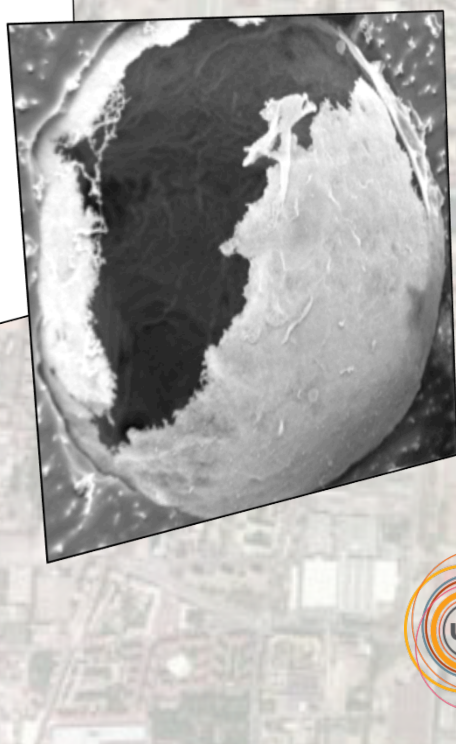

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II. SCIENTIFIC REPORT

T1R. Hydrodynamics and Geophysics

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Post-docs: E. Calzavarini, M. Creyssels, L. Ducasse, L. Fiabane, J. Munroe, C. Nardini, X. Riedinger, J. Salort, H. Scolan, F. Seychelles, H. Touil, A. Venaille, M. Vosskuhle

PhD students: G. Bordes, B. Bourget, C. Brouzet, A. Cahuzac, E. Horne, O. Liot, N. Machicoane, M. Mercier, S. Miralles, B. Percier, E. Rusaouen, C. Sánchez, T. Tangarife, J.C. Tisserand, G. Varas, G. Verhille, M. Vosskuhle, R. Zimmermann

Many activities of the laboratory involve fluids or complex matter flows. Some of these activities relate to fundamental hydrodynamics, whether experimental, theoretical or numerical. Following the new technical developments on particle tracking, a group in our laboratory has designed experiments to study the dynamics of particles in a turbulent flow, while other groups tackled the same issue via theoretical stochastic approaches. Another research axis has been focussing on mass or heat turbulent transport, studying ice melting or gravity currents dynamics, as well as forced turbulent convection. Finally, pursuing our solid tradition in statistical physics, several groups have been working on statistical turbulence, using multifractal or conformal invariance theory, and turbulence modeling, developing new Large Eddy Simulations (LES) approaches. Others activities are dedicated to, inspired by, or might be of potential applicability in the geophysical context. Regarding oceanic and atmospheric applications, the main focusses have been on energy transfer by internal gravity waves, as well as statistical approaches of large scale flows. Following the success of the VKS experiment, various new results have also been obtained on the behavior of a dynamo generated magnetic field and its coupling with the magnetohydrodynamics (MHD) flow. Other groups have concentrated their efforts of multiphase flows, working on the formation of ripples on roads, the discharge of a grain silo or the motion of gas bubbles through complex material. Regarding the complexity of all the considered phenomena in the geophysical context, we think that progress in these fundamental studies would be of primary interest to the understanding of field observations.

A. *Turbulent transport*

Particle dynamics in turbulent flows (ANR DEPSET and TEC, M. Bourgoin, LEGI, J. Bec, OCA, M. Lance LMFA)

Experimental studies of particle dynamics. Modern experimental techniques make possible nowadays to resolve the dynamics of small material particles in highly turbulent flows. Using Extended Laser Doppler Velocimetry, we have focused experimentally on the dynamics of small neutrally buoyant particles with sizes larger than the dissipative scale of the flow, and observed that not only their variance of acceleration decreases as $(D/\eta)^{-2/3}$ (following pressure increments), but also the intermittency of their dynamics [98]. These results compare qualitatively well with a Faxen model of material particle dynamics we implemented in a DNS simulation of homogeneous and isotropic turbulence [17, 18]. More recently we investigated the possible clustering of neutrally buoyant material particles, and compared the results with what was obtained for inertial particles with same Stokes number in a homogenous and isotropic turbulent flow [105]. We observed that if large neutrally buoyant particles share common properties with inertial particles, they do not exhibit clustering in homogeneous isotropic turbulence [34, 35]. Tracking the dynamics of painted spheres with diameters of the order of the integral length of the flow (L) allows for 6 dimensional tracking of both position and orientation in the whole flow volume of a turbulent von Kármán flow. We observed both translation and rotation dynamics are still very intermittent for these large scale objects, with strong coupling between the two through a lift force [104]. We also observed a transition in the dynamics of very large particles which become trapped in the large scale structures of the underlying flow, leading to non-homogeneous sampling [45].

Theoretical studies of particles dynamics. From the theoretical point of view, these studies raise questions about the statistical properties of the orientation of objects transported by the flow. In this spirit, we have proposed a very simple model of rotating sphere in a turbulent flow, and obtained explicit results about the dynamics of decorrelation of the orientation [101], which can be formally understood in terms of irrational quantum numbers. We have also demonstrated the alignment of small rods in the flow with the fluid vorticity [67]. A generalization of this study concerns the deformation of more complex objects, such as triangles in turbulent flows [68].

It has been noticed for many years that turbulence leads to an enhanced collision rate between (heavy) particles suspended in the flow. Using direct numerical simulations in the limit where the size of the particles is very small compared to the smallest length scale of the flow, we have demonstrated that the "sling effect" [29], whereby inertial particles slung by vortices acquire a velocity which is very different from the flow velocity, plays a much more important role than preferential concentration in the enhancement of collision rates, and prevents unexpected multiple collisions between pairs of particles, which we observe when particles are simply following the flow [100].

Tracking the motion of several particles following a turbulent flow allows us to obtain important information on the structure and on the dynamics of turbulence. In particular, varying the overall size of the set of particles leads to a systematic characterization of the flow properties on scale. Among the results obtained recently, we have determined the alignment properties between vorticity and the rate of strain tensor as a function of scale. Remarkably, we find an (essentially) self-similar behavior in the so-called inertial range of scales [64]. We have also demonstrated that the dynamics of alignment between vorticity and the rate of strain tensor can be understood in terms of elementary physical properties, such as angular momentum conservation [103].

Theoretical studies of velocity gradients dynamics, Application to particles. Following general developments aimed at modeling the velocity gradient dynamics along lagrangian trajectories in turbulent flows, we have applied this stochastic approach to diverse problems including the short-time dynamics [22] and the very peculiar structure of the pressure Hessian [21]. More recently, we have shown that this model was able to give a realistic picture of the rotation rate of rods in turbulence, whereas the level of fluctuation of discs remains an open problem [23]. Also, in a different but related context, we have shown in [43] how to use the short-time dynamics of the Euler equations to get new and realistic closures for the subgrid stress tensor entering the momentum equation of the filtered velocity field (also called Large Eddy Simulations).

Ergodic properties of inertial particles. In [38] the simplest model of massive inertial particles in turbulent flow was analyzed using the theory of stochastic equations with hypoelliptic generators. The rigorous results obtained were confronted with earlier numerical predictions of Bec-Cencini-Hillerbrand about the algebraic tails in the distribution of relative velocity differences of close particles. They confirmed the numerical predictions in two dimensions but also established the algebraic decay of the distribution and the values of the corresponding exponents in three and higher dimensions where the numerical analysis did not provide definite answers.

Turbulent mixing

Turbulent heat transfer. A particle larger than the dissipative scale cannot follow the fluid motion, and an important slip velocity between the particle and the flow is present which can enhance heat or mass transfer from the particle to the flow. We have studied the melting dynamics of large ice balls in a turbulent von Kármán flow, and compared the results obtained with attached particles to the ones obtained with freely transported particles in the whole flow (Fig. 1). Using an optical shadowgraphy setup, we recorded the time evolution of particle sizes which gives access to the Nusselt number Nu as a function of the particle Reynolds number Re_D. For the fixed particle case, we observed that the Nusselt number behaves as $Nu \propto {Re_D}^{0.8}$, an exponent smaller than the one obtained for freely advected ice balls, for which $Nu \propto Re_D$, compatible with what is expected in the ultimate regime of forced convection [44].

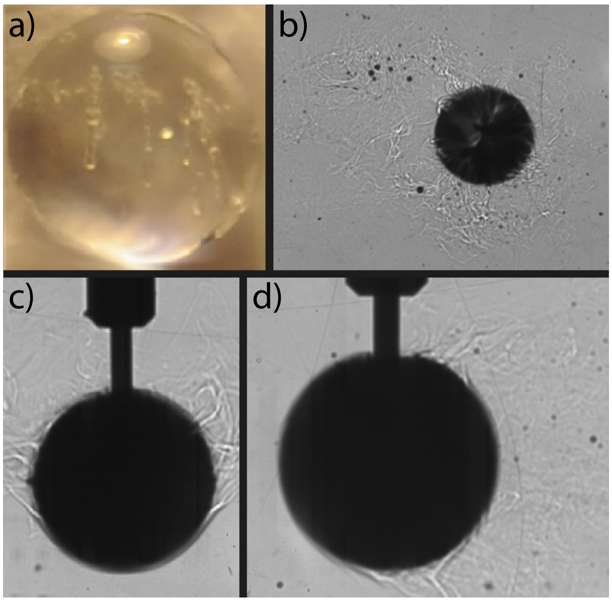

Figure 1: (a) Ice ball from a spherical mold. (b) Ice ball (14 mm diameter) freely advected by a counter-rotating von Kármán flow. (c) Ice ball (18 mm diameter) fixed at the center of a counter-rotating von Kármán flow, and melting under the effect of turbulent fluctuations only. (d) Ice ball (18 mm diameter) fixed at the center of a von Kármán flow with a single rotating disk, melting due to a strong mean shear and weak turbulent fluctuations.

Turbulent gravity currents. The entrainment and mixing properties of a turbulent gravity current was studied experimentally. Particle Image Velocimetry and Laser Induced Fluorescence were used to obtain a simultaneous measurement of the velocity and density fields. We showed that vertical fluxes of momentum and density display a quadratic correlation with vertical gradients of velocity and density, respectively [58]. We explained this correlation using a mixing length model. In addition, we characterized the entrainment of ambient fluid by the current, showing that it depends not only on the Richardson number (representing the shear/stratification balance) but also on the Reynolds number, a parameter often neglected in entrainment parametrizations used for ocean dynamics numerical simulations [57].

B. *Turbulent thermal convection*

(ANR Gimic, J.-P. Hulin, FAST, J. Magnaudet, IMFT; Region CIBLE).

One fundamental point in the highly turbulent thermal convection is the understanding of the role of the boundary layers versus the bulk, as well as their interaction [25]. We performed separate experimental measurements and modelizations of the bulk and boundary layers.

Our model system to study the bulk is a square channel (5×5 cm^2), vertical or inclined, connecting two chambers, a hot one at the bottom and a cold one at the top, filled with water. We measure the temperature gradient along the channel and the velocity field, using PIV (Particle Image Velocimetry). These measurements, which allow severe cross-checks, have been very fruitful, evidencing a laminar regime and a turbulent regime, separated by an intermittent one [69]. The laminar regime was interpreted in details, almost without adjustable parameters [71]. In the turbulent regime, the birth of an inertial range was clearly visible. The evolution of the velocity profile with the tilt angle of the device could be traced back to the growing influence of the stratification on turbulent mixing [73], an often neglected or under-estimated effect. We recently built a larger channel (20×20 cm^2) to reach the turbulent regime even at large tilt angle.

On the other hand, we studied the influence of a well-controlled roughness on the heat transfer between a plate and the fluid, and on the flow. This roughness consists in square blocks of height h_0, $d \times d$ horizontally, arranged in a square lattice of period $2d$. In our Rayleigh-Bénard cells, the hot plate is rough and the cold one is smooth. Their heat transfer behaviors are approximately independent. The rough plate heat transfer becomes more efficient when the thermal boundary layer is smaller than h_0. Doubling the d and h_0 values, we showed that this efficiency enhancement saturates in the neighborhood of 70%, larger than the surface enhancement (naive argument). Our first interpretation attributed the enhancement to the convection of the notch between two blocks [79]. However, we realized that a large part is due to the top of the block, where the boundary layer is much thiner. This was shown by temperature profile measurements close to the plate and confirmed in a air cell 6 times bigger, at Ilmenau University, within the European Initiative EuHiT.

We also used a smart lagrangian particle, able to measure and communicate the instantaneous temperature. It can work continuously 20 hours, which allows detailed statistical studies both lagrangian and eulerian. The goal is to evidence an asymmetry due to the difference between the plates, rough and smooth. This asymmetry seems very subtle, in agreement with the apparent independence of the plates.

C. Statistical turbulence and modelling

Multifractal. Our findings in the context of the multifractal modeling of Eulerian and Lagrangian velocity fluctuations in turbulent flow were gathered and explained in a review article [23] (see also [24]). We have furthermore added some new extensions allowing to take into account in a realistic way the asymmetry of the densities that are consequences of the energy transfers.

Recently, in collaboration with mathematicians [20], we have succeeded to build up a realistic incompressible homogeneous and isotropic random vectorial field able to mimic non trivial properties observed in simulations and experiments, in particular the preferential alignment of vorticity and the energy transfers.

Large Eddy Simulations (LES). In engineering and environmental contexts, numerical simulations are increasingly used to investigate complex flow phenomena, and accurately account for the time-dependent behavior of the large-scale motions ; this refers to large-eddy simulations (LES). When combined with computationally-efficient algorithms such as the Lattice Boltzmann method (LBM), LES opens a path to more and more trustworthy simulations. Our contributions on this topic have been both fundamental and applied. First, we have developed a shear-improved variant of the Smagorinsky model that allows us to address the LES of strongly non-homogeneous and unstationary turbulent flows. This innovative modeling relies on physical arguments combined with signal processing techniques (adaptive Kalman filtering) [15, 16]. A second contribution has been achieved within the industrial project LaBS (since 2010). The LBM, originally designed for regular flows on sufficiently-fine uniform lattices, has been extended to handle turbulence modeling on coarse non-uniform lattices [80] (Fig. 2). This study has been applied to the commercial solver LaBS, marketed since july 2013 and already used by Renault for aero-acoustics R&D.

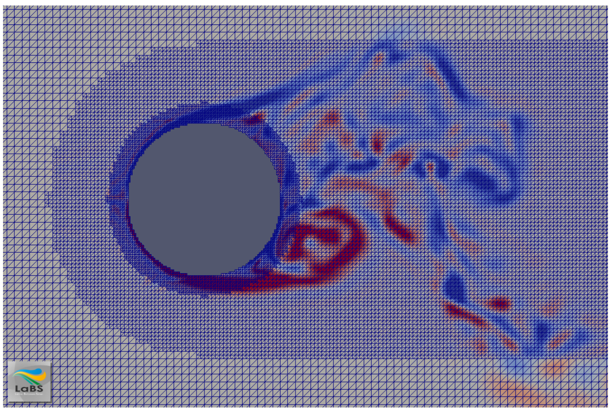

Figure 2: LES of the flow past a cylinder in the sub-critical turbulent regime on a multi-resolution lattice (colormap of axial vorticity).

2D turbulence. Seemingly without intermittency, the inverse energy cascade of two-dimensional Navier-Stokes turbulence offers more hope for analytical solution than the intermittent three-dimensional direct energy cascade. The numerical discovery of conformal invariance of the zero-vorticity lines statistics (of the SLE type) pointed to the presence of a conformal sector in the inverse cascade regime. We undertook a study of the influence of 2D curvature on the inverse cascade. Surfaces with different curvatures are locally conformally equivalent so the comparison of inverse cascades in different background curvatures should exhibit the conformal sector of 2D turbulence. By studying the Navier-Stokes turbulence on a hyperbolic plane, (a surface with constant negative curvature) we unraveled a spontaneously broken asymptotic long-distance conformal symmetry of the Navier-Stokes equation in that geometry. We also showed that the presence of negative curvature speeds up the energy transfer on scales longer than the radius of negative curvature, an effect that could be searched for in the soap-film flows. This work [32] opens new perspectives in the study of 2D turbulence.

D. *Geophysical fluid dynamics*

Internal gravity waves in stratified fluids (ANR PIWO, C. Staquet, LEGI, F. Auclair, POC, ANR ONLITUR, F. Moisy, FAST, CNRS PICS, T. Peacock, MIT)

The study of internal waves (IW) is of great interest owing to the evolving appreciation of their role in many geophysical systems. In addition to their particularly intriguing properties from a fundamental point of view, these waves play an important role in dissipating barotropic tidal energy in the ocean, are an important means of momentum transport in the atmosphere, while IW activity also impacts modern-day technology. However, many unanswered questions remain, particularly regarding the fate of internal waves and how much mixing they generate in the ocean and via what processes.

To tackle some of these questions, we have developed a *new wave generation* in stratified fluids. This innovative mechanism [10], which involves a tunable source composed of oscillating plates, generates well defined propagating plane wave beams, as shown in the left panel of Fig. 3. This generator has been used (and also copied in several laboratories throughout the world) for several studies described below.

For example, our study of the scattering of a low-mode internal tide by finite-amplitude gaussian topography allowed to support the belief that finite-amplitude topography produces significant reflection of the internal tide and transfers energy from low to high modes. Using this device, we have also evidenced the production of a robust horizontal mean flow induced by internal gravity waves, when a wave beam is forced at the lateral boundary of a tank. The key ingredient for the existence of these horizontal mean flows is the concomitant existence of variations of the wave amplitude in both horizontal directions. In the transverse direction, the variations are simply due to the fact that the wave generator is localized in a segment smaller than the tank width. In the longitudinal direction, the variations of the wave amplitude are due to viscous attenuation

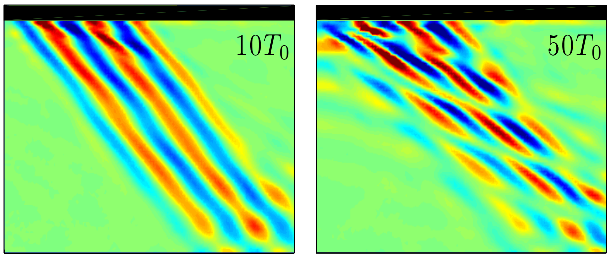

Figure 3: Snapshots of the experimental vertical density gradient field for 10 and 50 primary wave periods.

However, the study which has attracted most attention was related to another important way through which large-scale oceanic internal waves transfer their energy to small-scales, possibly inducing mixing: the parametric subharmonic instability (PSI). Using this novel generator, we were indeed able to provide the first experimental verifications of this nonlinear resonant interaction through which a primary wave (plane waves or vertical modes) excites pairs of waves whose frequencies and wave numbers add up to the frequency and wavenumber, respectively, of the primary wave [14]. The right panel of Fig. 3 presents how the initial beam is destabilized and emits secondary waves out of the beam, since the unusual dispersion relation of IW implies a different angle of propagation when the frequency is modified.

Interestingly, we discovered that the disconnect between theory, which assumes the waves are periodic in space and time, and reality in which waves are transient and more importantly spatially localized, modifies drastically the result. We have thus shown theoretically, numerically and experimentally that the width of the internal wave beam is a key element, a feature totally overlooked previously, despite numerous numerical simulations. In particular, we have reported dramatic consequences on the triad selection mechanism. The subharmonic plane waves that are theoretically unstable can only extract energy from the primary wave if they do not leave the primary beam too quickly. This finite-width mechanism has two opposite consequences on the wave energy dissipation: it can hinder the PSI onset (reducing transfer and therefore dissipation), but when PSI is present it enhances the transfer towards small wavelengths, more affected by dissipation.

We have also shown that PSI unexpectedly destroys the coherence of an internal wave attractor in a confined fluid domain [75]. The triadic resonance appears to be, moreover, a very efficient energy pathway from long to short length scales. This work provides an explanation of why attractors may be difficult or impossible to observe in natural systems subject to large amplitude forcing. Finally, let us stress also that we have also provided an experimental study of PSI in the very similar context of inertial waves in a rotating homogeneous fluid.

We studied internal solitary waves first by revisiting the deadwater phenomenon when a boat evolving on a two-layer fluid feels an extra drag due to waves being generated at the interface between the two layers whereas the free surface remains still. Second, we generated quasi-two-dimensional internal wave beam impinging on a pycnocline, resulting in the generation of internal solitary waves at this interface. These experiments were inspired by observations of internal solitary waves in the deep ocean from synthetic aperture radar (SAR) imagery.

In addition to above fundamental studies, we have started to study more realistic situations in which the different mechanisms studied separately occur simultaneously. The most challenging issue was related to the complex double-ridge system in the Luzon Strait in the South China Sea, which is one of the strongest sources of internal tides in the oceans. We have developed a large-scale laboratory experiment performed at the Coriolis platform in Grenoble. It was carefully designed so that the relevant dimensionless parameters closely matched the ocean scenario. The results [47] advocate that a broad and coherent weakly nonlinear, three-dimensional, diurnal internal tide, which is shaped by the overall geometry of the double-ridge system is radiated into the South China Sea and subsequently steepens; it explains one of the strongest sources of internal tides in the oceans, associated with which are some of the largest amplitude internal solitary waves on record.

Statistical mechanics of oceanic and atmospheric large scale flows (ANR Statocean, J. Sommeria, LEGI, X. Carton, LPO)

A striking property of oceanic and atmospheric flows is their propensity to self-organize into robust large scale coherent structures, which are major features explaining weather and climate (cyclones, anticyclones and jets). This robust self-organization involves a huge number of degrees of freedom coupled via complex nonlinear interactions. Statistical mechanics is a very powerful theory that allows us to reduce the complexity of the system down to a few thermodynamic parameters. Statistical mechanics approaches to the large scales of geophysical fluid dynamics can be decomposed into three classes. First, equilibrium statistical mechanics, following the pioneer works of Miller Robert and Sommeria(MRS) in the 90', applicable for 2d Euler flows and quasi-geostrophic models. Second, kinetic theory approaches, developed during the last ten years, allowing for taking into account effects of forcing and dissipation in a close to equilibrium framework. Third, the use of large deviation theory to deal with far from equilibrium problems. Here we present applications of the first and the second approaches, see also [13]. More fundamental aspects and the large deviation approach are discussed in section II T7R D.

Over these last five years we have applied the equilibrium theory to several problems of oceanic relevance [13]. For instance, we have shown the existence of a formal analogy between bubble formation and the emergence of mesoscale (300 km) oceanic rings, which are observed everywhere in the oceans. This theory explains many of the observed properties of mesoscale ocean vortices [89]. We have then shown that bottom intensified anticyclonic recirculations above topographic bumps such as the observed Zapiola anticyclone are close to an equilibrium state [85] and we have more generally provided a statistical mechanics interpretation for the vertical structure of oceanic flows, including the barotropization problem [87].

For atmospheric and oceanic flows at planetary scales in a statistically stationary regime, the long time effect of forces and dissipation is crucial. We have developed a kinetic theory for the description of planetary zonal (east-west) jets. It was developed in a inertial limit, when there is a clear separation of time scales between the rapid evolution of the fluctuations of the velocity field and the slow evolution of the zonal jets. This is relevant to describe for instance multiple zonal jet on Jovian atmosphere. The theory predicts the jet velocity profile and the turbulence statistics, with a systematic expansion improving the justification of previous approaches based on quasilinear approximations or cumulant expansions [12].

E. Magnetohydrodynamics and the dynamo effect

(ANR VKS-dynamo, S. Fauve, LPS, F. Daviaud, SPEC, CEA Saclay; PICS Russie, P. Frick, Perm)

Induction, dynamo and turbulence at low magnetic numbers. Experimental investigations of MHD flows at moderate magnetic Reynolds number ($R_m \sim 5$) have been developed in a von-Kármán gallium flow (the flow is driven by fast rotation of counter-rotating disks inside a cylinder) with characteristic size 10 cm and velocity 1 m/s. Our recent studies are a follow-up of previous investigations and were focussed on three items: (i) the effect of high conductivity and/or high permeability solid rotating parts on magnetic inductions mechanisms [93], (ii) the characterization of the dynamics of the Bullard-von Kármán flow - a simple synthetic experimental dynamo incorporating turbulent fluctuations and an external amplification - and in particular the occurence of on/off intermittency [76, 94], and (iii) the transition from hydrodynamic turbulent regimes to MHD turbulent regimes obtained with a high amplitude, externally applied magnetic field which modifies the flow [91]. Other investigations have also been developed, which are detailed in T8R.

Dynamos at high magnetic numbers: the VKS experiment. The VKS experiment is a joint experiment run by ENS Lyon, ENS Paris, and CEA Saclay consisting in a large scale von-Kármán flow driven in liquid sodium. Following the observation of self generation of the magnetic field, achieved in 2006 as well as dynamical regimes relevant to astrophysical situations, a detailed characterization of the generation mechanisms and the dynamics of these dynamos have been lead. The various dynamics and bifurcations are summarized in [6, 53] and include bistability between stationary and oscillating dynamos [5], and observation of localized dynamos [37]. Generation mechanisms were shown to be localized close to the high permeability driving impellers [8]. The statistical analysis of the response to an external forcing shed light on the influence of the conductivity and/or magnetic permeability on the dynamo threshold [51].

F. *Instabilities in 2- and 3-phase flows*

Washboard road (FRAMA, V. Langlois, LGL). The tendency of unpaved road surfaces to develop lateral ripples (washboard or corrugated road) is annoyingly familiar to drivers on dry gravel roads. Similar ripples are well known on railroad tracks and many other rolling or sliding, load bearing surfaces. Our approach combined laboratory experiments and soft-particle direct numerical simulations. In previous studies we have shown that the onset of the ripple pattern exhibits a sharp threshold as the speed is varied. The ripple pattern appears as small patches of travelling waves which eventually spread to the entire circumference (Fig. 4). The ripples move slowly

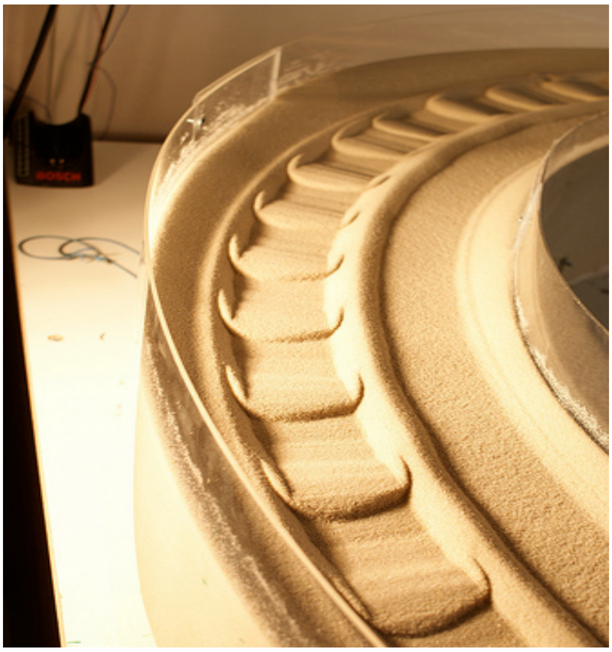

Figure 4: Washboard Road at the laboratory scale. A ripple pattern appears spontaneously due to the repeated passing of a wheel on a sandbed.

in the driving direction. Interesting secondary dynamics of the saturated ripples were observed. Based on empirical laws for force acting on a wheel, a linear stability analysis near onset was developed and recovers all experimental features. In more details we have performed measurements of the drag and lift forces experienced by a blade dragged at constant velocity at the surface of a sandbed. In order to probe the frequency response of the system, tests were carried out where the blade was forced to oscillate on a flat bed, or where a horizontal motion of the blade was imposed over a sinusoidal sandbed [60]. These measurements are the keystone of the linear stability analysis presented in [61]. The key results of this work are the prediction of a critical velocity for the onset on the instability and of the wavelength of the pattern.

Silo discharge Flows of granular media through orifices present interesting features that have been intensely studied in the last 50 years. Among them, the most peculiar is that the flow-rate from an orifice does not depend on the height of the granular column above it. Even if the flow-rate is well accounted for by empirical laws, the underlying physics is still not well understood and questions remain open.

In this context, using the discharge of a 2D horizontal silo [3] or measuring the stress profile at the base of a vertical 3D silo [62], we discussed the (in)dependence of the flow-rate on the local stress in the outlet region. In addition, we studied the discharge of a silo when the material is slightly cohesive. For small grains, Van der Waals forces or humidity indeed lead to sticky grains. We observed that the dynamics inside the silo (interesting by itself) does not significantly alter the flow-rate which still obeys the classical empirical law, but that the flowing particles are not individual grains but rather clusters of grains whose typical size depends on the humidity [36].

Degassing through complex fluids In many natural systems, gas rising through complex materials is at the origin of a wide variety of behaviours. Understanding the dynamics of such systems is of crucial importance in the mitigation of natural hazards. Flow regimes in saturated granular media, for instance, can go from homogeneous seepage (fluid percolation) to piping and partial failure. This last case plays a major role in soil liquefaction, mud volcanism and diapirism, and hydraulic fracture. Experiments were set up in the laboratory to model two main processes encountered in natural phenomena, and quantify the mechanisms that govern their dynamics.

First, we focused on gas venting at the seafloor. The experiment consists of a 2D or 3D cell, filled with a granular medium immersed in water. The grain size and polydispersity are varied, as controlled parameters. Air is injected at the bottom of the cell through a nozzle, at constant flow-rate. This, apparently simple, experiment exhibits a complex dynamics, from percolation to fracture when the air crosses the medium, as well as the formation of a fluidized zone whose characteristics were fully determined [81, 84]. Application to seismic microevents produced by gas expulsion at the seafloor in the sea of Marmara was performed [77]. Second, we modeled the degassing in a volcanic conduit by injecting air at the bottom of a complex-fluid column. The fluid is viscoelastic, with yield strength, to mimic the lava rheological properties. The dynamics alternates between successive bubbles and continuous degassing, and may be at the origin of the intermittent behavior observed on some volcanoes [27, 96, 124].

T2R. Soft Matter : Multi-scale Mechanics, from Measurements to Models

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Over the last five years, we have developped a wide range of studies in the field of Soft Condensed Matter Physics, combining *experimental work* with *theory* and *numerical simulations*. Our research interests have focused on the *mechanical and rheological properties* of a large variety of so-called *"Soft Materials"*, such as liquid crystals, melted polymers, elastomers, emulsions, gels, foams, granular and biological materials. In order to understand and establish links between the microscopic structures of such materials and their macroscopic physical properties (as for instance aging, flow, resistance to rupture), we haved combined experimental and theoretical tools used in many different fields of physics and engineering (optics, acoustics, non-linear and statistical physics). Thanks to the development of model systems and state-of-the-art instrumentation, we apply those tools on a wide range of scales - from the nano/microscopic constituents, through the coarse-grained mesoscopic level, and up to the macroscopic scale of the systems considered. This *multi-scale approach* constitutes the cornerstone of our work, highlighted in the following detailed description of our studies: from the nano-mechanics of viruses or carbon nanotubes, to the design of self-assembled structures, and the deformation, fluidization up to the failure of both brittle and ductile heterogeneous materials. Finally, we want to underline that a strong effort is placed on bridging the gap between fundamental studies and real-world applications, as witnessed by various active industrial collaborations (L'Oréal, Solvay, Bluestar). We are therefore conducting a multi-disciplinary approach, which as a result stimulates many collaborative efforts within the various teams of our laboratory, transverse to the various themes presented in this report, and also active exchanges with numerous world renowned institutes, national and international.

A. *Nano-mechanics*

Passive micro-rheology: from k_BT to $G(\omega)$ (Coll. LMA, ERC OutEFLUCOP) – At equilibrium, thermal fluctuations generate spontaneous random deformations in all materials, fluids or solids. The fluctuation-dissipation theorem directly links this thermal noise to the dissipative (imaginary) part of the associated susceptibility, *i.e.* the inverse of the linear viscoelastic modulus $1/G(\omega)$. Applying the Kramers-Krönig relations to this component yields the conservative (real) component. $G(\omega)$ can thus be fully determined from the measurement of the thermally excited deformations. We apply this strategy to many different systems:

- A μm-sized fiber glued to an Atomic Force Microscope (AFM) tip is dipped into a (possibly opaque) liquid to measure its viscosity.
- One or two μm-sized beads are inserted into a medium, and their Brownian motion is optically tracked (one-point or two-point micro-rheology). The resulting viscoelastic modulus compares well with that directly measured with a high-frequency piezo-rheometer on actin networks [187].
- The thermal noise driven waves at the medium-air interface are optically recorded using surface fluctuation specular reflection (SFSR) spectroscopy. After elimination of gravity and surface tension effects, the obtained viscoelastic modulus agrees with that directly measured on polymeric systems [173].
- AFM cantilevers with a metallic or dielectric coating (thicknesses from 10 to 500 nm) present $1/f$ thermal noise in deflection at low frequency, a signature of the viscoelasticity of the coating layer. Using an ultra-sensitive interferometer, we access to $G(\omega)$ with only a 10^{-4} relative incertitude over a 4 decade frequency range [151, 169].

All these methods allow assessing the viscoelastic properties of a material by probing its equilibrium mechanical fluctuations, on a much wider frequency range than conventional techniques, and in a true zero stress limit.

Nano-mechanics of single objects (Coll. JP. Aimé CBMN, A. Ayari ILM, ANR HiResAFM) – AFM can be used to apply mechanical stress on single nanoscale objects to study their mechanical response (stiffness, adhesion…). We use such an approach on systems ranging from viruses to carbon nanotubes with commercial as well as home made AFMs (see section Imaging and Instrumentation). Nano-indentation measurements are for example performed on retroviruses (HIV-1) or small icosahedral viruses (AAV) to study their mechanical properties at thermodynamic equilibrium and their stability as a function of the environment (temperature, pH, osmotic pressure) and/or genome (RNA, ss-DNA or ds-DNA). In other experiments, single wall carbon nanotubes, grown directly at the AFM tip apex, are pressed against a flat substrate. The quasi-static force vs distance curves are characteristic of processes of adhesion and peeling during retraction, leading to quantitative measurements of the adhesion energy (Fig. 5). In parallel, the nano-contact thermal noise

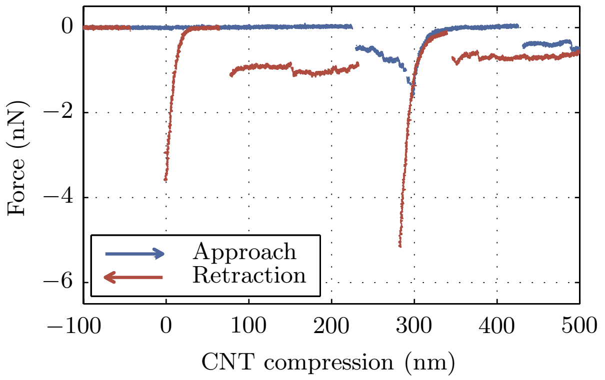

Figure 5: We push a single wall carbon nanotube (CNT) against a flat substrate and record the force vs the compression. The interaction is attractive and strongly hysteretic, showing force plateaux signaling the absorption of the CNT and a peeling process during retraction. The value of the plateau is a quantitative measurement of the adhesion energy per unit length: $E_a = 1\,\mathrm{nJ/m}$ for this CNT on graphite [113].

leads to the intrinsic stiffness of the nanotube [113]. This process is a close nano-scale analog to the macro-scale peeling of adhesive tapes (see section II T2R C).

Stress relaxation in entangled polymer melts (ANR CompPhysSoftBioMat) – Understanding the role of entanglements in the dynamics of high molecular weight polymeric liquids is a classical subject of polymer physics. We perform extensive computer simulations of the equilibrium and relaxation dynamics of entangled model polymer melts and explore the shear relaxation modulus, $G(t)$, into the plateau and into the terminal relaxation. Using the known (Rouse) mobility of unentangled chains and the melt entanglement length determined via the primitive path analysis of the microscopic topological state of our systems, we perform parameter-free tests of several different tube models. We find excellent agreement for the Likhtman-McLeish theory using the double reptation approximation for constraint release, if we remove the contribution of high-frequency modes to contour length fluctuations of the primitive chain, demonstrating that the primitive path analysis of the microscopic *structure* endows the tube model with predictive power for *dynamical* processes [142].

B. *Self-assembled systems*

We have a long-standing expertise in the self-assembled phases of soft matter including liquid crystals, surfactants, colloids, and polymers. The challenge in understanding, or in devising, self-assembled molecular structures consists in linking the macroscopic properties of a material to the symmetries of the interactions between its molecules via the formation of self-assembled ordered structures at mesoscale. Over the last five years we have been devoting efforts to colloidal self-assembly. Compared to molecular systems, colloidal phases offer a unique opportunity: their structures can be probed not only by scattering techniques to achieve high statistics and high temporal resolution [181], but also by optical imaging to gain a direct and quantitative insight into their structure and their slow dynamics. We shall focus here on two prototypical studies.

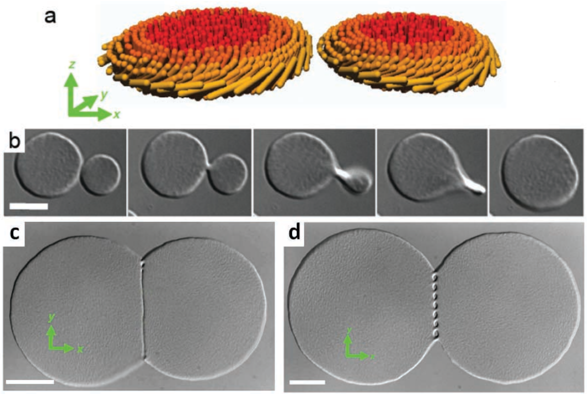

Figure 6: (a) Schematics of two chiral colloidal membranes. The twist of the colloidal rods at their edges leads to atypical coalescences: (b) coalescence by twist, (c) line defects formed through incomplete coalescence, (d) alternating pores and line defect also formed through incomplete coalescence. Scale bars: 10 μm.

Chiral Coalescence (ANR HARB) – We use colloidal-rod droplets as a proxy to address generic coalescence mechanisms which govern the equilibrium behaviour in various systems ranging from intercellular transport to planetary formation. We studied the coalescence pathways of circularly shaped 2d self-assembled colloidal membranes, which are one rod-length-thick liquid-like monolayers of aligned rods. We characterized pathways that do not proceed to completion but instead produce partially joined membranes connected by line defects (Fig. 6). Using laser tweezers we have shown the possibility to create and manipulate the line defects, leading to a robust on-demand method for imprinting networks of channels and pores into colloidal membranes [184],

Microbubbles that live longer – From an applied perspective, colloids at interfaces have been used to stabilize foams for decades. This so-called Pickering method is a well-established laboratory experiment. However, carrying out the process on an industrial scale is limited by the need to chemically modify the particle's surface and to establish a viable protocol for large-scale production and post processing. For practical applications including medical diagnostics, wastewater treatment, food and cosmetics, microbubbles need to be encapsulated to extend their lifetime. Our work has focused on creating new microbubble encapsulation techniques that overcome these limitations. The basis of the method resides in the use of ionic surfactants that adsorb to the

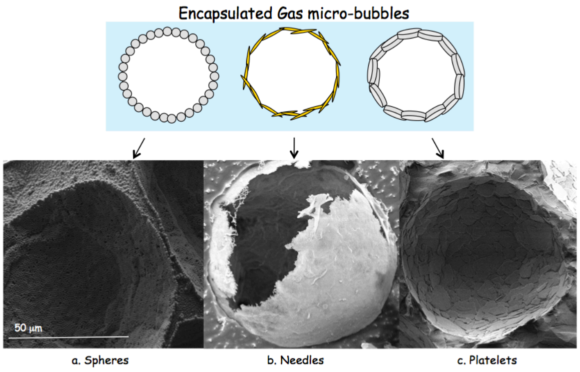

Figure 7: Cross-sectional schematic illustrations (top) and corresponding Scanning Electron Microscope images (below) of microbubbles encapsulated with nanoparticles of various geometrical shapes.

gas-liquid interface of the microbubble. They play two roles: i) they lower the surface tension, which decreases the energy needed to create microbubbles and diminishes the Laplace pressure, and ii) their ionic nature supplies the bubble surface with a residual charge that will induce electrostatic interactions. Choosing oppositely charged nanoparticles leads to a strong attraction of the particles to the bubble surface - the particles "stick" to the bubble surface and form a coherent encapsulating layer. This simple process is completely general and can be applied to a wide range of systems. We have demonstrated the method with particles having different geometrical forms (e.g. spheres, platelets, needles) (Fig. 7), and shown that the microbubbles can last for over a year (that led to pending patents in collaboration with L'Oréal).

C. *Deformation and instabilities*

In the previous section, we aimed both at inventing new materials from the self-assembly of microscopic constituents, and at characterizing the original physical properties of the resulting microstructures at rest. Here, we consider the behaviours of soft complex materials driven far from mechanical equilibrium. Not only does this question raise difficult fundamental issues but it is also of prime practical importance, as deformation is involved in virtually any everyday-life application of soft materials. In order to address the problem, we combine experimental and theoretical skills from many different fields in physics and engineering, *e.g.* microscopy and acoustics, rheology and mechanics, nonlinear and statistical physics, etc. The challenge lies in understanding how an external deformation couples to the material structure and possibly leads to highly nonlinear behaviours, instabilities or even collective phenomena. In the following we highlight our most important discoveries in the field.

Mechanics of liquid crystals – The effects of a temperature gradient, of a rotating magnetic field, or of an electrical field on the texture of liquid crystals have been systematically addressed, leading respectively to a better knowledge of the thermomechanical Lehmann effect in cholesterics with a profound questioning of the Leslie theory [160] (Fig. 8(a), to a better modeling of surface viscosity and yield torque at the nematic-substrate interface [164], and to the discovery of a new electro-capillary instability (Fig. 8(b)). We also initiated a study of smectic liquid crystals doped with gold nanoparticles which were shown to be responsible for a strong hardening of the smectic phase and could be used to improve the lubricant properties of the phase [166].

Creep of granular matter driven by temperature changes (ANR Internationale MicmacGrains) – Even minute temperature changes due to the associated dilation of the grains can lead to the destabilization of granular packings. Thus, subjected to temperature cycles, a granular column compacts slowly. We assessed the phenomenon experimentally [109] and numerically, in more [171] or less [110] model systems. The study reveals a critical amplitude of the temperature variations which separates rest from creep and around which the system flows erratically, alternating between rest and sudden flow events. Rest periods are characterized by temporal correlations whereas memory effects are absent in flow periods.

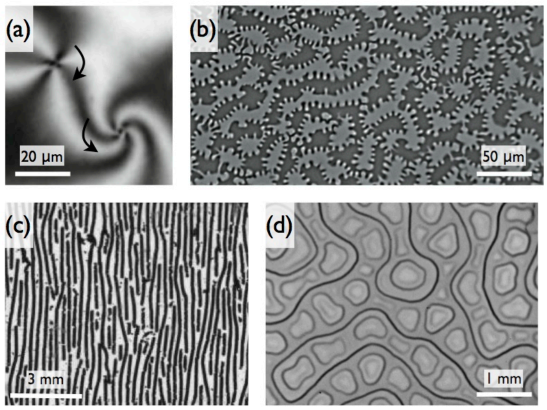

Figure 8: (a) Lehmann rotation of the extinction branches of two disclination lines observed between crossed polarizers in a planar cholesteric sample. (b) Electro-capillary instability of a nematic-isotropic interface. (c) Shear-induced structuration into vorticity-aligned rolls in a carbon black dispersion. (d) Wrinkle pattern in a confined layer of protein gel.

Instabilities in confinement (ERC USOFT) – Confinement often leads to original, unexpected effects in physical systems. When a homogeneous assembly of attractive particles is sheared between two walls with a gap distance comparable to the particle or aggregate size, a striking instability is observed in the microstructure: the system separates into log-rolling aggregates aligned perpendicular to the shear direction [139]. We have shown that this instability occurs not only in Brownian systems such as carbon black dispersions (Fig. 8(c)) but also in non-Brownian suspensions of attractive glass beads. Besides shear-induced structuration, we have studied thin layers of protein gels confined between two non-adhesive walls and discovered an original instability whereby, upon slow acidification of the initially stable protein suspension, a gel layer forms that progressively swells and wrinkles as shown in Fig. 8(d).

Fluidization dynamics of yield stress materials (ERC USOFT) – Yield stress materials such as concentrated emulsions or colloidal gels show solid-like properties at rest but flow easily when submitted to an external stress larger than some characteristic "yield" stress. We have shown that some model microgels display long-lived transient shear localization in the vicinity of the yield stress and that the timescales for full fluidization follow critical-like scalings with the applied stress or shear rate, raising the question of universality in yielding dynamics [126].

Elastic instabilities and shear banding (ERC USOFT) – Entangled polymer solutions develop strong normal forces under flow that lead to a rich phenomenology, akin to classical inertial instabilities in Newtonian fluids such as the Taylor-Couette instability. Combining ultrasonic imaging to rheometry, we compared the case of polymers to that of viscoelastic surfactant systems forming wormlike micelles. In the latter, strong flow–microstructure coupling drives shear-induced structures and/or shear banding, which affects elastic instabilities and the transition to elastic turbulence [132].

Strain localization in cohesive granular matter (Coll. F. Melo, Chili) – Cohesive granular materials (fine powders, wet grains) constitute another class of materials exhibiting instabilities due to their peculiar mechanical response. We revealed experimentally the formation of a complex fracture pattern in a stretched layer of cohesive granular material (Fig. 9(a)) and proposed a mechanism based on the *stretch-thinning* nature of the response to strain[106].

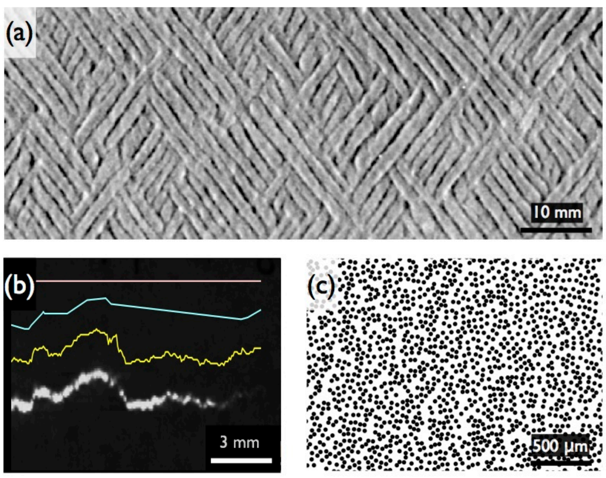

Figure 9: (a) Fracture pattern at the surface of a stretched layer of cohesive granular matter. (b) Analysis of a crack path in paper. (c) Droplet configuration in a confined emulsion submitted to a periodic flow.

Fracture of soft & heterogeneous materials (Coll. L. Vanel, O. Ramos, ILM, FRAMA CRACKS & ERC USOFT) – We characterize experimentally the mechanical instabilities during the deformation and failure of various heterogeneous materials. The main goal is to get a better understanding of those mechanical instabilities in order to control and prevent catastrophic rupture events. First, we have characterized the avalanche dynamics observed during the subcritical thermally activated slow crack growth in paper sheets (Fig. 9(b)) [182]. Thanks to high frequency acoustic monitoring, we have shown the existence of temporal correlations between rupture events, similar to aftershocks for earthquakes [177]. These correlations have an impact on the value of the exponent characterizing the distribution of the energy of avalanches, which is a crucial parameter for the prediction of catastrophic events. Second, we have found that acid-induced protein gels display creep deformation followed by the nucleation and growth of fractures when submitted to an external shear stress. The detailed rupture scenario of these soft biogels is strikingly reminiscent of brittle failure in hard materials and shows excellent agreement with the most recent fiber-bundle models.

Grains and compressible interstitial fluid – Dry granular materials have been widely studied, but the effect of the interstitial gas is generally neglected. However, due to complex interactions between the solid grains and the fluid, fine powders exhibit very surprising behaviours. For instance, droplets of such materials climb slopes when they are vertically vibrated [170]. A strong influence of the interstitial air is also clearly evidenced by the study of the acceleration signals from an instrumented sphere impacting into a granular medium, which leads to a cavity collapse as observed in fluids.

Stick-Slip peeling (Coll. L. Vanel, ILM, P.-P. Cortet, FAST, M. Cicotti, ESPCI, ANR StickSlip) – The crackling sound heard when unwinding quickly an adhesive tape is a direct manifestation of the jerky advance of the peeling front, moving at a speed that alternates between slow (stick) and fast (slip) phases. This rupture instability results from the coupling between the elastic tape and the nonlinear rheology of the adhesive. Our experiments show that the peeling angle is a control parameter of the instability [116] and unveil the crucial role played by inertial effects [117].

Collective behaviors in microfluidic flows – We have used emulsions as a proxy to investigate a broad class of hydrodynamically coupled objects. We showed that the combination of short-range collisions and long-range hydrodynamic interactions results in the propagation of density waves even though neither inertia nor potential interactions participate to the droplet dynamics [121]. When driven periodically and despite the reciprocal nature of the hydrodynamic couplings, emulsions undergo a nonequilibrium first-order phase transition where reversibility is collectively lost through structural (dis)organization of the droplet ensemble (Fig. 9(c)) [143]. We also addressed theoretically the emergence of collective motion in confined swimmer suspensions, demonstrating that homogeneous isotropic states are generically unstable and that the swimmers self-organize to display coherent motion at arbitrarily large scale [111].

T3R. Physics of Biological Systems

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We have an intense activity in the field of biological physics, where we study physical principles and mechanisms by which living organisms survive, adapt, and grow. Our interests span a broad range of length and time scales: from nucleic acids and proteins to cell nuclei, and from single cells to organisms. The projects often combine experimental work, the analysis of massive amounts of experimental data, and physical modeling using both analytical and numerical techniques. An increasing number of projects is carried out in collaboration with (mostly experimental) colleagues from biology laboratories at ENS de Lyon and elsewhere.

A. *Nucleic acids and proteins*

The interplay of proteins and nucleic acids is central to biological organisms. Proteins typically fold into a specific three-dimensional globular structure determined by their amino acid sequence. They act as catalysts and molecular machines or perform a structural role by assembling into cytoskeletal filaments or viral capsids. DNA's primary role is to store genetic information in the nucleotide sequences of the complementary strands of the double helix.
At low temperatures proteins exhibit a universal dynamical transition to a glassy state and there was evidence that this behavior is reproduced by one of the simplest physical models, the frustrated Gō model. We have investigated the incoherent neutron-scattering structure factor, the transitions among energy states at low temperatures, and the transient violation of the fluctuation–dissipation theorem in non-equilibrium fluctuations after a sudden temperature quench and found, that the equilibration in the Gō model follows Arrhenius behavior [220].
DNA shows different elastic behavior on different scales, crossing over from the nano-scale elasticity [194] of the double-helix to a kinked [273] worm-like chain [193] on large scales (ANR CompPhysSoft-BioMat). Some proteins binding to specific DNA sequences do so by probing the mechanical properties of the double helix ("indirect readout"). We have explored the nano-scale structure, elasticity, and fluctuations of the double helix as a function of sequence and temperature in the framework of the rigid base-pair model [240]. This allowed us to apply a standard exercise in mechanical engineering to high-resolution structures of DNA-protein complexes: the inference of external forces and torques on the DNA from its given static shape and its known elastic properties [195]. The revealed nanomechanical interaction patterns provide a new view on DNA-protein binding that complements structural analysis.

Key biological and nano-technological processes require the partial or complete association and dissociation of complementary DNA and RNA strands. We have developed a variant of the Poland-Scheraga model for DNA melting, which reproduces experimental data for melting temperatures over the full experimental range of strand length, strand concentration, and ionic strength of the solution [227]. For RNA we have shown how to systematically predict complex folded structures such as multiloops and pseudoknots from a lattice model for the conformational entropy of folded RNA, which avoids popular ad hoc generalizations of the Jacobson–Stockmayer loop entropy [229]. Bubbles or open loops also exist in the DNA double-helix. For long chains, the cooperativity of the melting transition and the different thermal stability of GC and AT base pairs lead to the successive step-wise opening of more and larger domains. The open sites introduce flexible joints that strongly reduce the DNA persistence length on approaching the melting transition [273]. The size of the closed regions can also be probed through neutron scattering [282]. We have measured a local melting profile of designed sequences and have shown that, at biological temperature, the fluctuations of AT-rich regions influence the local conformation of base pairs up to 10 base-pair away [208]. While correlations between *thermal* melting properties and the biological information content of genomic DNA can be used for *ab initio* gene finding [228], we found a much stronger signal when analyzing *mechanical* opening of superhelically stressed DNA where bubbles open with finite probability and are frequently located directly upstream of transcription start sites [225, 230].

B. *Chromatin*

The chromatin fiber constitutes the first step in the hierarchical packing of DNA in the nuclei of eukaryotic cells. Typically 80% of genomic DNA is bound inside of nucleosome core particles, where 147 base pairs of DNA tightly wrap around a "spool" formed by a histone octamer. The nano-mechanical analysis clearly reveals the dominant forces, which are exerted on the DNA at regularly spaced backbone-histone contact sites where the minor grove faces the histone octamer [196]. The remaining 20% form "linkers" between the core particles. Through interaction with the histone H1/H5 the linker DNA can further condense into a nucleosomal "stem." We have investigated the stem structure by combining the nano-scale description of the DNA structure and elasticity with results of biochemical footprinting and cryo-electron-micrography of reconstituted mono-, di- and tri-nucleosomes [239, 272]. Our results suggest that the stem should be viewed as a dynamic, polymorphic, hierarchically organized structure whose formation stabilizes and facilitates the formation of dense chromatin fibers.

As an important actor in the regulation of nuclear functions, the nucleosomal organization of the 10 *nm* chromatin fiber is the subject of increasing interest. Recent high-resolution mapping of nucleosomes along various genomes ranging from yeast to human, have revealed a patchy nucleosome landscape with alternation of depleted, well positioned and fuzzy regions. A recurrent question is to what extent the genomic sequence dictates and/or constrains nucleosome positioning and dynamics [275]? Combining single-molecule AFM measurements of the conformation of surface deposited "designed" DNA chains and 2D "worm-like chain" models with sequence-dependent elastical properties [247–249], we were able to show that long-range correlations (LRC) present in genomic DNA [186] can favour "mesoscopic" bending of naked DNA chains and reduce the mechanical cost of nucleosome formation (ANR DNAnucl (CGM-CNRS)).
To describe nucleosome positioning along the chromatin fiber, we developed a simple thermodynamical Tonks-gas model that accounts for both sequence specificity of the histone octamer and for nucleosome–nucleosome interactions [186, 205]. While the good agreement with genome-wide *in vitro* data demonstrates the reliability of the model, the comparison to *in vivo* data reveals the action of external factors including transcription factors, ATP-dependent chromatin remodelers [243, 274] and histone chaperones [215] (see Fig. 10). We experimentally confirmed this sequence-induced statistical positioning mechanism by AFM measurement of nucleosome distribution along *in vitro* reconstituted nucleosomal arrays [241].

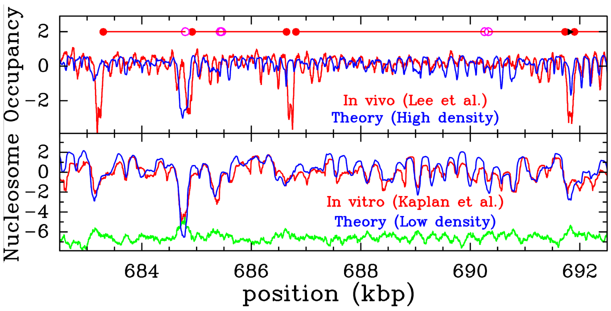

Figure 10: Comparison of predicted nucleosome occupancy (log_2) profile along the yeast chromosome II genome with *in vivo* and *in vitro* profiles.

While the preferred position of the histones along the DNA is sequence-dependent, cells can influence the fiber structure by locally recruiting histone variants. We have combined experiments and modeling to investigate this effect [246] as well as the consequences of the activity of chromatin remodeling proteins. In particular, we have shown [245] that RSC remodeling of oligosome templates results in the packing of the nucleosomes at the edge of the template with large stretches of nucleosome depleted regions in the center. This feature of RSC may be used by the cell to actively overcome barriers imposed by the presence of nucleosomes.

C. *Large-scale functional and structural organization of genomes*

(ANR HUGOREP (CGM-CNRS,IBENS,IBCP), ANR REFOPOL (IBENS,CEA,CGM-CNRS), ANRS LEDG-VIH-1). Chromatin displays a rich structure beyond the nucleosome scale and we try to elucidate the underlying physical mechanisms On the highly studied *S. cerevisiae* organism, we showed the implications of the highlighted "positioning via excluding" mechanism on the structure and function of yeast genes [205, 206, 241, 276]. The generalization of our modeling to other organisms such as humans has further provided new insight on the close relationship between the primary nucleosomal structure and the genome organization and function (replication [188], viral integration [236], gene activation [243]). In particular, analysis of *in silico* and *in vivo* nucleosome landscapes revealed that "master" replication origins in human cells were enriched in intrinsic nucleosome free regions as a signature of an open chromatin state [188].
In previous work, we had shown how to identify the likely location of replication origins from the analysis of DNA strand compositional asymmetry (skew) profiles [186, 526]. We found that the corresponding replication domains are closely related to (i) genome evolutionary dynamic [203, 204, 233], (ii) gene organization [285], (iii) epigenetic signaling [188, 231, 232], and (iv) chromosome 3D architecture [192, 244, 528, 555] These observations raise a number of interesting physical questions.

Concerning the influence of replication, we have proposed a global model for the spatio-temporal program of DNA replication in mammals [223]. Its central parameter is the replication polarity which measures the mean directionality of the DNA polymerase as a function of position. Both the skew resulting from mutational asymmetries associated with replication [190, 191] and the derivative of experimental replication timing profiles [192, 217] are shown to be proportional to replication polarity. We propose that replication initiates at the "master" origins located at borders of the observed megabase sized replication domains with characteristic N-shaped skew profiles [535] and corresponding U-shaped replication timing profiles [192, 529, 530]. Secondary origins are remotely activated by the approach of a center oriented DNA polymerases, allowing replication to progress faster than the known speed of a single fork [217].

Secondly, we have asked how cells self-organize and maintain the epigenetic marking allowing them to exhibit different stable phenotypes from the *same* DNA sequence. We have developed a stochastic model that describes the dynamics of epigenetic marks along a given DNA region [226]. In particular, we showed the emergence of bistable epigenetic states from the cooperative recruitment of modifying enzymes. Thirdly, we have further investigated a simple physical mechanism explaining the ubiquitous intra-chromosomal looping, the spatial organization in terms of domains, and the existence of chromosome territories. Similarly to macroscopic strings tied into knots, chromatin fibers can slide past each other, but their backbones cannot cross. With relaxation times for their topological state of the order of centuries, large chromosomes exhibit the same "territorial" behavior as corresponding *equilibrated*, *un*-entangled *ring* polymers. The crumpled state is characterized by randomly branched looping on the entanglement scale (100 kbp for chromatin) and the formation of locally compact domains on the scale of 10 entanglement lengths (or 1 Mbp of DNA) [269] (see Fig. 11). The model quantitatively predicts the generic form of the available experimental FISH and HiC data for distances, mobilities and contact probabilities of (pairs of) specific genetic loci [268].

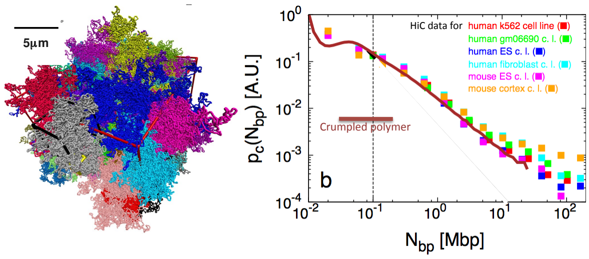

Figure 11: Crumpled polymers as a model for interphase chromosomes. L.h.s. The territorial behavior of crumpled polymers. Systems are comparable in size to human cell nuclei. R.h.s. Comparison of model predictions to experimental data for the generic, sequence-averaged contact probability as a function of genomic distance [268, 269].

The question of compaction of genetic material is not only relevant to higher organisms, but also to viruses. Again the mechanisms involve the association with proteins, but here in the form of a viral shell. Bacteriophages are viruses that infect bacteria. Their DNA is actively packaged inside a viral protein shell called the capsid. During the infection, phages inject their genome across the bacterial cell membrane. Using Isothermal Titration Calorimetry, we were able to measure the energy stored by genome compaction inside phage Lambda as it is externalized, and to relate this quantity to existing models of DNA packaging [224]. Similarly, we quantified the maximal amount of DNA to be filled inside an infectious phage, and we correlate this result to the efficiency of molecular motor performing the packaging[255]. Most viruses are incorporated as a whole into their target cells. They need to be completely disassembled upon cell entry and reassembled upon cell exit. Hence our interest to study formation and stability of viral protein shells (Prix Fondation Del Duca, ANRS HIV-AD). We investigated the Human Immunodeficiency Virus (HIV-1), which is responsible for AIDS. For the assembly of HIV-1, we isolated viral particles produced by transfected cells and imaged them at high resolution using an AFM. We observed quantitatively the size distribution of viral particles and found that mean size and polydispersity is larger for shells encompassing the viral genome. The analogy to molecular self-assembly suggests that this observation is explained by general entropic arguments [201, 202, 213]

The structures we have discussed above range from the nm to the μm scale. The associated complex dynamics involves an even wider range of time scales. Progress in cellular biology based on fluorescent microscopy techniques and the use of an original light scattering experimental device allow to study the the global internal dynamics of the nucleus of *living* cells. We found evidence that the dynamics is dominated by two different and independent kinds of relaxation that are well separated in time and specific to the phase of the cell cycle [271].

D. *From cells to tissues*

Swimming bacteria propelled by helicoidal flagella display an oriented circular motion near surfaces. This motion is antagonist to the run and tumble chemotactic behavior of bacteria in the bulk, since circling confines bacteria to a definite space. The dynamics of swimming is driven by hydrodynamic interactions and was theoretically predicted to be dependent of the slipping properties of the interface. We experimentally demonstrated by direct videomicroscopy (ANR CONE, Pasteur Institute), that the orientation is anti-clockwise at a clean air water-interfaces [234] and clockwise at non-slippery solid surfaces [235] . Interestingly, the orientation may change as a consequence of bacterial secretions modifying the surface properties, thereby freeing the bacteria from the trap on the surface and restoring the possibility of chemotaxis.

All the adult life long, two types of cells insure the permanent renewal of the bone material: the osteoclasts, which resorb the bone, and the osteoblasts, which secrete new material replacing the old one. The adhesion of these cells with substrates involves the formation of local structures, the podosomes, in the contact region. Individual podosomes consist of a dense polymerized-actin core surrounded by an actin cloud, whose dynamics we have modeled at the molecular level [221]. Depending on the substrate and on the differentiation stage, podosomes assemble and form clusters, rings or belts. We have shown experimentally, that these assemblies move collectively, dragging along the osteoclast cells, which catch up in rapid jumps whenever the posterior edge detaches from the substrate [222].

In tissues there is a dynamic mechanical equilibrium between cells exerting contractile stresses and the resisting extracellular matrix surrounding them. We have studied the mechanical adaptation of plant [242] or mammalian [216, 238] cells to an external constraint (ANR MECHASTEM, RDP) and the complex oscillatory dynamics in asymmetric division in C-elegans [265]. We found that the force balance is essentially dynamic and that cells control the velocity of their response to stress by recruiting a highly specialized assembly of molecular motors.

To some extent tissues resemble foams: the cell walls form an array of flexible membranes, which enclose the cytosol. However, the situation is more complex, because the cell cytoskeleton is a network of semiflexible actin proteins with the characteristics of a gel [187]. We have proposed a model for the viscoelastic behaviour of soft tissues [254] and have validated it for different soft organs[250, 251]. The model combines the elastic response of the cell walls, the newtonian behaviour of the inner fluid and the power-law time-dependent gel-like response of the cytoskeleton; it also accounts for the shear-thickening due to the low extensibility of cytoskeleton fibers, a characteristics opposite to the shear-thinning displayed by entropic polymer chains.

Finally, we are using non-linear physics approaches to study rhythm generation and synchronization in various biological tissues. The synchronization of biological activity with the alternation of day and night (circadian rhythm) is performed in the brain by a group of neurons, constituting the suprachiasmatic nucleus (SCN). We showed that both the period and strength of the external signal, and the coupling between the sensory and the oscillating neurons in the SCN are crucial in determining the synchronization of the system [283]. Similarly, the appearance of cell synchronization in the uterus before delivery is not really understood, given that none of these cells taken in isolation spontaneously oscillate. Instead, it had been noticed that the cellular coupling very significantly increases shortly before delivery, and that birth could be hindered by interfering with this increase in cellular coupling. This has led us to investigate assemblies of muscle and passive cells electrically coupled together, and to study the role of the coupling in the dynamical regimes occurring spontaneously [284]. Using simplified models of muscle cells, we have shown that increased coupling may indeed generate rhythmic activity in the system, and that, at sufficiently high values of the coupling, the activity is synchronized [270]. More recent results, using realistic models of uterine muscle cells, show that the transition towards synchronized activity occurs in the physiologically observed range of coupling values at delivery time.

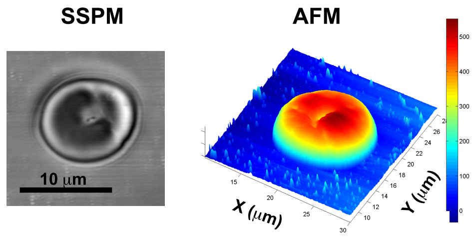

Figure 12: Scanning surface plasmon microscope topographic image of a smeared erythrocyte and its 3D height (in nm) image captured with atomic force microscopy.

Cardiac arrhythmias, which are due to a lack of synchronization of the organ, are the leading cause of death in the industrialized world. Our study has been aimed at understanding why the only method capable of restoring cardiac rhythm, cardiac defibrillation, requires extremely high electric fields, and how to reduce the energy necessary to re-synchronize the heart. We have developed an understanding of the interaction between the electric field and heterogeneities acting as "virtual electrodes", allowing us to propose a method which can reduce the energy necessary to defibrillate by 80-90% [214, 237].

E. *Technical advances*

Surface plasmon microscopy is widely recognized for its high sensitivity to nanoscale structures and interaction. Thanks to the coupling of this evanescent wave plasmonic excitation to high numerical aperture objective lenses, we pushed its resolution down to the diffraction limit (ANR BIOPLASMOSCOPE), allowing the detection of nanoscale objects, such as isolated single nucleosomes for instance [267, 286, 287]. We have also developed a complete modeling of the response of this system to explain how it can detect such small objects while most other microscopies are constrained by the diffraction limitation [209, 211]. Being a scanning method, surface plasmon microscopy is particularly efficient for cellular imaging since it spans nano- to submicroscales, affording more than four decades of scales [185, 197, 198, 266]. In the last two years we have both experimentally and theoretically demonstrated that from a set of images captured by this microscope, the topography and index of cells and soft objects can be retrieved. [200, 210, 774].

The understanding of biological systems requires a multi-scale approach. We have developed a concurrent multi-scale scheme for complex fluids, which is formulated in terms of a global Hamiltonian [259, 260]. Within the H-AdResS scheme molecules, or parts of them, can cross boundaries between areas at different resolution, while maintaining the overall thermodynamic equilibrium.

T4R. Mathematical Physics and Fundamental Interactions

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The main fields of research within the mathematical physics group include: rigorous methods in statistical physics, integrable models, conformal field theory, string theory, supergravity, and quantum gravity. Work at the interface between statistical physics and probability theory involves strong ties with mathematicians and has led to rigorous results in disordered systems and problems of relaxation to equilibrium for stochastic dynamics of spin systems. Integrable systems are thoroughly studied in the group ever since its creation, with many important results concerning in particular the asymptotics of correlation functions. In conformal field theory, the ongoing work involves the use of new mathematical tools – gerbes – and unfolds obstructions to the construction of gauged Wess-Zumino models. Supergravity has been a topic of intense activity in the last five years, with many original results concerning gauged, extended and higher-dimensional supergravities and supersymmetric field theories. The classical aspects of strings in a maximally symmetric background using integrable methods is a relatively recent subject in the group. Last but not least, considerable work has been devoted to quantum gravity, which is a subject of utmost importance in high energy theoretical physics.

Our results have given rise to 123 publications in international refereed journals. Before describing in more details the results obtained over the last five years, we would like to highlight the following main achievements:

– Form factor approach to asymptotic behavior of correlation functions in critical models.
– Classification of global gauge anomalies in gauged 2-dimensional sigma models with Wess-Zumino terms.
– Proof of inviscid damping for the linearized two–dimensional Euler equations.
– Proof of disorder relevance for the 1+1-dimensional disordered polymer pinning model.
– Construction of an integrable q-deformation of the $AdS_5 \times S^5$ superstring action.
– Construction of the E_n-covariant form of the full eleven-dimensional supergravity.
– Quantization and coherent states for discrete twisted geometries (with curvature & torsion).

A. *Integrable systems and conformal field theory*

Integrable systems: (ANR DIADEMS, IMB, Dijon, CNRS GDRI) Integrable systems are ubiquitous in modern theoretical physics appearing both in statistical mechanics and field theory with applications ranging from condensed matter to string theory. They provide unique possibility to obtain non-perturbative and exact results for strongly correlated systems that cannot be obtained by other methods; among others, it leads to invaluable benchmarks used in numerics for more general cases. Besides the computation of spectrum, scattering matrices and partition functions the main challenge in this domain concerns the exact computation of the form factors and correlation functions that connect to measurable physical quantities in such systems. Our group was at the origin of several significant breakthroughs in these problems along the last 15 years, starting from the resolution of the so-called quantum inverse scattering problem for spin chains that led to the computation of their form factors and correlation functions in the framework of the Algebraic Bethe Ansatz (ABA). Among the works done in the last five years we would like to emphasize the following three most promising directions :

- Extension of the above method to models associated to elliptic quantum algebras like the solid-on-solid (SOS) model, which is the archetype of the class of so-called *face* models with the XYZ model as the main future goal. We obtained determinant representations for the finite-size form factors of local operators [376] and multiple integral representations for the local height probabilities in the thermodynamic limit [377].

- Development of a new method to tackle the large distance and large time asymptotic behavior of correlation functions for interacting critical models starting from their form factor expansion, hence deriving from first principle their conformal properties in the thermodynamic limit for two point functions [365, 367] and then for arbitrary n-point functions. This also led to the exact derivation of the so-called X-ray edge singularities for the 1D Bose gas at arbitrary positive coupling and the computation of its correlation functions at low temperature [371, 372]. One of the goals of the method is to give a microscopic and physical approach to conformal field theories starting from lattice models.

- Setting up the resolution of the quantum inverse problem and the computation of correlation functions in the framework of the separation of variable (SOV) method to consider general integrable systems not solvable by ABA; the first examples worked out have been the lattice Sine-Gordon field theory [354] and the Chiral Potts model [355].

Conformal field theory: We continued to develop a geometric approach to 2- and 3-dimensional field theory models based on the theory of gerbes and their modules. In particular, we applied this approach to classify global gauge anomalies in gauged 2-dimensional sigma models with Wess-Zumino terms on worldsheets without boundary [343] and with boundaries or/and defects [344]. In the case of coset models of conformal field theory, an almost complete classification of the anomalous cases was obtained [320].

B. *Exact results in statistical physics and dynamical systems*

Our work is at the interface between statistical physics and probability theory. Among the topics of research are the rigorous study of disordered systems (spin glasses, polymers in random environment) and problems of relaxation to equilibrium for stochastic dynamics of spin systems.

Polymers in random environment: The random pinning model is one of the simplest disordered models exhibiting a phase transition. It is also an ideal testing ground to give mathematical basis to the so-called Harris criterion, that gives predictions on when disorder changes critical exponents (disorder relevance). The work [346] considers the case of the pinning models in dimension $1+1$, where disorder is "marginal" in terms of Harris criterion. In that work it is proven that the critical point is modified by disorder w.r.t. the homogeneous case (and that, for weak disorder, the critical point shift is smaller than any power of the disorder intensity). This proves a conjecture by Derrida, Hakim and Vannimenus ('92).

Stochastic dynamics and relaxation to equilibrium: Stochastic Markov evolutions of Glauber type are naturally associated to discrete statistical mechanics models (e.g. the Ising model). Classical question is how (and how quickly) the dynamical process converges to the equilibrium measure. These questions are particularly challenging at low temperature, where energy barriers between different thermodynamic phases dramatically slow down dynamics. In [312], sharp bounds on the time of relaxation to equilibrium for the zero-temperature dynamics of the three-dimensional Ising model were proven (Fig. 13).

Inviscid damping in fluid mechanics and stochastic partial differential equations: (ANR SYSCOM, LEGI, LPO) Turbulent flows are obviously irreversible. Less obviously this irreversibility is probably independent of the microscopic dissipation processes, and formally time reversible dynamics, like the two–dimensional Euler equations, have a macroscopic irreversible behavior. In a recent work we have shown that this is indeed the case, proving

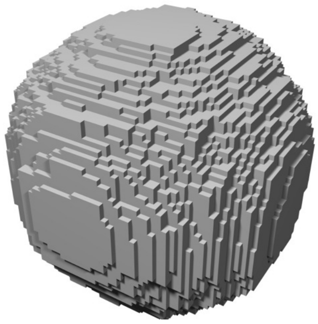

Figure 13: An initially cubic droplet of "minus" spins in a sea of "plus" spins for the 3D Ising model, evolving according to the zero-temperature Glauber dynamics, is eroded as time goes on. For the continuous-time evolution, an $L\times L\times L$ droplet takes a time approximately L^2 to disappear [312].

inviscid damping for the linearized two–dimensional Euler equations [307]. This phenomenon is analogous to the non-linear Landau damping, recently studied by Cédric Villani and Clément Mouhot. Moreover, the study of the non-linear inviscid damping for the two-dimensional Euler equations is a current hot subject in the mathematical physics community.

Related to the stochastic two dimensional Navier–Stokes equations, deep collaborations have been developed with mathematicians specialists of stochastic partial differential equations.

C. *String theory and supergravity*

String theory is a theory to describe nature at the smallest length scales, which replaces the concept of point-like elementary particles by extended strings. Its consistency requires supersymmetry and the presence of ten space-time dimensions. At low energies, and after compactification of the extra dimensions, the theory gives rise to supersymmetric effective field theories, the so-called gauged supergravities. Central themes of our research have been the classification and construction of supersymmetric field theories, the use of integrable methods in the study of string theory on $AdS_5\times S^5$, and the holographic dualities.

Integrability and $AdS_5\times S^5$ string theory: (PICS DIGEST, Hertfordshire) Integrability plays a key role in the context of the AdS/CFT correspondence between four-dimensional $\mathcal{N}=4$ superconformal Yang-Mills theory and type IIB superstring theory on the ten-dimensional $AdS_5\times S^5$ background. During the last five years, two important results have been obtained. The originality of the approach consists in focusing on the algebraic structure sustaining integrability at the classical hamiltonian level.

In this context, the first steps of the Faddeev-Reshetikhin approach developed in 1986 for the SU(2) principal chiral model have been extended to the $AdS_5\times S^5$ superstring [325]. We succeeded in determining the generalised Faddeev-Reshetikhin Poisson bracket for this theory. Unlike the case of the principal chiral model, this procedure does not completely do away with the non-ultralocality in the canonical Poisson bracket of the Lax matrix. However, it leads to an alleviation of the non-ultralocality. Indeed, the generalised Faddeev-Reshetikhin Poisson bracket of the Lax matrix can be regularized and leads to a well defined lattice algebra of the general quadratic form identified by Freidel and Maillet in 1991. It has also been shown that the Faddeev-Reshetikhin procedure leads naturally to performing a Pohlmeyer reduction of the superstring. This has therefore revealed an unknown link between these two approaches.

The generalised Faddeev-Reshetikhin Poisson bracket has also been used to construct an integrable q-deformation of the $AdS_5 \times S^5$ superstring action [328]. The properties of this deformation are the following. Its integrability is guaranteed from the very outset. The global $PSU(2,2|4)$ symmetry is broken to its Cartan subgroup $[U(1)]^6$. However, it admits a q-deformed symmetry, which is the classical analog of $U_q(psu(2,2|4))$. The action is invariant under κ-symmetry. The deformation interpolates between the $AdS_5 \times S^5$ and $dS_5 \times H^5$ spaces.

The original motivation related to these two results comes from the AdS/CFT correspondence. However, the methods have been developed within the general framework of integrable σ-models. For instance, in the case of the deformation, we have recovered in this way the Yang-Baxter σ-model introduced by Klimcik. This also generalises results obtained for the squashed S^3 σ-model.

Supersymmetric field theories: (ANR Chaire d'excellence) Understanding the detailed structure of the effective 6d theory of multiple M5-branes remains one of the important longstanding issues of string/M-theory. On general grounds this should be a (2,0) superconformal theory of non-Abelian chiral tensor supermultiplets. Such structures show similarity with concepts of higher gauge theories, Q structures, and non-abelian gerbes extended to higher degree forms. This is analysed in current work with mathematicians at ICJ, UCBL. In [403] explicit six-dimensional superconformal models with non-abelian gauge couplings for multiple tensor multiplets have been constructed. A crucial ingredient in the construction is the introduction of three-form gauge potentials which communicate degrees of freedom between the tensor multiplets and the Yang-Mills multiplet, but do not introduce additional degrees of freedom. In later work [404], we have classified the general gauge group structure of these models and extended the construction to the presence of hypermultiplets which complete the field content to that of superconformal (2,0) theories.

Supergravity: Supergravity theories arise as low-energy effective field theories of string compactifications with applications in the holographic description of gauge theories. In [396] the unique maximally supersymmetric theory in two dimensions with gauge group $SO(9)$ was constructed. The theory is expected to describe the low-energy effective action upon reduction on the D0-brane near-horizon geometry, dual to the supersymmetric (BFSS) matrix quantum mechanics. The existence of this theory has been a long-standing conjecture based on its field content and higher-dimensional analogies. Unlike all the other maximal supergravities relevant for the higher-dimensional holographic dualities whose construction has been accomplished in the 1980's, the construction of this theory had to await modern tools. Its construction is based on selecting the proper embedding of the gauge group into the infinite-dimensional symmetry group of the ungauged theory.

Another natural application of supergravity theories is the construction of globally supersymmetric field theories on curved spacetime. Such theories have attracted increased attention with the advent of localization techniques that allow for numerous exact results for supersymmetric gauge theories, such as the computation of indices, partition functions and Wilson loops, providing in many cases checks of highly non-trivial dualities. In recent work, the rigid supersymmetric theories in four-dimensional Riemannian spin manifolds have been classified [405]. The conditions for supersymmetry translate into set of conditions on the torsion classes of a suitable SU(2) or trivial G-structure. Later work has extended this analysis to interacting vector and tensor multiplets on six-dimensional Riemannian spin manifolds.

In further work, we have constructed and analyzed solutions of supergravity theories in various contexts (wrapped branes, AdS flux compactifications, black p-brane intersections, BPS black holes, warped AdS, rotating branes).

Exceptional field theories: Eleven-dimensional supergravity reveals large exceptional symmetries upon reduction, in accordance with the U-duality groups of M-theory, but their higher-dimensional geometric origin has remained a mystery. In [357, 360] and subsequent work, D=11 supergravity has been extended to a form which is fully covariant under the exceptional groups $E_{n(n)}, (n = 6, 7, 8)$. In this covariant formulation the exceptional symmetries acquire a geometric realisation in terms of a higher-dimensional 'exceptional spacetime'. Remarkably, this formulation likewise comprises the IIB theory.

D. *Quantum gravity*

(ANR LQG09, CPT, LPT Orsay, LPTA) A very interesting axis of development of the research activities of the mathematical physics group is quantum gravity. This is a huge challenge for theoretical physics. The goal is to produce a theory describing the gravitational interaction at all scales of length and energy, from the Planck scale at $10^{-35}m$ to astrophysical and cosmological scales. It should provide a unified framework for quantum field theory, particle physics and general relativity. There are a few solid and fruitful approaches to this longstanding issue. We distinguish string theory, loop gravity, dynamical triangulations, exact renormalization group techniques and non-commutative geometry. Although inspired from different perspectives, they often lead to comparable pictures.

The quantum gravity team of the laboratory focuses on loop quantum gravity and its associated spinfoam path integral framework. The theory defines quantum states of geometry and their dynamics is described by transition amplitudes given by spin foam models. The goal is to understand and analyze the quantum fluctuations of geometry and apply the results to extreme gravitational fields for which quantum gravity should cure the ill-behavior of general relativity, but we also aim to study the coarse-graining and renormalization flow of the quantum dynamics in order to recover the standard laws of gravity at our scale in a semi-classical regime and to derive consistently quantum corrections, which could be tested in cosmology, astrophysics or in the phenomenology of particle physics. Over the past five years, the team has produced a large array of relevant results among which one can emphasise the following:

Spinfoams: correlations, asymptotics & dynamics: In both 3 and 4 space-time dimensions, we have studied the properties of spinfoam transition amplitudes and correlations on quantum states, especially focusing on their large-scale asymptotics and recursion relations. On the one hand, beside powerful analytical results on asymptotics and new methods to derive the quantum corrections to the classical leading order, we have performed in collaboration with Canadian colleagues the first numerical simulations showing that we recover the r^{-2} behavior of Newton's law for classical gravity at large distances (see Fig. 14) while having completely regularized correlations at the Planck scale [316].

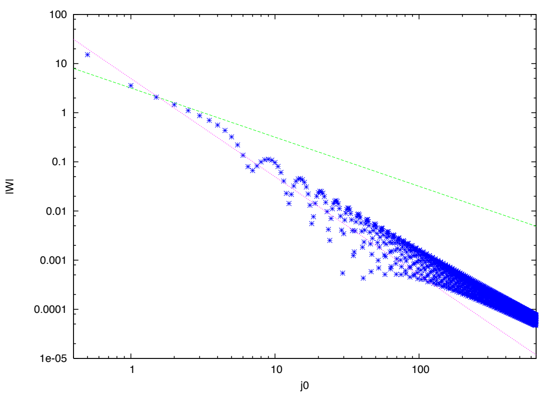

Figure 14: Numerical evaluation of the 2-function of 3d quantum gravity in terms of the scale parameter j_0: on the log-log plot, the green dashed line is the leading order reproducing the classical gravity law, the next-to-leading order in blue with the oscillations takes into account the path integral corrections.

On the other hand, recursion relations are not only very useful numerical tools to compute the spinfoam amplitudes but also reflect the existence of symmetries satisfied by those amplitudes. Having explored this relation for 3d gravity, we have interpreted spinfoam amplitudes for coherent states as generating functions for the amplitudes in the standard spin basis and shown how to convert the recursion relations into differential equations reflecting the Hamiltonian constraints of the theory.

Non-commutative geometry: Formulating spinfoams in terms of group field theory, which generalizes matrix and tensor models, they are interpreted as non-commutative quantum field theories that leads to deformed special relativities with possible experimental signature in particle physics [353]. From a physical viewpoint, it amounts to working with a curved momentun space. From the mathematical perspective, we formalized this non-commutative geometry in terms of $\star$-products and a group Fourier transform and showed it is related to a Moyal-Voros product.

Spinor networks & coherent states: We introduced a new parametrization of the phase space of loop gravity in terms of spinors. These spinor networks clarify the interpretation of the quantum states as discrete (twisted) geometry with torsion, also simplifying the analysis of the constraint algebra. They allow a direct quantization and the definition of well-behaved coherent states of geometry (see e.g. [341]). These have all become standard mathematical tools for loop quantum gravity and spinfoams. In particular, spinfoam amplitudes are now all naturally expressed as path integrals over these spinorial coherent states, which allows a more direct link with Regge calculus ofr discretized general relativity. We further generalized these tools to twistorial networks, which are covariant under Lorentz transformations and account explicitly for the extrinsic curvature of our 3d space into the 4d space-time.

Quantum cosmology: Cosmology is the main arena for potential tests of quantum gravity. We have developed a framework for homogeneous quantum cosmology from loop gravity and computed the spinfoam transition amplitude between cosmological coherent states. This allowed to derive modified FRW equations for the evolution of the universe[385], predicting a Big Bounce replacing the Big Bang singularity. We hope to extend these group quantization and coherent state techniques to dealing with inhomogeneities.

Side-products: mathematics & quantum information: Research in quantum gravity often requires deeper studies in geometry and quantum mechanics, leading to results relevant for pure mathematics (especially discrete geometry and knot theory) or other fields of physics. In particular, we have ad many interactions with the field of quantum information and we would like to put forward a work defining unitary N-designs [319].

T5R. Condensed Matter

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Condensed Matter embraces a wide range of different physical systems, whose common denominator is a complex behaviour emerging from either strong interactions, or quantum statistics, or the conjure of both. Our recent activities have covered a broad spectrum of subjects, ranging from the physics of bulk solids to that of nano-structures, quantum fluids, and dilute quantum gases. A pervasive theme in modern condensed matter is that of *emulation and emergence*, whereby the collective behaviour of a complex system (the "emulator") can exhibit the distinctive features of a widely different physical system, *a priori* unrelated to the emulator's elementary constituents. As an example of such a principle, semiconductors can reproduce the physics of relativistic fermions; magnetic materials can mimic the physics of classical and quantum electrodynamics admitting magnetic monopoles, or the physics of correlated Bose fluids; diluted quantum gases can mimic the physics of dense materials (becoming therefore a subject of condensed matter physics) both in equilibrium and far from equilibrium. On a different note, the *electron waves* in mesoscopic conductors can be used as a coherent probe of the solid environment in which these waves travel: electron waves can unveil the decoherence mechanisms at play in a quantum Hall bar, whose edges define an electron interferometer; and they can probe the complex spin pattern inside a spin glass. Finally *quantum fluids* exhibiting turbulent flow, or ionised to form a plasma, unveil the impact of quantum effects in extreme conditions.

A. *Emergence and topology*

ANR IsoTop, Univ. Bordeaux; FCAR, M. Gingras (Univ. Waterloo); ENS, F. Mila (EPFL).

The last decade has experienced an explosion of interest in materials whose low energy sector consists of "relativistic" excitations: Dirac fermions in graphene, topological insulators and Weyl fermions in semimetals. Dirac point engineering, relevant for cold atoms in optical lattices, microwave experiments on photonic crystals and the organic conductor α-(BEDT-TTF)$_2$ I$_3$ have also given access to diverse topological transitions. We have studied the effects of disorder on these excitations and transitions. In [447] we have studied 2D Dirac fermions in the presence of long-range correlated random potentials. The density of states and full counting statistics for fermionic transport at low energy have been investigated. In [430] the effect of disorder on the topological transition from a semi-metal to a band insulator due to merging of two Dirac points was studied.

We have studied geometrical and topological properties of energy band structures in crystals, with a particular interest in topological insulators and semimetals. Recently, in close collaboration with an experimental group in Grenoble, it was shown that the surface states originating from these topological properties can extend way beyond the expected energy range [433]. In parallel, we have clarified the notion of Berry curvatures in band structures, and their physical relevance (Fig. 15).

The emergence of magnetic monopole quasi-particles as low temperature excitations of spin ice materials is an exciting development in frustrated magnetism. In these extraordinary materials, the monopole vacuum is an extensive and quasi-degenerate band of states whose spin configurations are slave to an emergent U(1) gauge field. Consequences of the gauge field constraint include symmetry breaking transitions outside the usual Landau-Ginzburg-Wilson description and thermally induced topological sector fluctuations up to the mesoscopic scale. Analysis of the emergent electrostatics and stochastic dynamics of the Coulomb fluid shows regimes of monopole crystalization [426] (Fig. 16) and point towards non-Ohmic conduction via the Wien effect (see II T7R B).

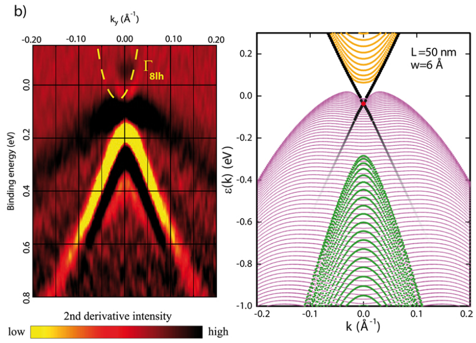

Figure 15: Dispersion relation of topological surface states of HgTe as observed in ARPES (left) and in a numerical k.P description (right). From [433].

Adding quantum fluctuations to spin ice endows its gauge-field description with intrinsic quantum dynamics, and it leads to an emergent compact quantum electrodynamics with gapped electric and mag-

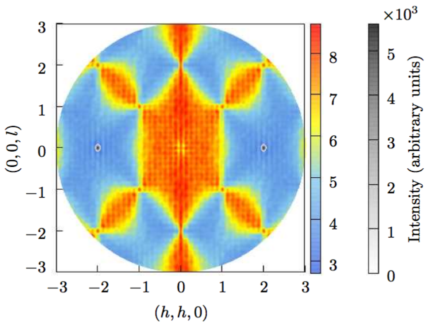

Figure 16: Simulated neutron scattering pattern from spin ice in a monopole crystal state. The moments fragment into two parts showing long range order (grey scale) and diffuse scattering characteristic of a Coulomb phase (color scale) [426].

netic monopoles and a gapless photon excitation. These features characterise a *U(1) spin liquid* phase, whose realization in realistic models and experiments remains challenging. Our recent efforts have focused on two-dimensional spin ice in a transverse field, providing quantum fluctuations, and a realistic Hamiltonian for frustrated Ising models realised *e.g.* in the context of trapped ions. A spin-wave analysis [457] has shown that the transverse field is not able to lift the exponential ground state degeneracy at the harmonic level. Anharmonic quantum fluctuations have been addressed via a novel quantum Monte Carlo scheme, which allows sampling of different topological sectors of the gauge theory, revealing a low-temperature *thermal* U(1) spin liquid phase.

B. *Quantum simulators: from cold atoms to condensed matter*

ANR ArtiQ; ENS, M. Boninsegni (U. Alberta); CNRS PEPS-PTI.

Quantum simulation, proposed in 1982 by Feynman, represents a rapidly developing subject, with potential implications for any physical domain whose models are susceptible to be implemented experimentally via synthetic quantum systems such as ultracold gases, trapped ions, superconducting circuits, etc. Our recent theoretical activities on the subject of quantum simulation have followed two main themes: 1) prediction of fundamental quantum many-body effects within realistic reach of experimental quantum simulation; 2) "calibration" of quantum simulators, in direct interaction with experiments. In particular our activity has focused on two classes of controllable quantum systems, which can be viewed as quantum simulators of fundamental quantum many-body models: (a) ultracold gases, and (b) quantum magnets.

In the case of ultracold gases, a significant part of our activity has been devoted to the study of the *equilibrium* properties of one-dimensional (1d) bosons and fermions [431]. In particular we have provided a comprehensive study of the experimental signatures of the localised Bose-glass phase for 1d bosons with on-site interactions in a random and quasi-periodic potential, addressing both its compressibility [480, 481], finite-size scaling [440] and its gapless spectral features [484] (Fig. 17). Moreover we have extended this study to the case of bosons with long-range dipolar interactions, unveiling the fate of the exotic Haldane insulator and the critical line separating it from the Mott insulator in the presence of strong disorder [441, 442]. Our investigations have also focused on the study of equilibrium properties of bosonic mixtures, reconstructing the complex phase diagram of binary hardcore-boson and fermion mixtures with mass [434, 478] and population [434, 479] imbalance, which features liquid and crystalline phases of dimer and trimer bound states, as well as finite-momentum (Fulde-Ferrell-Larkin-Ovchinnikov) pairing. For one-dimensional mixtures, a bosonization description was used to obtain the expressions of response [471, 473] and spectral functions [474]. In parallel to the study of equilibrium properties, we have also devoted our attention to strongly *out-of-equilibrium* systems, focusing in particular on *quantum quenches* (abrupt Hamiltonian changes) and their subsequent Hamiltonian evolution. In particular we have shown how a quantum quench can give rise to supersolidity [468] or to Anderson localization [460] in a strongly imbalanced Bose mixture trapped in a species-dependent optical lattice; and we have investigated crossovers between adiabatic and non-adiabatic correlations as a function of distance [419] (Fig. 17). Finally, we have used our theoretical tools to validate an actual quantum simulation of the Lieb-Liniger model in a trap via ultracold Rb-87 trapped on an atom chip [462].

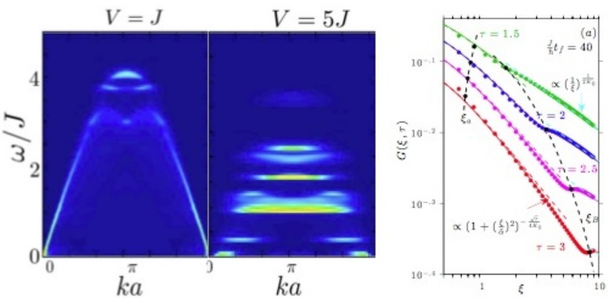

Figure 17: *Left:* Dynamic structure factor of a 1d lattice Bose gas undergoing localization due to a quasi-periodic potential. [484] *Right:*. Correlation function of 1d lattice bosons after a slow interaction quench. [419]

With respect to cold atoms, a complementary realization (or quantum simulation) of interacting degenerate Bose gases is provided by quantum magnets possessing an uniaxial symmetry, in which Bose-Einstein condensation (BEC) of magnetic quasiparticles (corresponding to spontaneous magnetic order) can be induced by an applied magnetic field. Advances in the synthesis of magnetic insulators have provided remarkable examples of magnetic BEC compounds, with quasi-1d magnetic interactions (such as $(C_5H_{12}N)_2CuBr_4$ - Hpip for brevity) or more markedly 3d ones (such as $NiCl_2{\cdot}4SC(NH_2)_2$, DTN for brevity). Our collaboration with different experimental groups has led to two main results. We have been able to establish that Hpip in a field realises a system of coupled Luttinger liquids, developing true condensation at low temperature due to the residual 3d coupling [424, 490]. We have also shown that field-induced magnetic quasiparticles in Br-doped DTN form a well-controlled realization of the long-sought Bose-glass state in 3d, and of its quantum phase transition to a BEC state [495, 497, 498] (Fig. 18).

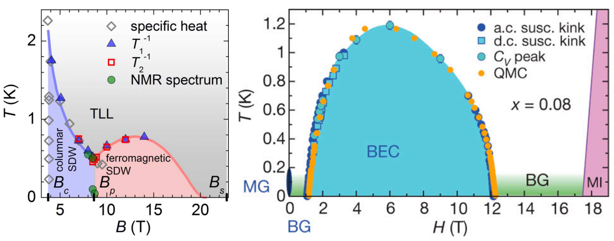

Figure 18: Phase diagram of $BaCo_2V_2O_8$ (left) and of Br-doped DTN [497] (right), comparing experimental and theoretical data.

Further work on magnetic insulators includes the study of quantum order by disorder, in which quantum fluctuations lift a classical degeneracy, giving a long-range ordered state. We have recently shown that the planar, frustrated antiferromagnet $Er_2Ti_20_7$ provides the first clear cut example of this counter-intuitive phenomenon [499], which has proved elusive for decades. We have also established that the quasi-one-dimensional antiferromagnet $BaCO_2V_2O_8$, featuring dominantly Ising intrachain interactions and frustrated interchain couplings, exhibits a field-induced Luttinger liquid behavior, in which the frustrated couplings between the Luttinger liquids are modulated by the field. The low-temperature ordered phase is an incommensurate spin density wave, with a transition induced by the field between a columnar and a ferromagnetic ordering in the transverse direction.

C. *Coherent transport*

ANR 1-shot, LPA (ENS Paris), CPT Marseille; ANR Mesoglass, NEEL Grenoble.

Coherent transport is a regime observed in samples whose size is smaller than the inelastic mean-free path. Electrons then remain coherent over the sample, giving rise to quantum deviations from classical transport theory. Our group has considered coherent transport in (1) quantum Hall edges, with the goal of realizing the equivalent of fiber quantum optics with electrons (2) quantum spin Hall and topological insulators, with the aim of characterizing remarkable properties of these novel states of matter.

Electron quantum optics : In nanophysics, there is a growing interest in the ultimate regime of quantum electronics involving single electron excitations. This regime is called electron quantum optics by analogy with its optical counterpart. Its accessibility arises from the recent availability of single electron sources in ballistic conductors acting as wave guides for electrons. However, electron quantum optics goes beyond the mere reproduction of optical setups using electron beams. Electrons differ from photons firstly because of their fermionic statistics which, in metals, implies the presence of the Fermi sea. Secondly, as charged particles they experience strong Coulomb interactions. Single electron manipulations in quantum

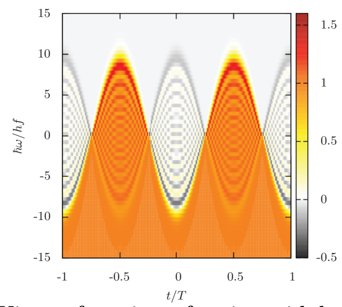

Figure 19: Wigner function of a sinusoidal electrical current at zero temperature. Image selected by Phys. Rev. B editors [448].

conductors have been the subject of intensive research in the recent years and important milestones such as the demonstration of Hanbury-Brown and Twiss [423] as well as Hong-Hu-Mandel experiment [420] have been achieved. Our group has played a key role in these developments by constructing the theoretical framework for electron quantum optics, thereby transposing basic quantum optics concepts and tools to electronics [453, 454]. This work is the result of a very fruitful collaboration with several leading experimental groups [436, 443, 452], leading in particular to the observation of spin/charge separation in quantum Hall edge channels at filling fraction 2 [421]. Our work provides a simple and unified framework for all the recent single and two particle interferences effects demonstrated in quantum nano-electronics over the last decade [422]. Supplemented by non perturbative computations of electronic decoherence [435], it opens the way to a quantum-signal-processing approach to electronic coherence [448] (Fig. 19).

Topological insulators : In Quantum Spin Hall systems, there are two counterpropagating edge states carrying opposite spins that are mapped to each other by time reversal symmetry. Those edges are protected by a topological invariant, and cannot be backscattered into each other by phonons or non-magnetic impurities. Our group has analyzed the

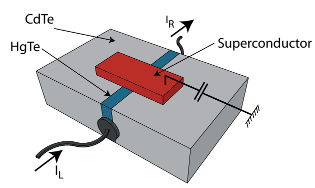

Figure 20: The setup of the superconducting barrier on a Quantum spin Hall edge realized in an HgTe/CdTe quantum well.

effect of a superconducting barrier, as the one represented on Fig. 20 on such edge states [411]. The absence of backscattering has remarkable effects: normal reflection and crossed Andreev reflection are completely suppressed leaving only transmission and normal Andreev reflection. In particular, in a sufficiently long superconductor, a perfect Andreev reflection takes place at each interface giving a total $G = 4e^2/h$ conductance without current noise. In shorter samples, Fabry-Perot resonances of the Bogoliubov quasiparticles inside the superconducting barrier are expected to give rise to perfect transmission of electrons at special energies.

Coherent Transport in Spin Glasses : Spin Glasses are amorphous magnetic phases. In a collaborative effort with an experimental group from Grenoble, we proposed to probe their physics through coherent transport of electrons at the micron scale. Among the initial results, we can mention a unique and original measure of the distribution of internal fields in a spin glass phase from monitoring the amplitude of conductance fluctuations. The evolution of the electronic dephasing rate as a function of a magnetic field allows to deduce the distribution of effective fields active on the various magnetic moments in the sample [427]. This technique should provide direct access to overlaps between spin configurations.

D. *Quantum fluids*

ANR Shrek, CEA et NEEL (Grenoble), CEA Saclay.

Our investigations on quantum fluids have mainly focused on two aspects: quantum (or superfluid) turbulence (QT), and quantum plasmas/ interacting Bose gases.

As far as turbulence is concerned, two different and complementary approaches have been carried out. i) Firstly, QT is studied within the framework of a two-fluid model that obeys coupled Navier-Stokes and Euler dynamics for a (thermally excited) normal fluid and a (ground state) superfluid respectively. The coupling originates from the interaction of the superfluid quantised vortices with the normal (viscous) fluid. Based on numerical simulations, it is argued that the energetics of QT shows similarity with classical turbulence at large scales (as usually admitted) but that some discrepancies are observable at small scales of motion where dissipation by mutual coupling prevails [477, 486, 487]). The influence of boundary conditions on the onset of turbulence is also investigated through Lattice Boltzmann simulation of the two-fluid model. ii) The second approach focuses on the microscopic structure of Helium, taking into account the roton minimum as measured in the dispersion law of the excitations [492] (Fig. 21). We have shown that the depth and position of the roton gap governs completely the density close to the singularity. Furthermore, in this zero temperature limit, we make use, theoretically and numerically, of the non local Gross-Pitaeviskii equations to understand the internal structure of the vortices. Let us also mention a parallel experimental investigation [485] taking place in Grenoble in which we are involved.

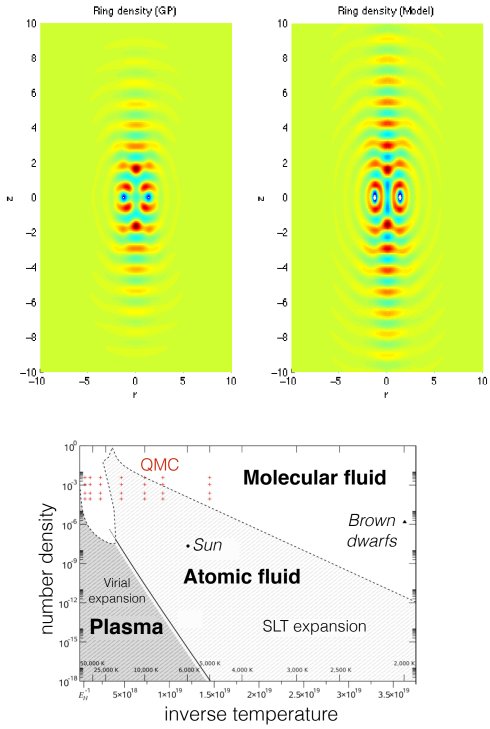

Figure 21: *Upper panel:* Superfluid density of a vortex ring in cylindrical coordinates. Left: Gross-Pitaeviskii simulation. Right: our model based on the roton gap [492]. *Lower panel:* Phase diagram of quantum plasmas, showing the validity domains of our Scaled Low Temperature (SLT) expansion (hatched region) and of the virial expansion (shaded region) [416]. Quantum Monte Carlo (QMC) results, as well as state points of Sun photosphere and of Brown dwarfs atmospheres, are also shown.

A proper treatment of recombination in quantum plasmas at equilibrium has been a long standing problem for many years. The combination of diagrammatic methods with path integrals allowed us to build a screened cluster representation [413] which is well suited for handling both recombination and screening. In particular, this formalism provides the equation of state of the hydrogen plasma in the partially ionised atomic regime, with a very good accuracy as shown through comparisons with quantum Monte Carlo calculations [416]. The effects of interactions on the condensation of a Bose gas is another central question which, despite numerous works and experiments, remains still debated. In particular, the persistence of off-diagonal long range order in the one-body density matrix, has been proven rigorously only within the familiar Kac limit which amounts to consider both infinitely weak and infinitely long-ranged two-body interactions. Using the hierarchy equations for the imaginary-time evolved Green functions, we have recovered the result that the mean-field approach becomes exact in that limit, and we have shown that the contributions of fluctuations invalidate the familiar Hartree-Fock approximation for large but finite interaction ranges [417].

T6R. Infophysics, Signal and Systems

Permanent Members: P. Abry, A. Arneodo, B. Audit, É. Bertin, P. Borgnat, L. Chevillard, P. Flandrin, N. Garnier, P. Jensen, J.F. Pinton, N. Pustelnik, S. Roux

Post-docs: V. Chudacek, G. Dewaele, J. Hamonier, H. Hegalson, G. Lozenguez, A.Moghtaderi, R. Pereira, J. Schmitt, J. Spilka

PhD students: F. Angeletti, R. Boulos, A. Costard, J. Frecon, S. Grauwin, R. Hamon, N. Mallick, G. Michau, N. Tremblay

Data analysis and signal processing play central roles in physics, as well as in many other fields beyond physics. From its early days, the Physics Laboratory has chosen to devote a specific activity deeply connecting Physics to Signal Processing and, more broadly, Information Sciences. This "infophysics" research effort gathers thus a twofold objective: On the one hand, methodological contributions are conducted per se, with applications relevant to many different domains, including physics; On the other hand, problems, as well as methods and approaches, stemming from physics, are nurturing and suggesting new methodological signal processing developments. In addition, extracting information contained in experimental data from various systems such as biological or medical applications, social and complex systems, computer networks, calls for advanced methods in signal and image processing and/or physics. These back and forth interplays between signal and physics constitute the leading theme of the "infophysics" activity within the laboratory, covering topics ranging from multifractal analysis, multifractal vector fields (cf. II T6R A), nonstationary approaches (cf. II T6R B), multiscale studies of genomic data, heart rate variability analysis, fMRI data of the brain (cf. II T6R E), social or transportation data (cf. II T6R F), Internet traffic analysis (cf. II T6R G), with thus a strong multidisciplinary flavors, from (statistical) signal and image processing to physics, mathematics or computer science. The success of this research line is made visible through the obtention of several funding competitive at the national level, as well as by publications in international top ranked journals both in signal processing, mathematics or physics and in leading journals in application fields. The "infophysics" theme also sustains numerous local, national and international well-established collaborations either with other signal processing teams, or with partners of other fields and world-reknowned experts in applications, thus making the results described below part of the fore-front international research effort on those subjects.

A. *Scale invariance for multivariate signals and fields: theory and applications*

Multivariate scaling signals. (V. Pipiras, UNC, USA) Theoretical definitions and practical synthesis of multivariate non Gaussian processes whose marginal distributions and covariance function are a priori and jointly prescribed has been achieved both via non linear pointwise transformations f of a suitable Gaussian process, whose covariance function depends both on the targeted covariance and on the Hermite polynomial expansion of f [606, 607, 657], and via optimal transport, a technique borrowed from image processing, that displaces alternatively and iteratively the time and frequency contents of a well chosen Gaussian seed [543]. This has notably been used to obtain long range dependent non Gaussian processes, with same covariance and marginals with yet different joint distributions. It has also been extended to multivariate fields [608]. Multifractal Random Walk, a close relative, yet with additional multifractal properties, has also been thoroughly studied theoretically, aiming at defining the range of parameters within which the process is well defined [509].

Multifractal and anisotropic image textures. (ANR AMATIS, S. Jaffard, Paris Est, H. Wendt, IRIT Toulouse, B. Vedel, Bretagne Sud, M. Clausel, UJF, Grenoble). Multifractal Analysis, based on wavelet Leaders, has been extended to isotropic fields. This required notably careful analyses and understanding of the role of Hölder global regularity and of the use of fractional integration [512, 612, 658, 675, 676, 678]. The interplay between self-similarity and anisotropy in image textures has been carefully studied, yielding an accurate estimate of the selfsimilar parameter despite anisotropy. This disentangling of selfsimilarity from anisotropy has been made possible by the use of the 2D Hyperbolic Wavelet Transform, that permits anisotropic dilations [501, 648, 652].

Multifractal vector fields. (ANR CHAMU, V. Vargas, ENS Paris, C. Garban, ENS Lyon, R. Rhodes, Paris 7) Motivated by the analysis the physical mechanisms for 3D fluid turbulence, modeled by Euler or Navier-Stokes equations (energy cascade and vorticity stretching,...), random vector fields that combines scaling (multifractal) properties and geometrical constraints have been defined and studied [20]. Their exact statistical characterization is challenging as it amounts to generalizing multiplicative chaos. A first step has been achieved in [559], that showed that such random vector fields defined from exponential of long range dependent processes are well defined mathematical objects, whose covariance and higher order moments are analytically tractable.

Further advances in multifractal analysis. (ANR AMATIS, S. Jaffard, Paris Est, H. Wendt, IRIT Toulouse). Have also been studied: The estimation of the Long Memory parameter for non Gaussian processes [511], the multifractal properties of non Gaussian self similar processes [673], and the relevance of a bayesian framework for estimation of the multifractality parameter [672, 677]. The segmentation of image textures into pieces with homogeneous local regularity (as measured from wavelet leaders) has been investigated; it relies on the use of proximal methods for functional minimization [642, 783].

Fractal analysis in Applications.

Ionosphere. (CNRS PICS, P. Sauli, Atmospheric Phys. Dept., Prague) The Ionosphere electron concentration fluctuations measured across several mid-latitude European stations have been shown to have correlation both in seasonal trends and within scaling behaviors, at short time scales, and they were related to the Geomagnetic activity [70, 651].

Astrophysics. The 2D Wavelet Transform Modulus Maxima Method has been used to detect and extract coronal loops in ultraviolet images of the solar corona [627] and to disentangle in solar magnetogram data the multifractal properties in active regions from the surrounding monofractal quiet-Sun field [620].

Art Investigations. (MoMA, NYC, Van Gogh Museum, Amsterdam) Scaling analysis in image textures was used for art work investigations, tending to show that copies, replica and forgeries show lesser irregularities (at very fine scales, below the millimeter) than originals [504, 506, 510]. The extend to which this betrays creation processes will be investigated.

B. *Non-stationarity*

Data-driven decompositions. Besides pointwise practical issues (e.g., sampling [646]), the data-driven technique of Empirical Mode Decomposition (EMD) has been investigated in four different directions:

1) Model-free disentanglement of nonstationary signals into a trend and a fluctuation [630, 632, 633].

2) Gap-filling in data with missing samples [631].

3) Limitation of "mode mixing" effects in a noise-assisted way, thanks to an improvement upon conventional Ensemble EMD that presents the two-fold advantage of increasing coherence of the averaging while guaranteeing a perfect reconstruction [569, 659, 663].

4) Reformulation in analogy with the "texture-geometry" decomposition problem in image analysis, taking advantage of recent advances in optimization and proximal methods [560, 639]: a new framework has been proposed, that gets rid of the loosely controlled "sifting" process that is involved in classical EMD, and replaces it by an optimization problem with constraints reflecting what EMD modes are supposed to be [640, 643]. This proved effective for signals and led to natural extensions to images [660].

Time-frequency methods. Fundamentals in time-frequency have been followed in two directions:

1) Construction of sparse energy distributions from a "compressed sensing" approach [586].

2) Exploitation of phase information in Short-Time Fourier Transforms, with new phase-magnitude relationships [531], an improved reassignment scheme [532] and new results on (reassigned) spectrogram geometry [583, 587]. This has also been explored within the framework of "synchrosqueezing" [679], with comparisons to both EMD and reassignment [533].

Characterizing and analysing nonstationarities. Apart from pointwise contributions to an alternative definition of instantaneous frequency [578, 579], multitapering in cepstral analysis [653], and an entropy-based method for counting components [656], most efforts have been devoted (within ANR StaRAC) to revisiting the concept of stationarity from an operational perspective:

1) It has first been argued that stationarity should only been considered in a relative sense, including an observation scale in the definition as well as in the analysis [585, 589, 636].

2) It has been shown that any signal, stationary or not, can be transformed in a "surrogate" stationary signal via a proper randomization of its phase spectrum [543, 547, 548].

3) A general methodology has been settled for testing stationarity on the basis of such surrogates used as elements of reference for the null hypothesis of stationarity [549, 572, 573, 645]. In the specific case of a non homogeneous process, an alternative stationarity test has been proposed by searching for an optimal partition thanks to a network flow algorithm [605].

4) Surrogates have been given a "machine learning" interpretation, leading to testing procedures as well as characterizations of different types of nonstationarities [514, 515, 552, 638].

C. *Graph signals and complex networks*

Signal on graphs and networks.

For sensor networks, cycles (e.g., daily, yearly) and trends are important. Using nonstationary tools, we show how to compute cycles, residuals and correlations for Live E! data (environmental sensors in Japan) [539, 540]. We have used also EMD to detect anomalies in sensor network of energy consumption in building, [592, 593].

Not restricted to signals on networks, we study complex networks. Using modularity, [597] studies communities in networks with correlated data. Revisiting multi-scale modularity with spectral graph wavelets a multi-scale community detection method detects relevant network structures in communities and their scales [666–668], as displayed on Fig. 22. This method is a wavelet-based clustering and we have shown how to use it on large networks with wavelet transform of random vectors as features [665].

Complex network dynamics. To study dynamical properties of networks, we have proposed new descriptors and a model for the dynamics of mobility networks [550], before adopting a signal processing approach. Leveraging on the transform of graphs in signals, we propose "time-frequency"-like analyses of dynamic networks [600, 601, 603]. This has been applied to the network of bike sharing system

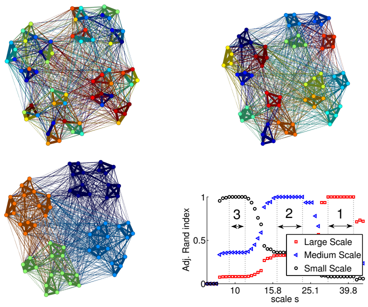

Figure 22: The 3 stable partitions obtained by multiscale community detection using wavelets on a Sales-Pardo graph (nodes in the same community share the same color). An index of recovery of each partition is also displayed, as function of the scale.

(cf. II T6R F). Relying on nonnegative matrix factorization, features of temporal networks are exhibited along with the periods they are active, opening a new approach to the study of dynamical networks [602].

D. *Statistical physics and signal processing*

A PhD thesis explored how interactions between tools and concepts of Statistical Physics and Signal Processing can help to analyze and understand situations and models (inspired from Statistical Physics) where usual convergence theorems fail. Studies of independent random variables raised to a power depending on the sample size were shown to yield non standard limit distributions for the maximum [520, 541]. For sums, it provided a link between linearization effect in moment estimation and glass transition in statistical physics [518, 521, 524]. In addition, it formalized the existence of an intrinsic critical moment order for a multifractal process [524], thus comforting earlier results [534]. A critical moment estimator has been defined and studied for a class of independent (yet with intricate marginal distribution) random variables [518]. A class of random variables with intricate correlation has been studied, whose joint distributions is written as a product of matrices and which can have long range correlations. This model can also be recast into the framework of Hidden Markov Chain models, leading to theoretical design and actual synthesis [519, 522]. The limit behavior of the sum of such random variables has been characterized, both using rescaled limit distributions [523] and large deviations [517].

E. *Biological, genomic and biomedical signal and image processing*

Multiscale and multivariate methodologies for genomic data analysis (ANR REFOPOL, O. Hyrien, ENS Paris, C. Thermes, CGM, Gif/Yvette, A. Goldar, CEA/Saclay) Multiscale and multivariate concepts and methodologies are necessary to account for the complexity of genome organization accommodating the tradeoff between DNA compaction and gene accessibility (as reviewed in [186, 526]). We developed multiscale wavelet-based algorithms providing us with original clues about the mammalian DNA replication program [186, 192, 203, 217, 526, 528–530, 535]. These signal-processing tools have now been accepted as *bona fide* molecular biology protocols [529]. Using a wavelet-based multiscale pattern recognition framework, we described megabase sized replication domain covering about 1/3 of the human genome as N-shaped regions in DNA strand compositional asymmetry (skew) profiles [186, 526, 535]. Determination of genome-wide replication timing profiles [204] provided us with the experimental confirmation of that skew N-domain border are active replication origins [203, 528]. Further multiscale analysis of replication timing profiles lead us (i) to describe replication U-domains that display a characteristic U-shaped replication timing profile as the counter part to skew N-domains [192, 529] and (ii) to compute space-scale maps of effective DNA replication speed [217]. These latter measurements are central to our modeling of DNA replication kinetic in mammalian genome (cf. T3R) [223]. Using PCA, the apparent complexity of a dataset of 13 epigenetic marks was reduced to 4 epigenetic states [231, 232]. Each states correspond to a well defined replication timing window so that the progression of the replication along U-domains corresponds to a directional path across the four chromatin states. These results sheds a new light on the epigenetic regulation of the spatio-temporal replication program in human and provides a framework for further studies in different cell types, in both health and disease. Finally, in a preliminary work using a graph representation of high throughput chromatin conformation capture data, we showed that replication domain borders are hubs of the chromatin conformation interaction network [554, 555].

Microscopy image analysis (PEPS PROMIS, L. Condat, GIPSA-lab, J. Boulanger, Institut Curie) Structured illumination microscopy increases fluorescence microscopy resolution without constraint on protein marking. This modality is based on the acquisition on several low resolution modulated images followed by a post-processing that aims at reconstructing the high resolution image. The first contribution concerns the estimation of the modulation parameters from the low resolution modulated images [570] while the second contribution aims at providing an efficient reconstruction procedure based on non-smooth convex optimization [641]. Such a framework allows us to deal with a variational approach where the data fidelity term and the regularization term are fitted to the degradation model (Poisson noise) and to the data (filaments that models actin and microtubules, spots such as single molecules or vesicles) [553].

Biomedical signal processing

Heart Rate Variability (ANR FETUSES, M. Doret, HCLyon, P. Goncalves, LIP ENS Lyon.) Heart rate variability analysis is revisited using fractal variability, with the aim of assisting obstetricians to perform early detection of fetal acidosis during labor. Fractal attributes have been shown to well characterize intrapartum fetal heart rate and to permit to decrease

False Positive detection rate, hence the number of non necessary operative deliveries (whose consequences are potentially dramatic of the mother and the newborn) [500, 503, 505, 507, 564, 565, 576, 604]. Dynamics in adult baroreflex regulation have also been investigated [516, 577], with notably a methodology for defining a time-frequency coherence function [634].

NeuroSciences (ANR SCHUBERT, P. Ciuciu, N. Zilber, V. Van Hassenove, NeuroSpin, CEA Saclay) Scaling in infraslow brain activity, considered before as noise, is now regarded as crucial. Wavelet Leader based multifractal analysis showed that scaling properties in fMRI data are modulated when subjects achieve tasks [567, 568] and that scaling is affected by multi-sensory perceptual learning [680, 681].

F. *Analyses of social and human activities*

The avalanche of digital data tracing social activities opens the way to combine data analysis and modeling with social science studies.

Human face-to-face interaction network. Using active RFID tag and a dedicated experimental apparatus, data of time-resolved person-to-person interaction networks were collected at conferences, schools, hospital wards to analyze their dynamics [558, 611]. Behavioral characteristics were studied, for instance in a school to quantify interaction between children [662]. To understand how the dynamics of contact networks affect infectious disease propagation, SEIR infection models were run on these networks, showing that the daily durations has to be accounted for [661]. The effect of time ordering of contacts on propagations was studied [536]. Hospital-acquired infections were studied by direct measurement in hospital wards [670]. Finally, having only one realization of these networks, we developed a bootstrapping method using constrained graphs to probe with statistical confidence the behavior of a group in such a network [664, 669].

Social systems and human behaviour

Developing new sociological concepts. (Médialab, Sciences Po, Paris) A naive approach of social systems by physicists would be to start with interacting “social atoms” to probe collective phenomena, “emerging” from the microscopic level. However, for social systems, isolated (“atomic”) individuals do not exist. Therefore we argue in [623] that it is more interesting to use “collecting” entities instead of individual and collective levels, and develop this idea through the use of heterogeneous networks.

Scientometrics. This approach is tested on scientometric data (scientific articles). Mapping of scientific institutions was developed [599], for instance for ENSL and CNRS. The interdisciplinary practices of 600 laboratories were studied through their publications [616]. Scientometrics is also useful to study scientific fields, for instance the “complex systems” domain [598], showing that it does not arise from a single universal theory, but from shared computational methods and concepts on self-organization. A study carried out on 7000 CNRS scientists regarding their public engagement activities, was propagated with a Special Issue in *Public Understanding of Science* [537].

Model for conference submission behavior. An empirical study of several datasets has revealed some ‘universal’ features in the temporal process of electronic submissions to conferences, leading to the proposition of a simple predictive model [580–582].

Collective Free Improvisation offers a situation of human interactions without any *a priori* reference frame. For musical production process, a model and studio experiments were done to gain a better understanding of emerging collective structures [556, 557].

Study of Vélo'v data and transportation. (LIRIS (INSA), LET (Lyon 2), CMW et EVS (ENS Lyon)). From 2008 on, we had access to data about uses of Lyon's Vélo'v system of shared bicycles, the first large scale bike sharing system (BSS) of Europe, and studied the mobility with BSS. In [542, 545], we studied the rhythms of use and statistical model for that. This was combined with spatial analysis of the trips to draw pictures of their use in the city [544, 551]. The data show that bicycles compete with the car in terms of speed in downtown Lyon [619]. The work goes on in a ANR project VEL'INNOV. Other works model part of the use of the system [629], or discuss the need for mapping tools to display the data [647]. Relying on network theory, we exhibited the different rhythms of the stations [635]. Finally, in a paper on spatial networks (such as transportation networks), it was shown that a spatial hierarchy can emerge in network as a large-scale consequence of local cost-benefit considerations [626].

G. *Internet traffic and network*

(K. Fukuda, K. Cho, H. Esaki, R. Fontugne from the NII, IJJ and Univ. Tokyo (Japan), CNRS-JSPS program) Signal processing is a great asset to study the communications over the Internet network (e.g., see the coordinated Special Issue [624]). Accurate host-level traffic classification is made possible by relying on statistical features describing traffic of a host, e.g. from the Multi-Scale Gamma Model [609], or from traffic patterns reminiscent of traffic graphlets [575, 610]. Leveraging on previous works, using sketches and multi-resolution analysis, we prove that long memory is a robust property in traffic, as shown on seven years of collected traffic [546]. We re-investigated the relationship between long memory (modeled as self-similarity) and heavy-tailness of flows, theoretically (Taqqu's theorem) [508], also questioning the respective roles of the flow and session levels [644], and experimentally on a grid [625], proving that long memory is a stable feature of Internet traffic (vulgarisation article in [502]). Finally, lacking methods to characterize and benchmark anomaly detectors, we used graph analyses to compare them, and we validated that by annotating the anomalies in the MAWI traffic database [590, 591].

T7R. Statistical Physics

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By vocation and design our laboratory covers a vast range of research topics. Statistical mechanics has traditionally been the cornerstone of this diversity, providing connecting links across the board, from mathematical and high energy physics, to hard and soft condensed matter, to applications in biology, geology, astrophysics, turbulence and complex systems applied to the macroscopic world. The present five year report is no exception, as we present a large array of research themes where strong fluctuations, confinement, disorder and absence of controlled equilibrium were key elements, providing exciting challenges for those seeking a statistical description. The laboratory made important theoretical contributions to the theory of active particles in these five years. A new theme is that of their experimental study, developed for the first time through a new protocol to motorize colloidal beads. This experimental simulator of active dynamics is providing an important link between numerical and theoretical work and biological systems driven by collective dynamics. Conversely, long-range interactions continue to be an active and innovative field of study in which the laboratory has played a leading role, as witnessed by the extensive reviews and text book produced during the report period. Applications from both the macroscopic and microscopic world include gravitating systems, hydrodynamic flow and Coulombic systems driven out of equilibrium by an applied field. Statistical approaches to disordered systems and non-equilibrium phenomena appear in projects from condensed matter to avalanche dynamics and the overlap in techniques used here and in statistical descriptions of turbulence is striking. In the search for effective thermodynamic descriptions of model driven systems progress was made in understanding how effective temperatures can depend on observables. The scope of effective thermodynamics is pushed still further in this report, with the development of analogies for free energy and intensive control parameters such as chemical potential in the study of social networks. Pinning centers are shown to play a key role in the non-linear physics of disordered systems, leading to multi fractal statistics in flux lattices, and intermittent dynamics for domain walls and interfaces strongly reminiscent of those observed in turbulent flow. Fluctuation theorems have underlaid much recent progress in stochastic thermodynamics, providing a vital link between equilibrium and non-equilibrium problems. Below we report spectacular results from both theoretical and experimental studies. In particular it was shown that a particle evolving out of equilibrium with Lagrangian dynamics appears to obey detailed balance when viewed from its Lagrangian reference frame, while in a ground breaking experiment, Landauer's bound on available work extracted from a two level system was confirmed using colloidal particles in a double well potential. This experiment, considered one of the ten most important results of 2012 by Physics World was extended to show the connection between the Landauer bound and Jarzynski's equality. The proposed projects maintain this wide range of themes. Projects include developments of existing research as well as new ventures such as "confinement and fluctuations" and "modeling social systems", or "large deviations and computation of rare events for turbulent flows related to climate dynamics and solar system dynamics", providing a bright future for this eclectic domain of research.

A. *Active particles*

Physicists have been looking for a unified framework to account for collective motion as observed in a number of animal groups for almost 20 years. We made significant contributions to this vivid field. From a theoretical perspective, flocking can be considered as a nonequilibrium phase transition in an assembly of self-propelled, or active, particles. We introduced an effective kinetic-theory framework to model assemblies of motile individuals and account for their large-scale behavior [693]. Starting from a prototypical microscopic model of pointwise motile particles interacting via binary collisions that promote either polar or nematic alignment, we established continuous equations for the density and the orientational order fields [691, 693, 760]. Motivated by recent observations on birds flocks, the case of interactions between topological neighbors defined by a Voronoi tesselation has also been successfully considered [762]. In agreement with numerical simulations of agent-based model, these non-linear equations correctly capture all the salient features of polar and nematic active matter. Among other results we analytically demonstrated that ensembles of self-propelled particle that align with their (metric) neighbors support non-linear excitations in the form of band-like swarms responsible for the first order nature of the transition toward collective motion [111].

From an experimental perspective, we took advantage of an overlooked electrohydrodynamic instability to motorize colloidal beads, which we turned into self-propelled rollers [111]. This unique system makes it possible to handle and visualize pop-

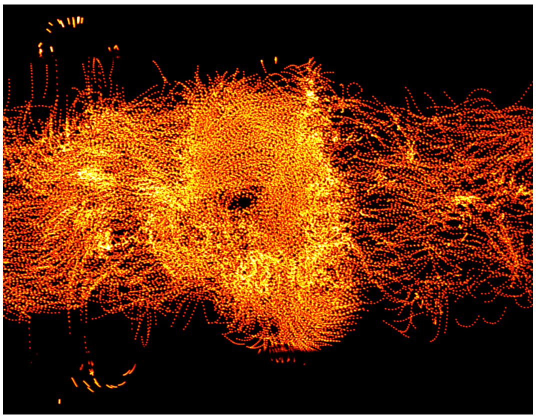

Figure 23: Collision between two herds of colloidal rollers propelling along opposite directions in a microfludic channel. Superimposed pictures. Colloid diameter: 5 μm. Duration of the collision 0.1 s.

ulations of millions of colloids on a single microfluidic chip (Fig. 23). Combining experiments and theory we demonstrated that the short-range hydrodynamic couplings between the rollers result in effective velocity-alignment interactions, and revealed the first homogeneous polar-liquid phase of synthetic active matter (ANR Mitra, collaboration Gulliver ESPCI).

B. Systems with long range interactions

(ANR LORIS (S. Ruffo), IUF, EPSRCF with Max Planck and UCL London). For systems with long-range interactions, the two-body potential decays at large distances as $V(r) \sim 1/r^{\alpha}$, with $\alpha \leq d$, where d is the space dimension. Examples are: gravitational systems, two-dimensional hydrodynamics, two-dimensional elasticity, charged and dipolar systems. Although such systems can be made extensive, they are intrinsically non additive: the sum of the energies of macroscopic subsystems is not equal to the energy of the whole system. Moreover, the space of accessible macroscopic thermodynamic parameters might be non convex. The violation of these two basic properties of the thermodynamics of short-range systems is at the origin of ensemble inequivalence.

We have presented a comprehensive review [708], and more recently a book, on the recent advances on the statistical mechanics and out-of-equilibrium dynamics of solvable systems with long-range interactions. It consists in the detailed presentation of the concept of ensemble inequivalence, as exemplified by the exact solution, in the microcanonical and canonical ensembles, of mean-field type models.

Gravitational interactions were studied for hard spheres within a stationary state described by the microcanonical ensemble. Introducing a new scaling limit, we showed that the system locally thermalize spontaneously as a consequence of both extensive properties and smallness of fluctuations. The derivation sheds light on the mechanisms which ensure that local equilibrium in infinite systems is entirely controlled by hard-core interactions, while gravitational interactions can be treated at the mean-field level.

Generalizations to models [720] with both short and long-range interactions, and to models with weakly decaying interactions [684], show the robustness of the effects obtained for mean-field models. We have also studied [753] needle-shaped three-dimensional classical spin systems with purely dipolar interactions in the microcanonical ensemble. We have observed and analytically explained spontaneous magnetization for different finite cubic lattices and first order transition from paramagnetic to ferromagnetic phases. Long-range interacting systems display an extremely slow relaxation towards thermodynamic equilibrium and, what is more striking, the convergence towards quasi-stationary states. The study of the effect of noise on this kind of systems is very important but is only at its infancy. We have studied long-range interacting systems driven by external stochastic forces [756] that act collectively on all the particles constituting the system, showing that it reaches a stationary state where external forces balance dissipation on average. These states have an invariant probability that does not respect detailed balance, and are characterized by non-vanishing currents of conserved quantities.

In weak electrolytes in moderate to high electric fields, deviations from Ohm's law can be cast in a universal form using Onsager's celebrated theory of the second Wien effect. This theory has been applied to a wide variety of scenarios, including photocurrents in solar cells, proton transport in water ice, and magnetic monopoles in spin ice (see Condensed Matter Emergence and Topology). The Wien effect was recently simulated for the first time using a lattice electrolyte [742]. The simulations provide direct access to the correlations and hierarchy of time and length scales driving the phenomenon in a simple model system.

C. Model systems, disorder, and pinning

Non-equilibrium and disordered systems are on the new frontiers of statistical physics and have important applications. The laboratory is strongly involved in developments based both on models systems that can be studied in depth and on experiments carried in parallel with theoretical analysis.

Among non-equilibrium systems, stationary states are the simplest. They allow us to revise basic concepts. When temperature is defined through fluctuation-dissipation theorems it may depend on the observable. We have related this to the non-uniformity of the phase space distribution [752].

We analyzed dissipation-induced non-Gaussian energy fluctuations and were able to equate the non-Gaussian order parameter fluctuations in model equilibrium systems at criticality with energy fluctuations in dissipative systems if there is macroscopic energy transfer from large to small scales [695].

Disordered systems have numerous applications from domain walls in ferromagnets to liquid crystals. Open questions concern their equilibrium structure, their aging and long term evolution. A key observable in diffraction experiments is the translational correlation function which was so far known only within a Gaussian approximation. To go beyond this, we developed a new method based on functional determinants and functional renormalization group [724]. We discovered multifractal structures in the Bragg glass made by the Abrikosov lattice in disordered superconductors and studied the surface scaling behavior [447]. The method allowed us to compute some class of diagrams which appear in the perturbative determination of Konishi amplitudes and thus brings together three different physical communities working on superconductors, multifractality and AdS/CFT.

Time dependence was studied for trapped electrons in resistive switching phenomenon in MgO-based tunnel junctions. Including the statistical distribution of the trap potential barrier heights leads to a power-law resistance as a function of time, under a constant bias voltage, in accordance with experiments [694].

When submitted to slow external driving, out-of-equilibrium heterogeneous systems respond by a complex intermittent dynamics, in the form of collective excitations or avalanches with scaling properties analogous to the ones observed close to critical phase transition. This occurs for a large variety of systems and length scales, from a few nanometers during the jerky motion of domain walls in magnetic systems, up to the geological scale during the fault dynamics for earthquakes. We studied the spatiotemporal dynamics of interfaces driven through random media, focusing our attention on the slow crack front propagation along a weak heterogeneous interface and on the imbibition dynamics of a fluid front slowly invading a laboratory model of an open fracture of variable aperture (Fig. 24). In both cases, with our high-resolution experiments, we characterized both the self-affine morphology [767] and the intermittent dynamics of these interfaces [763, 769]. We demonstrated that their propagation results from localized bursts that fulfill scaling relations expected close to critical depinning transition [745]. We have shown that the fluctuations of the global front velocity $V_l(t)$ spatially averaged at scale l follow asymmetric non-Gaussian distributions, either due to finite-size effects and long range spatial correlations [763], or to the diverging variance of the underlying local front velocity distribution [769]. We have also exhibited a broken time-reversal symmetry in the avalanche dynamics, which emerges from the local nature of the interaction kernel mediating the avalanche dynamics [744].

At the mesoscale friction occurs through the breaking and formation of local contacts. We showed that this phenomenon can be described by a master equation [704]. We examined the effect of temperature and aging of the contacts by replacing individual contacts by "macro-contacts" which describe collective effects. Their aging leads to the Gutenberg-Richter law, which relates the probability of occurrence of earthquakes to their magnitude [706].

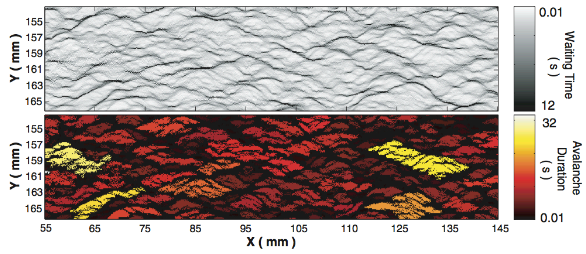

Figure 24: Top: Waiting time fluctuations of an oil/air interface slowly invading a model disordered medium (Hele-Shaw cell with a fluctuating gap spacing) obtained by the superposition of 10^4 interfaces for a forced-flow experiment performed at V = 0.134 mm/s. Bottom: corresponding spatial distribution and duration of avalanches.

A model for electrical conduction has been considered. The exact solution of the corresponding Boltzmann equation in an external accelerating field provides useful insights on out-of-equilibrium stationary states. For a strong applied external field, the stationary conduction state is far from equilibrium, so the conductivity is no longer given by linear response theory. Nevertheless, the diffusion coefficient is still related to the velocity correlations through a Kubo-like formula, while the relaxation processes are governed by hydrodynamic modes similarly to the close to thermodynamical equilibrium case [682].

D. Statistical mechanics and turbulence

(ANR Statocean, with LEGI and LPO. ANR Stosymap, with Polytechnique, Cergy and ENS-Cachan). Several researchers have independently studied aspects of two dimensional turbulence through statistical mechanics approaches. A first work related to cascades on the hyperbolic plane is described in section II T1R C. Another project concerns the connection between the statistical physics of disordered systems and turbulence. We applied a version of functional renormalization group (FRG) originally developed for disordered systems to decaying Burgers turbulence and then generalized it to study the Navier-Stokes equation [725]. We solved numerically the FRG flow equation for the decaying 2D Navier-Stokes turbulence. We found an inverse cascade with explicit results both for large and small distances in agreement with the Batchelor scaling. Finally several works were led in the framework of the equilibrium statistical mechanics of two dimensional and geophysical flows [13], as described further below.

Several studies dealt with the theoretical bases (properties of the invariant measures, generic properties of phase diagram) of the equilibrium statistical mechanics of two-dimensional and geostrophic turbulence. Monte Carlo simulations, based on the Creutz algorithm, have also been designed, allowing the prediction of a phase transitions. The equilibrium statistical mechanics has also been extended to the three dimensional axisymmetric Euler equations [770].

An emphasize has also been put on the development of large deviation theory in order to describe the dynamical properties of phase transitions in turbulent flows. A first work described large deviations in dynamical systems with a connected set of attractors, as is the case for the two-dimensional Euler equations and the quasi-geostrophic dynamics.

E. Complex systems

In a famous model in the literature of social modeling, Thomas Schelling showed that the relationship between agents' individual characteristics (micro level) and global states of the system (macro level) is far from trivial. Using the tools of statistical physics [732, 733], we could link analytically the two levels, extending the notion of free energy to systems driven by individual dynamics. We have then studied in which systems this extension of the free energy was possible [734]. The interest of this approach lies on the one hand on the possibility to easily describe segregation through standard methods used in the context of phase separation, and on the other hand in the connection it brings between socio-economic modeling and statistical physics tools like the free-energy. Going further in this direction, we managed to connect the socio-economic concept of utility to the thermodynamic concept of chemical potential [748]. Other directions have also been explored in the context of simple models of social systems studied through statistical physics methods, like the location of retail stores [622], opinion models [735], dynamical decision models [743] or urban housing markets [747].

F. Stochastic thermodynamics and fluctuation theorems

We have studied both experimentally and theoretically the problem of the thermodynamics of small out of equilibrium systems where fluctuations cannot be neglected. We have considered systems slowly evolving toward equilibrium and systems driven by external forces. The instrumentation to perform these experiments has been designed and mounted in our laboratory and the main features are described in T8R

Two review papers on the fluctuation theorem [714, 717] and a book chapter [746] discuss our results of the injected and dissipated power on an harmonic oscillator coupled with an heat bath. We have also studied the power fluctuations produced by an oscillating field applied to Liquid Crystals close to the Freedericksz transition [739]. This is an interesting example of a spatially extended system in which only a fluctuating macroscopic variable is measured. Recently we have established both theoretically and experimentally a new formulation for the heat flux produced by fluctuations in an electric system coupled with two thermal baths. This work has given the first experimental evidence of this kind of flux [715, 716].

In work on the Fluctuation Dissipation Theorem (FDT) it was shown [713] that non-equilibrium Langevin dynamics respects detailed balance when viewed in the Lagrangian frame of its mean local velocity rather than in the laboratory frame. This explained the relation between measurements [729] in both frames for a driven colloidal particle. In the context of a colloidal particle driven out of equilibrium we have experimentally verified other formulations of FDT in out of equilibrium [730, 731].

FDT has been also studied in relaxing gels both after mixing [738] and after a temperature quench [728]. In the last case we have shown the connection between heat flux in the systems and the violation of the equilibrium formulation of FDT. These questions have been experimentally analyzed in the context of a quench at a critical point [740] where the critical slowing down induces an extremely slow relaxation towards equilibrium, making the dynamics very similar to aging of amorphous materials.

It has been shown that the Landauer bound can be experimentally reached in an erasure procedure performed using a colloidal particle in a double well potential [697]. We have also shown the strong relationship between the Landauer's bound and the Jarzynski equality applied to this process [696].

In optimization studies following from the above, the least dissipative finite-time protocol for the memory erasure was found using the Monge-Kantorovich optimal mass transport as a special case of the finite-time refinement of the 2nd Law of Stochastic Thermodynamics established in [683] and reviewed in the wider context of fluctuation relations in not yet published lecture notes.

Some experiments have been built that allow measurements on granular gases, as examples of macroscopic dissipative thermostats. Parallels are drawn with usual statistical mechanics, by verifying some exact results out of their range of validity: in dissipative systems, where $kT_{\text{eff.}} \sim 10^{-7}$ J, and far from the thermodynamic limit.

– The FDT and the Gallavotti-Cohen Fluctuation Theorem have been shown to coincide with a harmonic oscillator coupled with this reservoir [755].

–Fluctuation relations hold for an asymmetric rotor experiment in a granular gas even if the angular velocity distribution of the rotor is double-peaked due to a symmetry breaking in the granular gas [741].

– The Hatano-Sasa relation that generalises Clausius inequality has been verified with a very high precision [754] in transitions between several states.

– The transport between two such systems at distinct $T_{\text{eff.}}$ is studied. It shows very specific intermittent and asymmetric statistics for the fluctuations. This asymmetry reveals the irreversibility of transport, and verifies the Gallavotti-Cohen relation for the first time between macroscopic dissipative systems far from the thermodynamic limit.

T8R. Instrumentation and imaging

Permanent Members: F. Argoul, L. Bellon, V. Bergeron, F. Chillà, S. Ciliberto, S. Manneville, A. Naert, A. Petrosyan, J.-F. Pinton, N. Plihon, A. Pumir, N. Pustelnik, S. Santucci, A. Steinberger, R. Volk

Our laboratory has a strong tradition in developing new instrumentations combined with specific signal or image analysis including theoretical developments. This activity covers many fields in physics, from atomic force microscopy to acoustical or optical imaging in complex flows. Several results described in the other sections have been obtained because of the good performance of the instruments designed in the laboratory. It is important to stress that these technical developments are only possible thanks to the excellent competence of the staff working in the mechanical shop of the ENSL and in the electronic shop of the laboratory. In this section we describe several instruments and imaging techniques, which have been either developed or improved in the last five years and which have played an important role for getting new scientific results. Note that several technological developments have led to patents and industrial contracts.

A. *Imaging*

Ultrasonic imaging coupled to rheometry (ERC USOFT): We developed an ultrafast ultrasonic scanner to image the deformation and flow of complex fluids sheared within concentric cylinder geometries of gap widths 1 to 5 mm. This scanner is coupled to a commercial rheometer so that the technique records simultaneously standard spatially-averaged rheological data and the local flow field with a spatial resolution of 50-100 microns and frame rates of up to 20,000 fps [776].

High resolution surface plasmon microscopy (ANR EMMA): Two Scanning Surface Plasmon Microscopes (SSPM) have been constructed, which can be operated in linear, radial and azimuthal polarizations. The first SSPM includes a fibered heterodyne interferometer [773], compacted inside a close box, coupled to an inverted microscope (fluorescence imaging) on which we have also installed an atomic force microscope head. The second SSPM operates at two wavelengths, namely 633 nm and 1500 nm, with two separate laser paths aligned on the imaging plane of a high aperture objective lens, it includes two distinct heterodyne interferometers. For both these systems we have also implemented a 3D adaptive scanning software that compensates the sample tilt and improves their sensitivity to nanoscale objects [774].

Fast imaging techniques for particle tracking in complex flows (ANR LTIF, LMFA/OCA/LEGI): We developed a technique to track simultaneously the position and orientation of painted particles in turbulent flows [789]. Recording images of particles with two independent views, and comparing images to a collection of synthetic images, this technique allows for a 6 dimensional tracking of spheres larger than 5 mm with resolution 7,000 fps at high Reynolds numbers.

Fast image acquisition for trapped particle tracking: We developed a fast image acquisition and processing program based on Labview and C++. The program allows us to follow the trapped particles x and y positions in real time at 1600 fps with a spatial resolution about of few nanometers (nm).

Creation of multiple traps with holographic techniques: We developed Labview programs to create phase patterns (holograms) on a spatial light modulator. In this multi tweezers we are using an infrared laser which is more suitable biological objects.

3D structure of liquid foam (PSI - SLS (Switzerland), LPMC, IPR): We have developed a new fully-automated method for segmenting and labelling the void space in cellular materials, and applied it successfully to reconstruct the 3D structure of liquid foams imaged by X-ray tomography [778].

Compressed sensing for tomography (TOTAL/IMS-IMB Bordeaux): Considering sparse data, the compressed sensing proposes a theoretical framework allowing to acquire less data with similar reconstruction performance. In a tomography framework it leads to the reduction of the view number. We have developed an efficient greedy algorithm that provides an upper bound of the maximal sparsity for which a given measurement matrix allows exact reconstruction through a ℓ_1-minimization [775].

B. *Instrumentation*

Atomic Force Microscopy (AFM) with ultra-high force resolution (ERC OutEFLUCOP): Our home built AFM [781] is constantly upgraded to maintain a cutting edge force resolution to probe nanomechanics and thermal fluctuations. In its current design, the spectral resolution in the measurement of the cantilever deflection is of the order of a few $\mathrm{fm}/\sqrt{\mathrm{Hz}}$ from 1 Hz to 1 MHz, a world leading result. Moreover, thanks to the quadrature phase interferometric approach, this resolution is constant on a few μm input range, giving this single instrument a 9 orders of magnitude dynamics. This AFM has been duplicated so as to operate in a variety of environments: controlled atmosphere, regulated temperature ($[15-120]$°C). Its unique characteristics have been used to demonstrate a precise calibration of AFM cantilevers through a mapping of the spatial distribution of the thermal noise on standard [782] or functionnalized [777] cantilevers. In recent developments, such a functionnalization replaces the tip by a cylindrical probe of a few μm in diameter and a hundred of μm long. This probe can be partially dipped in a fluid to perform microrheology measurements (including in opaque liquids), as well as interfacial mechanics and wetting measurements.

Holographic/dynamic multiple tweezers: We have developed and constructed a two-in-one switchable multi tweezers that combine fast scanning optical tweezers based on an acousto-optic deflector (AOD) and holographic optical tweezers. The AOD can scan the laser beam very fast. It allows to modulate or change the traps position at about 100 kHz rate. Moreover, with holographic optical tweezers, which are much slower ($\sim$ 20 Hz) to use for measurements of dynamics, we can create the controllable 3D static traps with different shapes. In order to create a given pattern on the focal plane of the focusing objective we are using a commercial SLM from Hamamatsu.

Two beam optical tweezer with large dynamic range: We developed and made a versatile modular multi tweezers based on visible laser with wavelength 532 nm. In that model we use two spatially separated orthogonally polarized beams. Having two separated beams is important for the measurements correlation. We can easily implement an AOD or a beam shaping optics. We can do the particle position tracking with a fast camera or with a position sensitive detector.

FractoLuminescence - when fractures dazzle particle detectors (SNOLAB Queen's (Canada), ILM, MATEIS): The quest for ultra-rare particle events demands the most rigorous exclusion of background noise in detectors. However, we have shown that fractures due to mechanical stresses occurring in scintillator crystals – used as particle detectors – could produce enough light to reduce their sensitivity [786]. We have built a specific device to compress scintillator crystals up to failure, and simultaneously measure light and acoustic emissions at a very high frequency (streaming at 2MHz for several hours). Using radioactive sources, we were able to accurately calibrate the energy emitted by the scintillator and quantify the fraction of elastic energy converted into light during the fracturing process.

Joint heat flux-velocity probe for turbulent flows (EuHit WP 21: Ins. Neel, IMUST Denvib: Cethil): The understanding of turbulent thermal convection currently lacks local experimental heat flux data. In particular, the turbulent contribution to the advected heat flux is unknown. It requires a joint measurement of local velocity and temperature, which is a challenge for the experimentalist. We investigate a novel kind of sensor, based on state-of-the-art silicon microtechology, to make this type of measurement possible. The new probe is a micromachined 1.2 micron-thick 375 x 50 microns cantilever. The elongation induced by the flow velocity is measured with a strain gauge patterned in a thin nickel-chrome layer sputtered on the beam. This gives access to a signed local velocity component. A thin thermometric layer is sputtered on the tip of the beam to get the local temperature at the same position.

Acceleration measurements using instrumented particles (FUI PATVAX, Sanofi/Merial/Leti/smartINST/Cyberstar): Smart particles are instrumented device whose role is to gather measurements in the Lagrangien reference frame. For an industrial partner FUI PATVAX, we developed new sensors for conductivity and reflectance measurements with low consumption. These devices can be mounted in smart particles currently used for industrial applications. We also tested acceleration measurements against position-angle tracking with cameras, and found new estimators for acceleration moments and correlations that are insensitive to the rotation of the particle [787, 788].

Velocimetry in electrically conducting fluids (ANR VKS): Usual water flow measurement techniques are usually restricted to media transparent to optical wavelengths and thus do not apply in opaque liquid metals which require very specific techniques.

- *Potential probes in highly turbulent flows (PICS ICMM):* The method relies on linking the potential difference measured between two electrodes to the local velocity field characteristics in presence of a permanent magnetic field. We developed a miniature potential probe allowing to probe fast dynamics of a spin-down flow driven inside a torus filled with liquid gallium [780], not accessible with usual methods in a water prototype.
- *Magnetohydrodynamic turbulent electromotive force:* The development of a 3-dimensional potential probe coupled with magnetic field measurements allowed for the first measurement of the turbulent electromotive force in regimes of interest for astrophysical modeling of the dynamo instability [784].
- *A new concept: the magnetic distortion probe*: We developed a new local velocity measurement method based on the interpretation of the magnetic induction from a conducting fluid flow in the presence of a localized magnetic field [779] (Fig. 25). This work led to the patent [FR10 54250] and several industrial actors showed a strong interest in the technology.

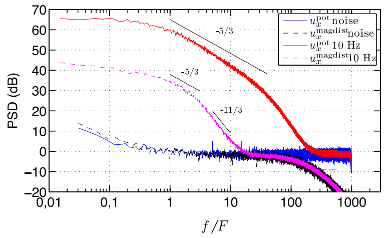

Figure 25: Turbulent spectra of velocities measured with a reference potential probe and the newly-developed magnetic distorsion probe in a liquid gallium flow.

Physics of the violin (C. Macabrey): To characterize a musical instrument of the family of the violin (viola, cello, etc.), it must be submitted to a perturbation that does not affect bridge and strings. The important point is that these last elements have a strong but irrelevant response. A system has been developed that measures the response to a broadband perturbation [patent FR12 60891]. The response function is very sensitive with a high signal to noise ratio. This might become very helpful for the stringed-instrument maker, in repair as well as construction. It can also be used to artificially play the instrument, and improve its quality this way.

III. SCIENTIFIC PRODUCTION

A. Books

A Concise Introduction to the Statistical Physics of Complex Systems, E. Bertin, Springer (2011).

Physics of Long-Range Interacting Systems, A. Campa, T. Dauxois, D. Fanelli, S. Ruffo, Oxford University Press (2014).

B. Edited Books

Scaling, Fractal and Wavelets, P. Abry, P. Gonçalvès, J. Lévy Vehel (Eds), Wiley (2009).

Peyresq Lectures on Nonlinear Phenomena, vol 3, B. Audoly, F. Bouchet, J.A. Sepulchre (Eds), World Scientific (2012).

Long-Range Interacting Systems, T. Dauxois, S. Ruffo, L. Cugliandolo (Eds), Oxford University Press (2009).

C. Chapters of books

A Dynamical Network View of Lyon's Velo'v Shared Bicycle System P. Borgnat, C. Robardet, P. Abry, P. Flandrin, J.-B. Rouquier, N. Tremblay, in "Dynamics on and of Complex Networks, Volume 2", N.Ganguly, A. Mukherjee, B. Mitra, F. Peruani, M. Choudhury (Eds), Springer (2013).

Heart rate variability analyses E. Pereira de Souza Neto, P. Abry, J. Frutoso, P. Flandrin, C. Gharib in "Monitorage des Paramètres Physiologiques en Situation Critique", J. J. Lehot, M. Cannesson (Eds), Arnette (2012).

Applications of Equilibrium Statistical Mechanics to Atmospheres and Oceans F. Bouchet, A. Venaille in "Peyresq Lectures on Nonlinear Phenomena, vol 3", B. Audoly, F. Bouchet, J.A. Sepulchre (Eds), World Scientific (2012).

Non-equilibrium statistical mechanics of the stochastic Navier–Stokes equations and geostrophic turbulence F. Bouchet, C. Nardini, T. Tangarife in "5th Warsaw School of Statistical Physics", B. Cichocki, M. Napiorkowski, J. Piasecki (Eds).

Function spaces vs. scaling functions: Tools for image classification S. Jaffard, P. Abry, S. G. Roux, in "Mathematical Image processing", M. Bergounioux (Ed), Springer (2011).

On the impact of the number of vanishing moments on the dependence structures of compound Poisson motion and fractional Brownian motion in multifractal time B. Vedel, H. Wendt, P. Abry, S. Jaffard, in "Dependence in Probability and Statistics", P. Doukhan, G. Lang, G. Teyssière, D. Surgailis (Eds), Springer (2010).

The contribution of wavelets in multifractal analysis S. Jaffard, P. Abry, H. Wendt, S. Roux, B. Vedel, in "Series in contemporary applied mathematics", A. Damlamian, S. Jaffard, L. T. Tsien (Eds), World scientific publishing (2009).

Wavelet decomposition of measures: Application to multifractal analysis of images P. Abry, S. Jaffard, S. Roux, B. Vedel, H. Wendt, in "Proc. NATO-ASI Conf. on Unexploded Ordnance Detection and Mitigation", J. Byrnes (Ed), Springer (2009).

Fractals and Wavelets : what can we learn on transcription and replication from wavelet-based multifractal analysis of DNA sequences? A. Arneodo, B. Audit, E.-B. Brodie of Brodie, S. Nicolay, M. Touchon, Y. D'Aubenton-Carafa, M. Huvet, C. Thermes in "Encyclopedia of Complexity and Systems Science", R. A. Meyers (Ed), Springer (2009).

Measuring out of equilibrium fluctuations L. Bellon, J. R. Gomez-Solano, A. Petrosyan, S. Ciliberto in "Nonequilibrium Statistical Physics of Small Systems: Fluctuation relations and beyond", C. Jarzynski, R. Klages, W. Just (Eds), Wiley (2013).

Time-Frequency Learning Machines For NonStationarity Detection Using Surrogate P. Borgnat, P. Flandrin, C. Richard, A. Ferrari, H. Amoud, P. Honeine, in "Data Mining and Machine Learning for Astronomical Applications", K. Ali, A. Srivastava, J.D. Scargle, M.J. Way (Eds), CRC Press (2012).

Physics of viral infectivity: matching genome length with capsid size A. Evilevitch M. Castelnovo in "Emerging topics in physical virology", P. Stockley (Ed), World Scientific Publishing (2010).

Internal Waves in Laboratory Experiments B. Sutherland, T. Dauxois, T. Peacock in "Atmospheric and Oceanic Flows: Insights from Laboratory Experiments and Numerical Simulations", T. von Larcher, P. Williams (Eds), AGU Books (2014).

Des signaux stationnaires en quel sens ? P. Flandrin in "Le traitement de l'information en interaction avec les mathématiques et la physique", A. Appriou, O. Macchi (Eds), CNRS Éditions (2010).

Écrire un article P. Flandrin in "Écritures : sur les traces de Jack Goody", É. Guichard (Ed), Presses de l'ENSSIB (2012).

Nonstationary signal analysis with kernel machines P. Honeine, P. Borgnat, C. Richard, P. Flandrin in "Handbook of Research on Machine Learning Applications and Trends: Algorithms, Methods and Techniques", E. Soria, J. D. Martin, R. Magdanela, M. Martinez, A.J. Serrano (Eds), ICI Global (2012).

Une fréquence peut-elle être instantanée ? P. Flandrin in "Produire le temps", H. Vinet (Ed), Hermann (2014).

The Physics of Turbulence E. Lévêque in "Structure Formation in the Universe", G. Chabrier (Ed), Cambridge University Press (2009).

Towards a Covariant Loop Quantum Gravity E.R. Livine in "Approaches to Quantum Gravity: Toward a New Understanding of Space, Time and Matter", D. Oriti (Ed), Cambridge University Press (2009).

Apport de techniques couplées (diffusion de rayonnements, résonance magnétique, vélocimétrie ultrasonore) à la rhéologie E. Peuvrel-Disdier, S. Manneville, G. Ovarlez, F. Pignon, S. Rodts in "La mesure en rhéologie: des avancées récentes aux perspectives", J.-L. Grossiord, A. Ponton (Eds), EDP Sciences (2013).

A Lagrangian view of turbulent dispersion and mixing B. Sawford, J.-F. Pinton in "Ten chapters in Turbulence", P.A. Davidson, Y. Kaneda, K.R. Sreenivasan (Eds), Cambridge UP (2013).

Publications

Only articles published in peer-reviewed journals have been listed.

T1B. Hydrodynamics and Geophysics

[1] Claudia Adam and Valérie Vidal. Mantle Flow Drives the Subsidence of Oceanic Plates. *Science*, 328(5974):83–85, Apr 2 2010.

[2] Claudia Adam and Valérie Vidal. Response to Comment on "Mantle Flow Drives the Subsidence of Oceanic Plates". *Science*, 331(6020), Feb 25 2011.

[3] M. A. Aguirre, J. G. Grande, A. Calvo, L. A. Pugnaloni, and J-C. Geminard. Pressure Independence of Granular Flow through an Aperture. *Physical Review Letters*, 104(23), Jun 11 2010.

[4] Maria Alejandra Aguirre, Juan Gabriel Grande, Adriana Calvo, Luis A. Pugnaloni, and Jean-Christophe Geminard. Granular flow through an aperture: Pressure and flow rate are independent. *Physical Review E*, 83(6, 1), Jun 30 2011.

[5] M. Berhanu, B. Gallet, R. Monchaux, M. Bourgoin, Ph. Odier, J. F. Pinton, N. Plihon, R. Volk, S. Fauve, N. Mordant, F. Petrelis, S. Aumaitre, A. Chiffaudel, F. Daviaud, B. Dubrulle, and F. Ravelet. Bistability between a stationary and an oscillatory dynamo in a turbulent flow of liquid sodium. *Journal of Fluid Mechanics*, 641:217–226, Dec 25 2009.

[6] M. Berhanu, G. Verhille, J. Boisson, B. Gallet, C. Gissinger, S. Fauve, N. Mordant, F. Petrelis, M. Bourgoin, P. Odier, J. F. Pinton, N. Plihon, S. Aumaitre, A. Chiffaudel, F. Daviaud, B. Dubrulle, and C. Pirat. Dynamo regimes and transitions in the VKS experiment. *European Physical Journal B*, 77(4):459–468, Oct 2010.

[7] Anne-Florence Bitbol, Nicolas Taberlet, Stephen W. Morris, and Jim N. McElwaine. Scaling and dynamics of washboard roads. *Physical Review E*, 79(6), Jun 2009.

[8] J. Boisson, S. Aumaitre, N. Bonnefoy, M. Bourgoin, F. Daviaud, B. Dubrulle, Ph Odier, J-F Pinton, N. Plihon, and G. Verhille. Symmetry and couplings in stationary Von Karman sodium dynamos. *New Journal of Physics*, 14, Jan 23 2012.

[9] Guilhem Bordes, Frederic Moisy, Thierry Dauxois, and Pierre-Philippe Cortet. Experimental evidence of a triadic resonance of plane inertial waves in a rotating fluid. *Physics of Fluids*, 24(1), Jan 2012.

[10] Guilhem Bordes, Antoine Venaille, Sylvain Joubaud, Philippe Odier, and Thierry Dauxois. Experimental observation of a strong mean flow induced by internal gravity waves. *Physics of Fluids*, 24(8), Aug 2012.

[11] Wouter J. T. Bos, Laurent Chevillard, Julian F. Scott, and Robert Rubinstein. Reynolds number ef-

fect on the velocity increment skewness in isotropic turbulence. *Physics of Fluids*, 24(1), Jan 2012.

[12] Freddy Bouchet, Cesare Nardini, and Tomas Tangarife. Kinetic Theory of Jet Dynamics in the Stochastic Barotropic and 2D Navier-Stokes Equations. *Journal of Statistical Physics*, 153(4):572–625, Nov 2013.

[13] Freddy Bouchet and Antoine Venaille. Statistical mechanics of two-dimensional and geophysical flows. *Physics Reports*, 515(5):227–295, Jun 2012.

[14] Baptiste Bourget, Thierry Dauxois, Sylvain Joubaud, and Philippe Odier. Experimental study of parametric subharmonic instability for internal plane waves. *Journal of Fluid Mechanics*, 723:1–20, May 2013.

[15] A. Cahuzac, J. Boudet, P. Borgnat, and E. Lévêque. Smoothing algorithms for mean-flow extraction in large-eddy simulation of complex turbulent flows. *Physics of Fluids*, 22(12), Dec 2010.

[16] A. Cahuzac, J. Boudet, E. Lévêque, and P. Borgnat. Extraction de flot moyen dans des simulations numériques à grande échelle de fluides par filtre de kalman adaptatif. In *23e Colloque sur le Traitement du Signal et des Images. Gretsi-2011*, page id. 191, Sept 2011.

[17] E. Calzavarini, R. Volk, M. Bourgoin, E. Leveque, J. F. Pinton, and F. Toschi. Acceleration statistics of finite-sized particles in turbulent flow: the role of Faxen forces. *Journal of Fluid Mechanics*, 630:179–189, Jul 10 2009.

[18] Enrico Calzavarini, Romain Volk, Emmanuel Leveque, Jean-Francois Pinton, and Federico Toschi. Impact of trailing wake drag on the statistical properties and dynamics of finite-sized particle in turbulence. *Physica D*, 241(3, SI):237–244, Feb 1 2012.

[19] L. Chevillard, B. Castaing, A. Arneodo, E. Lévêque, J.F. Pinton, and S.G. Roux. A phenomenological theory of eulerian and lagrangian velocity fluctuations in turbulent flows. *Comptes Rendus Physique*, 13(9-10):899–928, November 2012.

[20] L. Chevillard, R. Robert, and V. Vargas. A stochastic representation of the local structure of turbulence. *Europhysics Letters*, 89(5), Mar 2010.

[21] Laurent Chevillard, Emmanuel Leveque, Francesco Taddia, Charles Meneveau, Huidan Yu, and Carlos Rosales. Local and nonlocal pressure Hessian effects in real and synthetic fluid turbulence. *Physics of Fluids*, 23(9), Sep 2011.

[22] Laurent Chevillard and Charles Meneveau. Lagrangian time correlations of vorticity alignments in isotropic turbulence: Observations and model predictions. *Physics of Fluids*, 23(10), Oct 2011.

[23] Laurent Chevillard and Charles Meneveau. Orientation dynamics of small, triaxial-ellipsoidal particles in isotropic turbulence. *Journal of Fluid Mechanics*, 737:571–596, Dec 2013.

[24] Laurent Chevillard and Michael Wilczek. Structures and statistics of fluid turbulence Foreword. *Comptes Rendus Physique*, 13(9-10):865, Nov-Dec 2012.

[25] F. Chilla and J. Schumacher. New perspectives in turbulent Rayleigh-Benard convection. *European Physical Journal E*, 35(7), Jul 2012.

[26] S. Denisov, V. Dolgikh, I. Kolesnichenko, R. Khalilov, S. Khripchenko, G. Verhille, N. Plihon, and J. F. Pinton. Flow of liquid metal in a cylindrical crystalizer generating two-directional MHD-stirring. *Magnetohydrodynamics*, 46(1):69–78, Jan-Mar 2010.

[27] Thibaut Divoux, Eric Bertin, Valérie Vidal, and Jean-Christophe Géminard. Intermittent outgassing through a non-Newtonian fluid. *Physical Review E*, 79(5, 2), May 2009.

[28] Thibaut Divoux, Valérie Vidal, Maurizio Ripepe, and Jean-Christophe Géminard. Influence of non-Newtonian rheology on magma degassing. *Geophysical Research Letters*, 38, Jun 24 2011.

[29] Lauris Ducasse and Alain Pumir. Inertial particle collisions in turbulent synthetic flows: Quantifying the sling effect. *Physical Review E*, 80(6, 2), Dec 2009.

[30] E. Falcon, S.G. Roux, and B. Audit. Revealing intermittency in experimental data with steep power spectra. *European Physical Journal*, 90(5):50007, June 2010.

[31] E. Falcon, S.G. Roux, and C. Laroche. On the origin of intermittency in wave turbulence. *European Physical Journal*, 90(3):34005, May 2010.

[32] Gregory Falkovich and Krzysztof Gawedzki. Turbulence on hyperbolic plane: the fate of inverse cascade. *Journal of Statistical Physics*, 156(1):10–54, Jul 2014.

[33] Gregory Falkovich, Haitao Xu, Alain Pumir, Eberhard Bodenschatz, Luca Biferale, Guido Boffetta, Alessandra S. Lanotte, Federico Toschi, and Int Collaboration Turbulence Res. On Lagrangian single-particle statistics. *Physics of Fluids*, 24(5), May 2012.

[34] L. Fiabane, R. Volk, J-F Pinton, R. Monchaux, A. Cartellier, and M. Bourgoin. Do finite-size neutrally buoyant particles cluster? *Physica Scripta*, T155, Jul 2013.

[35] L. Fiabane, R. Zimmermann, R. Volk, J. F. Pinton, and M. Bourgoin. Clustering of finite-size particles in turbulence. *Physical Review E*, 86(3, 2), Sep 21 2012.

[36] E. Freyssingeas, M. J. Dalbe, and J. C. Geminard. Flowers in flour: Avalanches in cohesive granular matter. *Physical Review E*, 83(5, 1), May 27 2011.

[37] B. Gallet, S. Aumaitre, J. Boisson, F. Daviaud, B. Dubrulle, N. Bonnefoy, M. Bourgoin, Ph. Odier, J. F. Pinton, N. Plihon, G. Verhille, S. Fauve, and F. Petrelis. Experimental Observation of Spatially Localized Dynamo Magnetic Fields. *Physical Review Letters*, 108(14), Apr 2 2012.

[38] Krzysztof Gawedzki, David P. Herzog, and Jan Wehr. Ergodic Properties of a Model for Turbulent Dispersion of Inertial Particles. *Communications in Mathematical Physics*, 308(1):49–80, Nov 2011.

[39] M. Gibert, H. Pabiou, J. C. Tisserand, B. Gertjerenken, B. Castaing, and F. Chilla. Heat convection in a vertical channel: Plumes versus turbulent diffusion. *Physics of Fluids*, 21(3), Mar 2009.

[40] Eugenio Hamm and Jean-Christophe Geminard. The weight of a falling chain, revisited. *American Journal of Physics*, 78(8):828–833, Aug 2010.

[41] Sylvain Joubaud, James Munroe, Philippe Odier, and Thierry Dauxois. Experimental parametric subharmonic instability in stratified fluids. *Physics of Fluids*, 24(4), Apr 2012.

[42] Jason Larkin, M. M. Bandi, Alain Pumir, and Walter I. Goldburg. Power-law distributions of particle concentration in free-surface flows. *Physical Review E*, 80(6, 2), Dec 2009.

[43] Yi Li, Laurent Chevillard, Gregory Eyink, and Charles Meneveau. Matrix exponential-based closures for the turbulent subgrid-scale stress tensor.

Physical Review E, 79(1, 2), Jan 2009.

[44] N. Machicoane, J. Bonaventure, and R. Volk. Melting dynamics of large ice balls in a turbulent swirling flow. *Physics of Fluids*, 25(12), Dec 2013.

[45] Nathanael Machicoane, Robert Zimmermann, Lionel Fiabane, Mickael Bourgoin, Jean-Francois Pinton, and Romain Volk. Large sphere motion in a nonhomogeneous turbulent flow. *New Journal of Physics*, 16(1):013053, 2014.

[46] M. J. Mercier, R. Vasseur, and T. Dauxois. Resurrecting dead-water phenomenon. *Nonlinear Processes in Geophysics*, 18(2):193–208, 2011.

[47] Matthieu J. Mercier, Louis Gostiaux, Karl Helfrich, Joel Sommeria, Samuel Viboud, Henri Didelle, Sasan J. Ghaemsaidi, Thierry Dauxois, and Thomas Peacock. Large-scale, realistic laboratory modeling of M-2 internal tide generation at the Luzon Strait. *Geophysical Research Letters*, 40(21):5704–5709, Nov 16 2013.

[48] Matthieu J. Mercier, Denis Martinand, Manikandan Mathur, Louis Gostiaux, Thomas Peacock, and Thierry Dauxois. New wave generation. *Journal of Fluid Mechanics*, 657:308–334, Aug 25 2010.

[49] Matthieu J. Mercier, Manikandan Mathur, Louis Gostiaux, Theo Gerkema, Jorge M. Magalhaes, Jose C. B. Da Silva, and Thierry Dauxois. Soliton generation by internal tidal beams impinging on a pycnocline: laboratory experiments. *Journal of Fluid Mechanics*, 704:37–60, Aug 10 2012.

[50] P. Mininni, P. Dmitruk, P. Odier, J.-F. Pinton, N. Plihon, G. Verhille, R. Volk, and M. Bourgoin. Long-term memory in experiments and numerical simulations of hydrodynamic and magnetohydrodynamic turbulence. *Phys. Rev. E*, 89:053005, May 2014.

[51] Sophie Miralles, Nicolas Bonnefoy, Mickael Bourgoin, Philippe Odier, Jean-Francois Pinton, Nicolas Plihon, Gautier Verhille, Jean Boisson, Francois Daviaud, and Berengere Dubrulle. Dynamo threshold detection in the von Karman sodium experiment. *Physical Review E*, 88(1), Jul 8 2013.

[52] Sophie Miralles, Johann Herault, Stephan Fauve, Christophe Gissinger, Fran çois Pétrélis, Fran çois Daviaud, Bérengère Dubrulle, Jean Boisson, Mickaël Bourgoin, Gautier Verhille, Philippe Odier, Jean-Fran çois Pinton, and Nicolas Plihon. Dynamo efficiency controlled by hydrodynamic bistability. *Phys. Rev. E*, 89:063023, Jun 2014.

[53] Romain Monchaux, Michael Berhanu, Sebastien Aumaitre, Arnaud Chiffaudel, Francois Daviaud, Berengere Dubrulle, Florent Ravelet, Stephan Fauve, Nicolas Mordant, Francois Petrelis, Mickael Bourgoin, Philippe Odier, Jean-Francois Pinton, Nicolas Plihon, and Romain Volk. The von Karman Sodium experiment: Turbulent dynamical dynamos. *Physics of Fluids*, 21(3), Mar 2009.

[54] G. Montagnac, R. Caracas, E. Bobocioiu, F. Vittoz, and B. Reynard. Anharmonicity of graphite from UV Raman spectroscopy to 2700 K. *Carbon*, 54:68–75, Apr 2013.

[55] Balasubramanya T. Nadiga and Freddy Bouchet. The equivalence of the Lagrangian-averaged Navier-Stokes-alpha model and the rational large eddy simulation model in two dimensions. *Physics of Fluids*, 23(9), Sep 2011.

[56] P. Odier, J. Chen, and R. E. Ecke. Understanding and modeling turbulent fluxes and entrainment in a gravity current. *Physica D*, 241(3, SI):260–268, Feb 1 2012.

[57] P Odier, J. Chen, and R. E. Ecke. Entrainment and mixing in a laboratory model fo oceanic overflow. *J. Fluid Mech.*, 746:498–535, 2014.

[58] P. Odier, J. Chen, M. K. Rivera, and R. E. Ecke. Fluid Mixing in Stratified Gravity Currents: The Prandtl Mixing Length. *Physical Review Letters*, 102(13), Apr 3 2009.

[59] Thomas Peacock, Matthieu J. Mercier, Henri Didelle, Samuel Viboud, and Thierry Dauxois. A laboratory study of low-mode internal tide scattering by finite-amplitude topography. *Physics of Fluids*, 21(12), Dec 2009.

[60] Baptiste Percier, Sebastien Manneville, Jim N. McElwaine, Stephen W. Morris, and Nicolas Taberlet. Lift and drag forces on an inclined plow moving over a granular surface. *Physical Review E*, 84(5, 1), Nov 3 2011.

[61] Baptiste Percier, Sebastien Manneville, and Nicolas Taberlet. Modeling a washboard road: From experimental measurements to linear stability analysis. *Physical Review E*, 87(1), Jan 17 2013.

[62] Christophe Perge, Maria Alejandra Aguirre, Paula Alejandra Gago, Luis A. Pugnaloni, Denis Le Tourneau, and Jean-Christophe Geminard. Evolution of pressure profiles during the discharge of a silo. *Physical Review E*, 85(2, 1), Feb 8 2012.

[63] Nicolas Plihon and Pascal Chabert. Ion acoustic waves and double-layers in electronegative expanding plasmas. *Physics of Plasmas*, 18(8), Aug 2011.

[64] Alain Pumir, Eberhard Bodenschatz, and Haitao Xu. Tetrahedron deformation and alignment of perceived vorticity and strain in a turbulent flow. *Physics of Fluids*, 25(3), Mar 2013.

[65] Alain Pumir and Aurore Naso. Statistical properties of the coarse-grained velocity gradient tensor in turbulence: Monte-Carlo simulations of the tetrad model. *New Journal of Physics*, 12, Dec 16 2010.

[66] Alain Pumir and Aurore Naso. Insight on turbulent flows from Lagrangian tetrads. *Comptes Rendus Physique*, 13(9-10):889–898, NOV-DEC 2012.

[67] Alain Pumir and Michael Wilkinson. Orientation statistics of small particles in turbulence. *New Journal of Physics*, 13, Sep 20 2011.

[68] Alain Pumir and Michael Wilkinson. A Model for the Shapes of Advected Triangles. *Journal of Statistical Physics*, 152(5):934–953, Sep 2013.

[69] X. Riedinger, J.-C. Tisserand, F. Seychelles, B. Castaing, and F. Chilla. Heat transport regimes in an inclined channel. *Physics of Fluids*, 25(1), Jan 2013.

[70] S.G. Roux, P. Koucká Knížová, Z. Mošna, and P. Abry. Ionosphere fluctuations and global indices: A scale dependent wavelet-based cross-correlation analysis. *Journal of Atmospheric and Solar-Terrestrial Physics*, 90–91:186–197, 2012.

[71] E. Rusaouen, X. Riedinger, J. C. Tisserand, F. Seychelles, J. Salort, B. Castaing, and F. Chilla. Laminar and Intermittent flow in a tilted heat pipe. *European Physical Journal E*, 37(1), Jan 29 2014.

[72] J. Salort, O. Liot, E. Rusaouen, F. Seychelles, J-C Tisserand, M. Creyssels, B. Castaing, and F. Chilla. Thermal boundary layer near roughnesses in turbulent Rayleigh-Benard convection: Flow structure and multistability. *Physics of Fluids*, 26(1), Jan 2014.

[73] J. Salort, X. Riedinger, E. Rusaouen, J. C. Tisserand, F. Seychelles, B. Castaing, and F. Chilla. Turbulent velocity profiles in a tilted heat pipe.

Physics of Fluids, 25(10), Oct 2013.

[74] S. Schael et al. Electroweak measurements in electron positron collisions at W-boson-pair energies at LEP. *Physics Reports*, 532(4):119–244, Nov 30 2013.

[75] Helene Scolan, Eugeny Ermanyuk, and Thierry Dauxois. Nonlinear Fate of Internal Wave Attractors. *Physical Review Letters*, 110(23), Jun 7 2013.

[76] Luca Sorriso-Valvo, Vincenzo Carbone, Michael Bourgoin, Philippe Odier, Nicolas Plihon, and Romain Volk. Statistical analysis of magnetic field reversals in laboratory dynamo and in paleomagnetic measurements. *Internatonal Journal of Modern Physics B*, 23(28-29):5483–5491, Nov 20 2009. Workshop on Modelling Geophysical Systems by Statistical Mechanics Methods, Erice, Italy, Apr 27-May 02, 2008.

[77] J. B. Tary, L. Geli, C. Guennou, P. Henry, N. Sultan, N. Cagatay, and V. Vidal. Microevents produced by gas migration and expulsion at the seabed: a study based on sea bottom recordings from the Sea of Marmara. *Geophysical Journal International*, 190(2):993–1007, Aug 2012.

[78] J. C. Tisserand, M. Creyssels, Y. Gasteuil, H. Pabiou, M. Gibert, B. Castaing, and F. Chilla. Comparison between rough and smooth plates within the same Rayleigh-Benard cell. *Physics of Fluids*, 23(1), Jan 2011.

[79] J-C Tisserand, M. Creyssels, M. Gibert, B. Castaing, and F. Chilla. Convection in a vertical channel. *New Journal of Physics*, 12, Jul 28 2010.

[80] Hatem Touil, Denis Ricot, and Emmanuel Leveque. Direct and large-eddy simulation of turbulent flows on composite multi-resolution grids by the lattice Boltzmann method. *Journal of Computational Physics*, 256:220–233, Jan 1 2014.

[81] Germán Varas, Jean-Christophe Géminard, and Valérie Vidal. Air invasion in a granular layer immersed in a fluid: morphology and dynamics. *Granular Matter*, 15(6):801–810, Dec 2013.

[82] Germán Varas, Valérie Vidal, and Jean-Christophe Géminard. Dynamics of crater formations in immersed granular materials. *Physical Review E*, 79(2, 1), Feb 2009.

[83] Germán Varas, Valérie Vidal, and Jean-Christophe Géminard. Morphology of air invasion in an immersed granular layer. *Physical Review E*, 83(6, 1), Jun 23 2011.

[84] Germán Varas, Valérie Vidal, and Jean-Christophe Géminard. Venting dynamics of an immersed granular layer. *Physical Review E*, 83(1, 1), Jan 28 2011.

[85] A. Venaille. Bottom-trapped currents as statistical equilibrium states above topographic anomalies. *Journal of Fluid Mechanics*, 699:500–510, May 25 2012.

[86] A. Venaille, J. Le Sommer, J. M. Molines, and B. Barnier. Stochastic variability of oceanic flows above topography anomalies. *Geophysical Research Letters*, 38, Aug 27 2011.

[87] A. Venaille, G. K. Vallis, and S. M. Griffies. The catalytic role of the beta effect in barotropization processes. *Journal of Fluid Mechanics*, 709:490–515, Oct 25 2012.

[88] Antoine Venaille and Freddy Bouchet. Statistical Ensemble Inequivalence and Bicritical Points for Two-Dimensional Flows and Geophysical Flows. *Physical Review Letters*, 102(10), Mar 13 2009.

[89] Antoine Venaille and Freddy Bouchet. Oceanic Rings and Jets as Statistical Equilibrium States. *Journal of Physical Oceanography*, 41(10):1860–1873, Oct 2011.

[90] Antoine Venaille, Geoffrey K. Vallis, and K. Shafer Smith. Baroclinic Turbulence in the Ocean: Analysis with Primitive Equation and Quasigeostrophic Simulations. *Journal of Physical Oceanography*, 41(9):1605–1623, Sep 2011.

[91] Gautier Verhille, Ruslan Khalilov, Nicolas Plihon, Peter Frick, and Jean-Francois Pinton. Transition from hydrodynamic turbulence to magnetohydrodynamic turbulence in von Karman flows. *Journal of Fluid Mechanics*, 693:243–260, Feb 25 2012.

[92] Gautier Verhille, Nicolas Plihon, Mickael Bourgoin, Philippe Odier, and Jean-Francois Pinton. Laboratory Dynamo Experiments. *Space Science Reviews*, 152(1-4):543–564, May 2010.

[93] Gautier Verhille, Nicolas Plihon, Mickal Bourgoin, Philippe Odier, and Jean-Francois Pinton. Induction in a von Karman flow driven by ferromagnetic impellers. *New Journal of Physics*, 12, Mar 9 2010.

[94] Gautier Verhille, Nicolas Plihon, Gregory Fanjat, Romain Volk, Mickael Bourgoin, and Jean-Francois Pinton. Large-scale fluctuations and dynamics of the Bullard-von Karman dynamo. *Geophysical and Astrophysical Fluid Dynamics*, 104(2-3):189–205, 2010.

[95] V. Vidal, M. Ripepe, T. Divoux, D. Legrand, J. C. Geminard, and F. Melo. Dynamics of soap bubble bursting and its implications to volcano acoustics. *Geophysical Research Letters*, 37, Apr 2 2010.

[96] Valérie Vidal, Mie Ichihara, Maurizio Ripepe, and Kei Kurita. Acoustic waveform of continuous bubbling in a non-Newtonian fluid. *Physical Review E*, 80(6, 2), Dec 2009.

[97] Valérie Vidal, François Soubiran, Thibaut Divoux, and Jean-Christophe Géminard. Degassing cascades in a shear-thinning viscoelastic fluid. *Physical Review E*, 84(6, 2), Dec 2 2011.

[98] R. Volk, E. Calzavarini, E. Leveque, and J-F Pinton. Dynamics of inertial particles in a turbulent von Karman flow. *Journal of Fluid Mechanics*, 668:223–235, Feb 10 2011.

[99] M Vosskuhle, A Pumir, E Lévêque, and M Wilkinson. Prevalence of the sling effect for enhancing collision rates in turbulent suspensions. *J. Fluid Mech.*, 749:841–852, 2014.

[100] Michel Vosskuhle, Emmanuel Leveque, Michael Wilkinson, and Alain Pumir. Multiple collisions in turbulent flows. *Physical Review E*, 88(6), Dec 10 2013.

[101] Michael Wilkinson and Alain Pumir. Spherical Ornstein-Uhlenbeck Processes. *Journal of Statistical Physics*, 145(1):113–142, Oct 2011.

[102] H Xu, A Pumir, G Falkovich, E Bodenschatz, M Shats, H Xia, N Francois, and G Boffetta. Flight-crash events in turbulence. *Proceedings of the National Academy of Sciences of the United States of America*, 111:7558–7563, 2014.

[103] Haitao Xu, Alain Pumir, and Eberhard Bodenschatz. The pirouette effect in turbulent flows. *Nature Physics*, 7(9):709–712, Sep 2011.

[104] Robert Zimmermann, Yoann Gasteuil, Mickael Bourgoin, Romain Volk, Alain Pumir, and Jean-Francois Pinton. Rotational Intermittency and Turbulence Induced Lift Experienced by Large Particles in a Turbulent Flow. *Physical Review Letters*, 106(15), Apr 11 2011.

[105] Robert Zimmermann, Haitao Xu, Yoann Gasteuil,

Mickael Bourgoin, Romain Volk, Jean-Francois Pinton, and Eberhard Bodenschatz. The Lagrangian exploration module: An apparatus for the study of statistically homogeneous and isotropic turbulence. *Review of Scientific Instruments*, 81(5), May 2010.

T2B. Soft matter : multi-scale mechanics, from measurements to models

[106] Hector Alarcon, Osvanny Ramos, Loic Vanel, Franck Vittoz, Francisco Melo, and Jean-Christophe Geminard. Softening Induced Instability of a Stretched Cohesive Granular Layer. *Physical Review Letters*, 105(20), Nov 10 2010.

[107] Pierre Ballesta, Minne Paul Lettinga, and Sebastien Manneville. Interplay between a hydrodynamic instability and a phase transition: the Faraday instability in dispersions of rodlike colloids. *Soft Matter*, 7(24):11440–11446, 2011.

[108] Julien Beaumont, Nicolas Louvet, Thibaut Divoux, Marc-Antoine Fardin, Hugues Bodiguel, Sandra Lerouge, Sebastien Manneville, and Annie Colin. Turbulent flows in highly elastic wormlike micelles. *Soft Matter*, 9(3):735–749, 2013.

[109] Baptiste Blanc and Jean-Christophe Geminard. Intrinsic creep of a granular column subjected to temperature changes. *Physical Review E*, 88(2), Aug 5 2013.

[110] Baptiste Blanc, Luis A. Pugnaloni, and Jean-Christophe Geminard. Creep motion of a model frictional system. *Physical Review E*, 84(6, 1), Dec 27 2011.

[111] Antoine Bricard, Jean-Baptiste Caussin, Nicolas Desreumaux, Olivier Dauchot, and Denis Bartolo. Emergence of macroscopic directed motion in populations of motile colloids. *Nature*, 503(7474):95–98, 2013.

[112] Tommaso Brotto, Jean-Baptiste Caussin, Eric Lauga, and Denis Bartolo. Hydrodynamics of confined active fluids. *Physical Review Letters*, 110(3), 2013.

[113] Julien Buchoux, Ludovic Bellon, Sophie Marsaudon, and Jean-Pierre Aimé. Carbon nanotubes adhesion and nanomechanical behavior from peeling force spectroscopy. *European Physical Journal B*, 84(1):69–77, Nov 2011.

[114] D. Chateau and J. C. Geminard. Fracture path in an anisotropic material in the light of a friction experiment. *Physical Review E*, 88(3), Sep 16 2013.

[115] Doru Constantin, Patrick Davidson, Eric Freyssingeas, and Anders Madsen. Slow dynamics of a colloidal lamellar phase. *Journal of Chemical Physics*, 133(22), Dec 14 2010.

[116] Pierre-Philippe Cortet, Marie-Julie Dalbe, Claudia Guerra, Caroline Cohen, Matteo Ciccotti, Stephane Santucci, and Loic Vanel. Intermittent stick-slip dynamics during the peeling of an adhesive tape from a roller. *Physical Review E*, 87(2), Feb 19 2013.

[117] Marie-Julie Dalbe, Stephane Santucci, Pierre-Philippe Cortet, and Loic Vanel. Strong dynamical effects during stick-slip adhesive peeling. *Soft Matter*, 10(1):132–138, 2014.

[118] Jalal Dehmoune, Sebastien Manneville, and Jean-Paul Decruppe. Local Velocity Measurements in the Shear-Thickening Transition of Dilute Micellar Solutions of Surfactants. *Langmuir*, 27(3):1108–1115, Feb 1 2011.

[119] S. Deschanel, L. Vanel, N. Godin, E. Maire, G. Vigier, and S. Ciliberto. Mechanical response and fracture dynamics of polymeric foams. *Journal of Physics D-Applied Physics*, 42(21), 2009.

[120] S. Deschanel, L. Vanel, N. Godin, G. Vigier, and S. Ciliberto. Experimental study of crackling noise: conditions on power law scaling correlated with fracture precursors. *Journal of Statistical Mechanics-Theory and Experiment*, 2009.

[121] Nicolas Desreumaux, Jean-Baptiste Caussin, Raphael Jeanneret, Eric Lauga, and Denis Bartolo. Hydrodynamic fluctuations in confined particle-laden fluids. *Physical Review Letters*, 111(11), 2013.

[122] Clemence Devailly, Justine Laurent, Audrey Steinberger, Ludovic Bellon, and Sergio Ciliberto. Mode coupling in a hanging-fiber AFM used as a rheological probe. *Europhysics Letters*, 106(5):54005, Jun 2014.

[123] Thibaut Divoux, Catherine Barentin, and Sebastien Manneville. From stress-induced fluidization processes to Herschel-Bulkley behaviour in simple yield stress fluids. *Soft Matter*, 7(18):8409–8418, 2011.

[124] Thibaut Divoux, Catherine Barentin, and Sebastien Manneville. Stress overshoot in a simple yield stress fluid: An extensive study combining rheology and velocimetry. *Soft Matter*, 7(19):9335–9349, 2011.

[125] Thibaut Divoux, Vincent Grenard, and Sebastien Manneville. Rheological Hysteresis in Soft Glassy Materials. *Physical Review Letters*, 110(1), Jan 2 2013.

[126] Thibaut Divoux, David Tamarii, Catherine Barentin, and Sebastien Manneville. Transient Shear Banding in a Simple Yield Stress Fluid. *Physical Review Letters*, 104(20), May 21 2010.

[127] Thibaut Divoux, David Tamarii, Catherine Barentin, Stephen Teitel, and Sebastien Manneville. Yielding dynamics of a Herschel-Bulkley fluid: a critical-like fluidization behaviour. *Soft Matter*, 8(15):4151–4164, 2012.

[128] Arthur A. Evans, Saverio E. Spagnolie, Denis Bartolo, and Eric Lauga. Elastocapillary self-folding: buckling, wrinkling, and collapse of floating filaments. *Soft Matter*, 9(5):1711–1720, 2013.

[129] Ralf Everaers. Topological versus rheological entanglement length in primitive-path analysis protocols, tube models, and slip-link models. *Physical Review E*, 86(2, 1), Aug 13 2012.

[130] M. A. Fardin, T. Divoux, M. A. Guedeau-Boudeville, I. Buchet-Maulien, J. Browaeys, G. H. McKinley, S. Manneville, and S. Lerouge. Shear-banding in surfactant wormlike micelles: elastic instabilities and wall slip. *Soft Matter*, 8(8):2535–2553, 2012.

[131] M. A. Fardin, T. J. Ober, V. Grenard, T. Divoux, S. Manneville, G. H. McKinley, and S. Lerouge. Interplay between elastic instabilities and shear-banding: three categories of Taylor-Couette flows and beyond. *Soft Matter*, 8(39):10072–10089, 2012.

[132] Marc-Antoine Fardin, Christophe Perge, Nicolas Taberlet, and Sebastien Manneville. Flow-induced structures versus flow instabilities. *Physical Review E*, 89:011001(R), 2014.

[133] Jean-Christophe Geminard and Eric Bertin. Aging

of the frictional properties induced by temperature variations. *Physical Review E*, 82(5, 2), Nov 9 2010.

[134] Jean-Christophe Geminard, Lorene Champougny, Pierre Lidon, and Francisco Melo. Flexural fracturing of a cohesive granular layer. *Physical Review E*, 85(1, 1), Jan 17 2012.

[135] Thomas Gibaud, Catherine Barentin, Nicolas Taberlet, and Sebastien Manneville. Shear-induced fragmentation of laponite suspensions. *Soft Matter*, 5(16):3026–3037, 2009.

[136] Thomas Gibaud, Damien Frelat, and Sebastien Manneville. Heterogeneous yielding dynamics in a colloidal gel. *Soft Matter*, 6(15):3482–3488, 2010.

[137] Thomas Gibaud, Alessio Zaccone, Emanuela Del Gado, Veronique Trappe, and Peter Schurtenberger. Unexpected Decoupling of Stretching and Bending Modes in Protein Gels. *Physical Review Letters*, 110(5), Jan 30 2013.

[138] Vincent Grenard, Thibaut Divoux, Nicolas Taberlet, and Sebastien Manneville. Timescales in creep and yielding of attractive gels. *Soft Matter*, 10:1555–1571, 2014.

[139] Vincent Grenard, Nicolas Taberlet, and Sebastien Manneville. Shear-induced structuration of confined carbon black gels: steady-state features of vorticity-aligned flocs. *Soft Matter*, 7(8):3920–3928, 2011.

[140] M. Grob, J. Schmittbuhl, R. Toussaint, L. Rivera, S. Santucci, and K. J. Maloy. Quake Catalogs from an Optical Monitoring of an Interfacial Crack Propagation. *Pure and Applied Geophysics*, 166(5-7):777–799, Jul 2009.

[141] A. Guarino and S. Ciliberto. Thermally activated fracture of porous media. *European Physical Journal B*, 83(2):215–221, 2011.

[142] Ji-Xuan Hou, Carsten Svaneborg, Ralf Everaers, and Gary S. Grest. Stress Relaxation in Entangled Polymer Melts. *Physical Review Letters*, 105(6), Aug 5 2010.

[143] Raphael Jeanneret and Denis Bartolo. Geometrically-protected reversibility in hydrodynamic loschmidt-echo experiments. *Nature Communication*, page in press, 2014.

[144] C. Nadir Kaplan, Thomas Gibaud, and Robert B. Meyer. Intrinsic curvature determines the crinkled edges of “crenellated disks”. *Soft Matter*, 9(34):8210–8215, 2013.

[145] Z. S. Khan, A. Steinberger, R. Seemann, and S. Herminghaus. Wet granular walkers and climbers. *New Journal of Physics*, 13, May 24 2011.

[146] A. V. Klopper, Carsten Svaneborg, and Ralf Everaers. Microphase separation in cross-linked polymer blends. *European Physical Journal E*, 28(1):89–96, Jan 2009.

[147] Olivier Lengline, Renaud Toussaint, Jean Schmittbuhl, Jean E. Elkhoury, J. P. Ampuero, Ken Tore Tallakstad, Stephane Santucci, and Knut Jorgen Maloy. Average crack-front velocity during subcritical fracture propagation in a heterogeneous medium. *Physical Review E*, 84(3, 2), Sep 9 2011.

[148] Samuel Leroy, Audrey Steinberger, Cecile Cottin-Bizonne, Frederic Restagno, Liliane Leger, and Elisabeth Charlaix. Hydrodynamic Interaction between a Spherical Particle and an Elastic Surface: A Gentle Probe for Soft Thin Films. *Physical Review Letters*, 108(26), Jun 26 2012.

[149] M. Paul Lettinga and Sebastien Manneville. Competition between Shear Banding and Wall Slip in Wormlike Micelles. *Physical Review Letters*, 103(24), Dec 11 2009.

[150] Bertrand Levaché and Denis Bartolo. Revisiting the safman-taylor experiment: imbibition patterns and liquid-entrainment transitions. *Physical Review Letters*, page sub judice, 2014.

[151] Tianjun Li and Ludovic Bellon. Dissipation of micro-cantilevers as a function of air pressure and metallic coating. *Europhysics Letters*, 98(1), Apr 2012.

[152] Tianjun Li, Felipe A. Aguilar Sandoval, Mickael Geitner, Ludovic Bellon, Gianpietro Cagnoli, Jerome Degallaix, Vincent Dolique, Raffaele Flaminio, Daniele Forest, Massimo Granata, Christophe Michel, Nazario Morgado, and Laurent Pinard. Measurements of mechanical thermal noise and energy dissipation in optical dielectric coatings. *Physical Review D*, 89(9), May 8 2014.

[153] Sebastien Michelin, Eric Lauga, and Denis Bartolo. Spontaneous autophoretic motion of isotropic particles. *Physics of Fluids*, 25(6), 2013.

[154] P. Oswald. Experimental study of the growth of cholesteric fingers subjected to an AC electric field and a temperature gradient. *Liquid Crystals*, 36(9):967–975, 2009.

[155] P. Oswald. Lehmann rotation of cholesteric droplets subjected to a temperature gradient: Role of the concentration of chiral molecules. *European Physical Journal E*, 28(4):377–383, Apr 2009.

[156] P. Oswald. Elasto- and electro-capillary instabilities of a nematic-isotropic interface: Experimental results. *European Physical Journal E*, 33(1):69–79, Sep 2010.

[157] P. Oswald. Electro-capillary instability of a nematic-isotropic interface. *Europhysics Letters*, 90(1), Apr 2010.

[158] P. Oswald. About the Leslie explanation of the Lehmann effect in cholesteric liquid crystals. *Europhysics Letters*, 97(3), Feb 2012.

[159] P. Oswald. Measurement with a rotating magnetic field of the surface viscosity of a nematic liquid crystal. *Europhysics Letters*, 100(2), Oct 2012.

[160] P. Oswald. Microscopic vs. macroscopic origin of the Lehmann effect in cholesteric liquid crystals. *European Physical Journal E*, 35(2), Feb 2012.

[161] P. Oswald and Scalliet C. Lehmann rotation of the cholesteric helix in droplets oriented by an electric field. *Physical Review E*, 89(), Mar 2014.

[162] P. Oswald and A. Dequidt. Lehmann effect in chiral liquid crystals and Langmuir monolayers: an experimental survey. *Liquid Crystals*, 36(10-11):1071–1084, 2009.

[163] P. Oswald and A. Dequidt. Comment on “Direct measurements of the thermomechanical Lehmann coefficient in a compensated cholesteric crystal” by Oswald P. and Dequidt A. Reply. *Europhysics Letters*, 89(2), Jan 2010.

[164] P. Oswald and A. Dequidt. Yield torque sliding anchoring in nematic liquid crystals. *Europhysics Letters*, 103(2), Jul 2013.

[165] P. Oswald, L. Jorgensen, and A. Zywocinski. Lehmann rotatory power: a new concept in cholesteric liquid crystals. *Liquid Crystals*, 38(5):601–613, 2011.

[166] P. Oswald, J. Milette, S. Relaix, L. Reven, A. Dequidt, and L. Lejcek. Alloy hardening of a smectic A liquid crystal doped with gold nanoparticles. *Europhysics Letters*, 103(4), Aug 2013.

[167] P. Oswald, G. Poy, F. Vittoz, and V. Popa-Nita.

Experimental relationship between surface and bulk rotational viscosities in nematic liquid crystals. *Liquid Crystals*, 40(6):734–744, Jun 1 2013.

[168] P. Oswald and Pirkl S. Lehmann rotation of the cholesteric helix in droplets oriented by an electric field. *Physical Review E*, 89(2), Feb 2014.

[169] Pierdomenico Paolino and Ludovic Bellon. Frequency dependence of viscous and viscoelastic dissipation in coated micro-cantilevers from noise measurement. *Nanotechnology*, 20(40), Oct 7 2009.

[170] Javier C. Pastenes, Jean-Christophe Geminard, and Francisco Melo. Oscillating gas flow induces reptation of granular droplets. *Physical Review E*, 88(1), Jul 3 2013.

[171] Baptiste Percier, Thibaut Divoux, and Nicolas Taberlet. Insights on the local dynamics induced by thermal cycling in granular matter. *Europhysics Letters*, 104(2), Oct 2013.

[172] Christophe Perge, Marc-Antoine Fardin, and Sebastien Manneville. Inertio-elastic instability of non shear-banding wormlike micelles. *Soft Matter*, 10:1450–1454, 2014.

[173] Basile Pottier, Allan Raudsepp, Christian Fretigny, Francois Lequeux, Jean-Francois Palierne, and Laurence Talini. High frequency linear rheology of complex fluids measured from their surface thermal fluctuations. *Journal of Rheology*, 57(2):441–455, Mar 2013.

[174] Andreas S. Poulos, Doru Constantin, Patrick Davidson, Brigitte Pansu, Eric Freyssingeas, Anders Madsen, and Corinne Chaneac. Communications: Short-range dynamics of a nematic liquid-crystalline phase. *Journal of Chemical Physics*, 132(9), Mar 7 2010.

[175] O. Ramos, P. P. Cortet, S. Ciliberto, and L. Vanel. Experimental study of the effect of disorder on subcritical crack growth dynamics. *Physical Review Letters*, 110(16), 2013.

[176] Siti Aminah Setu, Ioannis Zacharoudiou, Gareth J. Davies, Denis Bartolo, Sebastien Moulinet, Ard A. Louis, Julia M. Yeomans, and Dirk G. A. L. Aarts. Viscous fingering at ultralow interfacial tension. *Soft Matter*, 9(44):10599–10605, 2013.

[177] M. Stojanova, S. Santucci, L. Vanel, and O. Ramos. High frequency monitoring reveals aftershocks in subcritical crack growth. *Physical Review Letters*, 112(11):115502, Mar 2014.

[178] Ken Tore Tallakstad, Renaud Toussaint, Stephane Santucci, Jean Schmittbuhl, and Knut Jorgen Maloy. Local dynamics of a randomly pinned crack front during creep and forced propagation: An experimental study. *Physical Review E*, 83(4, 2), Apr 14 2011.

[179] Joe W. Tavacoli, Pierre Bauer, Marc Fermigier, Denis Bartolo, Julien Heuvingh, and Olivia du Roure. The fabrication and directed self-assembly of micron-sized superparamagnetic non-spherical particles. *Soft Matter*, 9(38):9103–9110, 2013.

[180] Shashi Thutupalli, Jean-Baptiste Fleury, Audrey Steinberger, Stephan Herminghaus, and Ralf Seemann. Why can artificial membranes be fabricated so rapidly in microfluidics? *Chemical Communications*, 49(14):1443–1445, 2013.

[181] Kevin Tse-Ve-Koon, Nicolas Tremblay, Doru Constantin, and Eric Freyssingeas. Structure, thermodynamics and dynamics of the isotropic phase of spherical non-ionic surfactant micelles. *Journal of Colloid and Interface Science*, 393:161–173, Mar 1 2013.

[182] Loic Vanel, Sergio Ciliberto, Pierre-Philippe Cortet, and Stephane Santucci. Time-dependent rupture and slow crack growth: elastic and viscoplastic dynamics. *Journal of Physics D-Applied Physics* , 42(21), Nov 7 2009.

[183] Stefan von Kann, Sylvain Joubaud, Gabriel A. Caballero-Robledo, Detlef Lohse, and Devaraj van der Meer. Effect of finite container size on granular jet formation. *Physical Review E*, 81(4, 1), Apr 2010.

[184] Mark J. Zakhary, Thomas Gibaud, C. Nadir Kaplan, Edward Barry, Rudolf Oldenbourg, Robert B. Meyer, and Zvonimir Dogic. Imprintable membranes from incomplete chiral coalescence. *Nature Communications*, 5, Jan 2014.

T3B. Physics of Biological Systems

[185] F Argoul, T Roland, A Fahys, and L Berguiga. Uncovering phase maps from surface plasmon resonance images: towards a sub-wavelength resolution. *Comptes Rendus Physique*, 13:800–814, 2012.

[186] Alain Arneodo, Cédric Vaillant, Benjamin Audit, Françoise Argoul, Yves d'Aubenton-Carafa, and Claude Thermes. Multi-scale coding of genomic information: From DNA sequence to genome structure and function. *Physics Reports*, 498:45–188, 2011.

[187] M. Atakhorrami, G. H. Koenderink, J. F. Palierne, F. C. MacKintosh, and C. F. Schmidt. Scale-Dependent Nonaffine Elasticity of Semiflexible Polymer Networks. *Physical Review Letters*, 112(8), Feb 24 2014.

[188] Benjamin Audit, Lamia Zaghloul, Cédric Vaillant, Guillaume Chevereau, Yves d'Aubenton-Carafa, Claude Thermes, and Alain Arneodo. Open chromatin encoded in DNA sequence is the signature of "master" replication origins in human cells. *Nucleic Acids Research*, 37(18):6064–6075, Oct 2009.

[189] A. Baker, B. Audit, S. C.-H. Yang, J. Bechhoefer, and A. Arneodo. Inferring where and when replication initiates from genome-wide replication timing data. *Physical Review Letters*, 108:268101, 2012.

[190] A. Baker, C. L. Chen, H. Julienne, B. Audit, Y. d'Aubenton Carafa, C. Thermes, and A. Arneodo. Linking the DNA strand asymmetry to the spatio-temporal replication program: II. accounting for neighbor-dependent substitution rates. *European Physical Journal E*, 35(11):123, Nov 2012.

[191] A. Baker, H. Julienne, C. L. Chen, B. Audit, Y. d'Aubenton Carafa, C. Thermes, and A. Arneodo. Linking the DNA strand asymmetry to the spatio-temporal replication program. I. about the role of the replication fork polarity in genome evolution. *European Physical Journal E*, 35(9):92, Sep 2012.

[192] Antoine Baker, Benjamin Audit, Chun-Long Chen, Benoit Moindrot, Antoine Leleu, Guillaume Guilbaud, Aurélien Rappailles, Cédric Vaillant, Arach Goldar, Fabien Mongelard, Yves d'Aubenton

Carafa, Olivier Hyrien, Claude Thermes, and Alain Arneodo. Replication fork polarity gradients revealed by megabase-sized U-shaped replication timing domains in human cell lines. *PLoS Computational Biology*, 8(4):e1002443, 2012.

[193] N. B. Becker, A. Rosa, and R. Everaers. The radial distribution function of worm-like chains. *European Physical Journal E*, 32(1):53–69, May 2010.

[194] Nils B. Becker and Ralf Everaers. Comment on "Remeasuring the Double Helix". *Science*, 325(5940), Jul 31 2009.

[195] Nils B. Becker and Ralf Everaers. DNA nanomechanics: How proteins deform the double helix. *Journal of Chemical Physics*, 130(13), Apr 7 2009.

[196] Nils B. Becker and Ralf Everaers. DNA Nanomechanics in the Nucleosome. *Structure*, 17(4):579–589, Apr 15 2009.

[197] Lotfi Berguiga, Elise Boyer-Provera, Cristina Martinez-Torres, Juan Elezgaray, Alain Arneodo, and Françoise Argoul. Guided wave microscopy: mastering the inverse problem. *Optics Letters*, 38(21):4269–4272, Nov 2013.

[198] Lotfi Berguiga, Thibault Roland, Karine Monier, Juan Elezgaray, and Françoise Argoul. Amplitude and phase images of cellular structures with a scanning surface plasmon microscope. *Optics Express*, 19(7):6571–6586, 2011.

[199] R. Bernal, Ch. Tassius, F. Melo, and J. Ch. Geminard. Elastic response and wrinkling onset of curved elastic membranes subjected to indentation test. *European Physical Journal E*, 34(2), Feb 2011.

[200] E. Boyer-Provera, A. Rossi, L. Oriol, C. Dumontet, A. Plesa, L. Berguiga, J. Elezgaray, A. Arneodo, and F. Argoul. Wavelet-based decomposition of high resolution surface plasmon microscopy v(z) curves at visible and near infrared wavelengths. *Optics Express*, 21(6):7456–7477, Mar 2013.

[201] M. Castelnovo, D. Muriaux, and C. Faivre-Moskalenko. Entropic control of particle sizes during viral self-assembly. *New Journal of Physics*, 15, Mar 26 2013.

[202] Martin Castelnovo, Timothée Verdier, and Lionel Foret. Comparing open and closed molecular self-assembly. *Europhysics Letters*, 105, 2014.

[203] Chun-Long Chen, Lauranne Duquenne, Benjamin Audit, Guillaume Guilbaud, Aurélien Rappailles, Antoine Baker, Maxime Huvet, Yves d'Aubenton Carafa, Olivier Hyrien, Alain Arneodo, and Claude Thermes. Replication-associated mutational asymmetry in the human genome. *Molecular Biology and Evolution*, 28(8):2327–2337, Aug 2011.

[204] Chun-Long Chen, Aurélien Rappailles, Lauranne Duquenne, Maxime Huvet, Guillaume Guilbaud, Laurent Farinelli, Benjamin Audit, Yves d'Aubenton-Carafa, Alain Arneodo, Olivier Hyrien, and Claude Thermes. Impact of replication timing on non-CpG and CpG substitution rates in mammalian genomes. *Genome Research*, 20:447–457, Jan 2010.

[205] G. Chevereau, A. Arneodo, and C. Vaillant. Influence of the genomic sequence on the primary structure of chromatin. *Frontiers in Life Science*, 5(1–2):28–68, 2011.

[206] G. Chevereau, L. Palmeira, C. Thermes, A. Arneodo, and C. Vaillant. Thermodynamics of intragenic nucleosome ordering. *Physical Review Letters*, 103(18):188103, Oct 2009.

[207] S. Cuesta-Lopez, D. Angelov, and M. Peyrard. Adding a new dimension to DNA melting curves. *Europhysics Letters*, 87(4), Aug 2009.

[208] Santiago Cuesta-Lopez, Herve Menoni, Dimitar Angelov, and Michel Peyrard. Guanine radical chemistry reveals the effect of thermal fluctuations in gene promoter regions. *Nucleic Acids Research*, 39(12):5276–5283, Jul 2011.

[209] J Elezgaray, L Berguiga, and F Argoul. Optimization of branched resonant nanostructures illuminated by a strongly focused beam. *Applied Physics Letters*, 97:243103, 2010.

[210] Juan Elezgaray, Lotfi Berguiga, and Françoise Argoul. Plasmon-based tomographic microscopy. *Journal of the Optical Society of America A*, 31(1):155, December 2013.

[211] Juan Elezgaray, Thibault Roland, Lotfi Berguiga, and Françoise Argoul. Modeling of the scanning surface plasmon microscope. *Journal of the Optical Society of America A*, 27(3):450–457, 2010.

[212] Ralf Everaers and Angelo Rosa. Multi-scale modeling of diffusion-controlled reactions in polymers: Renormalisation of reactivity parameters. *Journal of Chemical Physics*, 136(1), Jan 7 2012.

[213] Cendrine Faivre-Moskalenko, Julien Bernaud, Audrey Thomas, Kevin Tartour, Yvonne Beck, Maksym Iazykov, John Danial, Morgane Lourdin, Delphine Muriaux, and Martin Castelnovo. RNA Control of HIV-1 Particle Size Polydispersity. *PLOS One*, 9(1), Jan 24 2014.

[214] Flavio H. Fenton, Stefan Luther, Elizabeth M. Cherry, Niels F. Otani, Valentin Krinsky, Alain Pumir, Eberhard Bodenschatz, and Robert F. Gilmour, Jr. Termination of Atrial Fibrillation Using Pulsed Low-Energy Far-Field Stimulation. *Circulation*, 120(6):467–4, Aug 11 2009.

[215] X Gaume, K Monier, F Argoul, F Mongelard, and P Bouvet. *In-vivo* study of the histone chaperon activity of nucleolin by FRAP. *Biochemistry Research International*, 2011:187624, 2011.

[216] Jeremy Grant, Craig Verrill, Vincent Coustham, Alain Arneodo, Francesca Palladino, Karine Monier, and Andre Khalil. Perinuclear distribution of heterochromatin in developing C. elegans embryos. *Chromosome Research*, 18(8):873–885, Dec 2010.

[217] Guillaume Guilbaud, Aurélien Rappailles, Antoine Baker, Chun-Long Chen, Alain Arneodo, Arach Goldar, Yves d'Aubenton-Carafa, Claude Thermes, Benjamin Audit, and Olivier Hyrien. Evidence for sequential and increasing activation of replication origins along replication timing gradients in the human genome. *PLoS Computational Biology*, 7(12):e1002322, Dec 2011.

[218] Johannes-Geert Hagmann, Karol K. Kozlowski, Nikos Theodorakopoulos, and Michel Peyrard. On four-point correlation functions in simple polymer models. *Journal of Statistical Mechanics-Theory and Experiment*, Apr 2009.

[219] Johannes-Geert Hagmann, Naoko Nakagawa, and Michel Peyrard. Critical examination of the inherent-structure-landscape analysis of two-state folding proteins. *Physical Review E*, 80(6, 1), Dec 2009.

[220] Johannes-Geert Hagmann, Naoko Nakagawa, and Michel Peyrard. Characterization of the low-temperature properties of a simplified protein model. *Physical Review E*, 89(1), Jan 1 2014.

[221] S. Hu, T. Biben, X. Wang, P. Jurdic, and J. C.

Geminard. Internal dynamics of actin structures involved in the cell motility and adhesion: Modeling of the podosomes at the molecular level. *Journal of Theoretical Biology*, 270(1):25–30, Feb 7 2011.

[222] Shiqiong Hu, Emmanuelle Planus, Dan Georgess, Christophe Place, Xianghui Wang, Corinne Albiges-Rizo, Pierre Jurdic, and Jean-Christophe Geminard. Podosome rings generate forces that drive saltatory osteoclast migration. *Molecular Biology of the Cell*, 22(17):3120–3126, SEP 1 2011.

[223] Olivier Hyrien, Aurélien Rappailles, Guillaume Guilbaud, Antoine Baker, Chun-Long Chen, Arach Goldar, Nataliya Petryk, Malik Kahli, Emilie Ma, Yves d'Aubenton Carafa, Benjamin Audit, Claude Thermes, and Alain Arneodo. From simple bacterial and archaeal replicons to replication N/U-domains. *Journal of Molecular Biology*, 425(23):4673–4689, Nov 2013.

[224] Meerim Jeembaeva, Bengt Jonsson, Martin Castelnovo, and Alex Evilevitch. DNA Heats Up: Energetics of Genome Ejection from Phage Revealed by Isothermal Titration Calorimetry. *Journal of Molecular Biology*, 395(5):1079–1087, FEB 5 2010.

[225] Daniel Jost. Twist-DNA: computing base-pair and bubble opening probabilities in genomic superhelical DNA. *Bioinformatics*, 29(19):2479–2481, Oct 1 2013.

[226] Daniel Jost. Bifurcation in epigenetics: Implications in development, proliferation, and diseases. *Physical Review E*, 89(1), Jan 23 2014.

[227] Daniel Jost and Ralf Everaers. A Unified Poland-Scheraga Model of Oligo- and Polynucleotide DNA Melting: Salt Effects and Predictive Power. *Biophysical Journal*, 96(3):1056–1067, Feb 4 2009.

[228] Daniel Jost and Ralf Everaers. Genome wide application of DNA melting analysis. *Journal of Physics-Condensed Matter*, 21(3), Jan 21 2009.

[229] Daniel Jost and Ralf Everaers. Prediction of RNA multiloop and pseudoknot conformations from a lattice-based, coarse-grain tertiary structure model. *Journal of Chemical Physics*, 132(9), Mar 7 2010.

[230] Daniel Jost, Asif Zubair, and Ralf Everaers. Bubble statistics and positioning in superhelically stressed DNA. *Physical Review E*, 84(3, 1), Sep 12 2011.

[231] Hanna Julienne, Azedine Zoufir, Benjamin Audit, and Alain Arneodo. Epigenetic regulation of the human genome: coherence between promoter activity and large-scale chromatin environment. *Frontiers in Life Science*, 7(1-2):44–62, 2013.

[232] Hanna Julienne, Azedine Zoufir, Benjamin Audit, and Alain Arneodo. Human genome replication proceeds through four chromatin states. *PLoS Computational Biology*, 9(10):e1003233, Oct 2013.

[233] Claire Lemaitre, Lamia Zaghloul, Marie-France Sagot, Christian Gautier, Alain Arneodo, Eric Tannier, and Benjamin Audit. Analysis of fine-scale mammalian evolutionary breakpoints provides new insight into their relation to genome organisation. *BMC Genomics*, 10:335, 2009.

[234] Laurence Lemelle, Jean-Francois Palierne, Elodie Chatre, and Christophe Place. Counterclockwise Circular Motion of Bacteria Swimming at the Air-Liquid Interface. *Journal of Bacteriology*, 192(23):6307–6308, Dec 2010.

[235] Laurence Lemelle, Jean-Francois Palierne, Elodie Chatre, Cedric Vaillant, and Christophe Place. Curvature reversal of the circular motion of swimming bacteria probes for slip at solid/liquid interfaces. *Soft Matter*, 9(41):9759–9762, 2013.

[236] Paul Lesbats, Yair Botbol, Guillaume Chevereau, Cédric Vaillant, Christina Calmels, Alain Arneodo, Marie-Line Andreola, Marc Lavigne, and Vincent Parissi. Functional coupling between HIV-1 integrase and the SWI/SNF chromatin remodeling complex for efficient in vitro integration into stable nucleosomes. *PLoS Pathogens*, 7(2):e1001280, 2011.

[237] Stefan Luther, Flavio H. Fenton, Bruce G. Kornreich, Amgad Squires, Philip Bittihn, Daniel Hornung, Markus Zabel, James Flanders, Andrea Gladuli, Luis Campoy, Elizabeth M. Cherry, Gisa Luther, Gerd Hasenfuss, Valentin I. Krinsky, Alain Pumir, Robert F. Gilmour, Jr., and Eberhard Bodenschatz. Low-energy control of electrical turbulence in the heart. *Nature*, 475(7355):235–U152, Jul 14 2011.

[238] C Martinez-Torres, L Berguiga, L Streppa, E Boyer-Provera, L Schaeffer, J Elezgaray, A Arneodo, and F Argoul. Diffraction phase microscopy: retrieving phase contours on living cells with a wavelet based space-scale analysis. *Journal of Biomedical Optics*, 19(3):036007, 2014.

[239] Sam Meyer, Nils B. Becker, Sajad Hussain Syed, Damien Goutte-Gattat, Manu Shubhdarshan Shukla, Jeffrey J. Hayes, Dimitar Angelov, Jan Bednar, Stefan Dimitrov, and Ralf Everaers. From crystal and NMR structures, footprints and cryo-electron-micrographs to large and soft structures: nanoscale modeling of the nucleosomal stem. *Nucleic Acids Research*, 39(21):9139–9154, Nov 2011.

[240] Sam Meyer, Daniel Jost, Nikos Theodorakopoulos, Michel Peyrard, Richard Lavery, and Ralf Everaers. Temperature Dependence of the DNA Double Helix at the Nanoscale: Structure, Elasticity, and Fluctuations. *Biophysical Journal*, 105(8):1904–1914, Oct 15 2013.

[241] Pascale Milani, Guillaume Chevereau, Cédric Vaillant, Benjamin Audit, Zofia Haftek-Terreau, Monique Marilley, Philippe Bouvet, Françoise Argoul, and Alain Arneodo. Nucleosome positioning by genomic excluding-energy barriers. *Proceedings of the National Academy of Sciences of the United States of America*, 106(52):22257–22262, Dec 2009.

[242] Pascale Milani, Maryam Gholamirad, Jan Traas, Alain Arneodo, Arezki Boudaoud, Françoise Argoul, and Olivier Hamant. In vivo analysis of local wall stiffness at the shoot apical meristem in Arabidopsis using atomic force microscopy. *The Plant Journal*, 67(6):1116–1123, Sep 2011.

[243] Pascale Milani, Monique Marilley, Albert Sanchez-Sevilla, Jean Imbert, Cédric Vaillant, Françoise Argoul, Jean-Marc Egly, José Rocca-Serra, and Alain Arneodo. Mechanics of the IL2RA gene activation revealed by modeling and atomic force microscopy. *PLOS One*, 6(4):e18811, 2011.

[244] Benoit Moindrot, Benjamin Audit, Petra Klous, Antoine Baker, Claude Thermes, Wouter de Laat, Philippe Bouvet, Fabien Mongelard, and Alain Arneodo. 3D chromatin conformation correlates with replication timing and is conserved in resting cells. *Nucleic Acids Research*, 40(19):9470–9481, Oct 2012.

[245] Fabien Montel, Martin Castelnovo, Herve Menoni, Dimitar Angelov, Stefan Dimitrov, and Cendrine Faivre-Moskalenko. RSC remodeling of oligo-nucleosomes: an atomic force microscopy study. *Nucleic Acids Research*, 39(7):2571–2579, Apr 2011.

[246] Fabien Montel, Herve Menoni, Martin Castelnovo, Jan Bednar, Stefan Dimitrov, Dimitar Angelov, and Cendrine Faivre-Moskalenko. The Dynamics of Individual Nucleosomes Controls the Chromatin Condensation Pathway: Direct Atomic Force Microscopy Visualization of Variant Chromatin. *Biophysical Journal*, 97(2):544–553, Jul 22 2009.

[247] J. Moukhtar, C. Faivre-Moskalenko, P. Milani, B. Audit, C. Vaillant, E. Fontaine, F. Mongelard, G. Lavorel, P. St-Jean, P. Bouvet, F. Argoul, and A. Arneodo. Effect of genomic long-range correlations on DNA persistence length: From theory to single molecules experiments. *Journal of Physical Chemistry B*, 114:5125–5143, 2010.

[248] J. Moukhtar, C. Vaillant, B. Audit, and A. Arneodo. Generalized wormlike chain model for long-range correlated heteropolymers. *Europhysics Letters*, 86:48001, 2009.

[249] J. Moukhtar, C. Vaillant, B. Audit, and A. Arneodo. Revisiting polymer statistical physics to account for the presence of long-range-correlated structural disorder in 2D DNA chains. *European Physical Journal E*, 34(11):119, Nov 2011.

[250] S. Nicolle, L. Noguer, and J. F. Palierne. Shear mechanical properties of the spleen: Experiment and analytical modelling. *Journal of the Mechanical Behavior of Biomedical Materials*, 9:130–136, May 2012.

[251] S. Nicolle, L. Noguer, and J. F. Palierne. Shear mechanical properties of the porcine pancreas: Experiment and analytical modelling. *Journal of the Mechanical Behavior of Biomedical Materials*, 26:90–97, Oct 2013.

[252] S. Nicolle and J. F. Palierne. Dehydration effect on the mechanical behaviour of biological soft tissues: Observations on kidney tissues. *Journal of the Mechanical Behavior of Biomedical Materials*, 3(8):630–635, Nov 2010.

[253] S. Nicolle and J. F. Palierne. On the efficiency of attachment methods of biological soft tissues in shear experiments. *Journal of the Mechanical Behavior of Biomedical Materials*, 14:158–162, Oct 2012.

[254] S. Nicolle, P. Vezin, and J. F. Palierne. A strain-hardening bi-power law for the nonlinear behaviour of biological soft tissues. *Journal of Biomechanics*, 43(5):927–932, Mar 22 2010.

[255] Elmar Nurmemmedov, Martin Castelnovo, Elizabeth Medina, Carlos Enrique Catalano, and Alex Evilevitch. Challenging Packaging Limits and Infectivity of Phage lambda. *Journal of Molecular Biology*, 415(2):263–273, Jan 13 2012.

[256] M. Peyrard, S. Cuesta-Lopez, and D. Angelov. Experimental and theoretical studies of sequence effects on the fluctuation and melting of short DNA molecules. *Journal of Physics-Condensed Matter*, 21(3), Jan 21 2009.

[257] M. Peyrard, S. Cuesta-Lopez, and G. James. Nonlinear Analysis of the Dynamics of DNA Breathing. *Journal of Biological Physics*, 35(1):73–89, Feb 2009.

[258] Franck Picard, Jean-Charles Cadoret, Benjamin Audit, Alain Arneodo, Adriana Alberti, Christophe Battail, Laurent Duret, and Marie-Noelle Prioleau. The spatiotemporal program of DNA replication is associated with specific combinations of chromatin marks in human cells. *PLoS Genet.*, 10:e1004282, 2014.

[259] Raffaello Potestio, Pep Espanol, Rafael Delgado-Buscalioni, Ralf Everaers, Kurt Kremer, and Davide Donadio. Monte Carlo Adaptive Resolution Simulation of Multicomponent Molecular Liquids. *Physical Review Letters*, 111(6), Aug 8 2013.

[260] Raffaello Potestio, Sebastian Fritsch, Pep Espanol, Rafael Delgado-Buscalioni, Kurt Kremer, Ralf Everaers, and Davide Donadio. Hamiltonian Adaptive Resolution Simulation for Molecular Liquids. *Physical Review Letters*, 110(10), Mar 5 2013.

[261] Anais Poulet, Rémi Buisson, Cendrine Faivre-Moskalenko, Mélanie Koelblen, Simon Amiard, Fabien Montel, Santiago Cuesta-Lopez, Olivier Bornet, Francoise Guerlesquin, Thomas Godet, Julien Moukhtar, Francoise Argoul, Anne-Cécile Déclais, David M J Lilley, Stephen C Y Ip, Stephen C West, Eric Gilson, and Marie-Josèphe Giraud-Panis. TRF2 promotes, remodels and protects telomeric Holliday junctions. *EMBO Journal*, 28(6):641–651, March 2009.

[262] Anaïs Poulet, Sabrina Pisano, Cendrine Faivre-Moskalenko, Bei Pei, Yannick Tauran, Zofia Haftek-Terreau, Frédéric Brunet, Yann-Vaï Le Bihan, Marie-Hélène Ledu, Fabien Montel, Nicolas Hugo, Simon Amiard, Françoise Argoul, Annie Chaboud, Eric Gilson, and Marie-Josèphe Giraud-Panis. The N-terminal domains of TRF1 and TRF2 regulate their ability to condense telomeric DNA. *Nucleic Acids Research*, 40(6):2566–2576, 2012.

[263] Alain Pumir and Boris Shraiman. Epistasis in a Model of Molecular Signal Transduction. *PLOS Computational Biology*, 7(5), May 2011.

[264] Alain Pumir, Sitabhra Sinha, S. Sridhar, Mederic Argentina, Marcel Hoerning, Simonetta Filippi, Christian Cherubini, Stefan Luther, and Valentin Krinsky. Wave-train-induced termination of weakly anchored vortices in excitable media. *Physical Review E*, 81(1, 1), Jan 2010.

[265] Soizic Riche, Melissa Zouak, Françoise Argoul, Alain Arneodo, Jacques Pecreaux, and Marie Delattre. Evolutionary comparisons reveal a positional switch for spindle pole oscillations in caenorhabditis embryos. *The Journal of Cell Biology*, 201(5):653–662, May 2013.

[266] T Roland, L Berguiga, J Elezgaray, and F Argoul. Scanning surface plasmon imaging of nanoparticles. *Physical Review B*, 81(23):235419, 2010.

[267] T. Roland, A. Khalil, A. Tanenbaum, L. Berguiga, P. Delichere, L. Bonneviot, J. Elezgaray, A. Arneodo, and F. Argoul. Revisiting the physical processes of vapodeposited thin gold films on chemically modified glass by atomic force and surface plasmon microscopies. *Surface Science*, 603:3307, 2009.

[268] Angelo Rosa, Nils B. Becker, and Ralf Everaers. Looping Probabilities in Model Interphase Chromosomes. *Biophysical Journal*, 98(11):2410–2419, Jun 2 2010.

[269] Angelo Rosa and Ralf Everaers. Ring Polymers in the Melt State: The Physics of Crumpling. *Physical Review Letters*, 112, 2014.

[270] Rajeev Singh, Jinshan Xu, Nicolas G. Garnier, Alain Pumir, and Sitabhra Sinha. Self-Organized Transition to Coherent Activity in Disordered Media. *Physical Review Letters*, 108(6), Feb 9 2012.

[271] M. Suissa, C. Place, E. Goillot, and E. Freyssingeas. Evolution of the Global Internal Dynamics of a Living Cell Nucleus during Interphase. *Biophysical Journal*, 97(2):453–461, Jul 22 2009.

[272] Sajad Hussain Syed, Damien Goutte-Gattat, Nils Becker, Sam Meyer, Manu Shubhdarshan Shukla, Jeffrey J. Hayes, Ralf Everaers, Dimitar Angelov, Jan Bednar, and Stefan Dimitrov. Single-base resolution mapping of H1-nucleosome interactions and 3D organization of the nucleosome. *Proceedings of the National Academy of Sciences of the United States of America*, 107(21):9620–9625, May 25 2010.

[273] Nikos Theodorakopoulos and Michel Peyrard. Base Pair Openings and Temperature Dependence of DNA Flexibility. *Physical Review Letters*, 108(7), Feb 16 2012.

[274] Andrew A. Travers, Cédric Vaillant, Alain Arneodo, and Georgi Muskhelishvili. DNA structure, nucleosome placement and chromatin remodelling: a perspective. *Biochemical Society Transactions*, 40(2):335–340, Apr 2012.

[275] Cédric Vaillant and Thierry Grange. DNA: a structural "band-pass" filter of genomic sequence. *Physical Review Letters*, 10:68–69, 2013.

[276] Cédric Vaillant, Leonor Palmeira, Guillaume Chevereau, Benjamin Audit, Yves d'Aubenton-Carafa, Claude Thermes, and Alain Arneodo. A novel strategy of transcription regulation by intragenic nucleosome ordering. *Genome Research*, 20(1):59–67, Jan 2010.

[277] Jessica Valle-Orero, Jean-Luc Garden, Jacques Richard, Andrew Wildes, and Michel Peyrard. Glassy Behavior of Denatured DNA Films Studied by Differential Scanning Calorimetry. *Journal of Physical Chemistry B*, 116(14):4394–4402, Apr 12 2012.

[278] Jessica Valle-Orero, Andrew Wildes, Jean-Luc Garden, and Michel Peyrard. Purification of A-Form DNA Fiber Samples by the Removal of B-Form DNA Residues. *Journal of Physical Chemistry B*, 117(6):1849–1856, Feb 14 2013.

[279] T. S. van Erp, S. Cuesta-Lopez, J. G. Hagmann, and M. Peyrard. Comment on "A generalized Langevin formalism of complete DNA melting transition" by Das T. and Chakraborty S. *Europhysics Letters*, 85(6), Mar 2009.

[280] Titus S. van Erp and Michel Peyrard. The dynamics of the DNA denaturation transition. *Europhysics Letters*, 98(4), May 2012.

[281] Andrew Wildes, Nikos Theodorakopoulos, Jessica Valle-Orero, Santiago Cuesta-Lopez, Jean-Luc Garden, and Michel Peyrard. Structural correlations and melting of B-DNA fibers. *Physical Review E*, 83(6, 1), Jun 30 2011.

[282] Andrew Wildes, Nikos Theodorakopoulos, Jessica Valle-Orero, Santiago Cuesta-Lopez, Jean-Luc Garden, and Michel Peyrard. Thermal Denaturation of DNA Studied with Neutron Scattering. *Physical Review Letters*, 106(4), Jan 24 2011.

[283] Jinshan Xu, Changgui Gu, Alain Pumir, Nicolas Garnier, and Zonghua Liu. Entrainment of the suprachiasmatic nucleus network by a light-dark cycle. *Physical Review E*, 86(4, 1), Oct 8 2012.

[284] Jinshan Xu, Rajeev Singh, Nicolas B. Garnier, Sitabhra Sinha, and Alain Pumir. The effect of quenched disorder on dynamical transitions in systems of coupled cells. *New Journal of Physics*, 15, Sep 30 2013.

[285] Lamia Zaghloul, Antoine Baker, Benjamin Audit, and Alain Arneodo. Gene organization inside replication domains in mammalian genomes. *Comptes Rendus Mécanique*, 340:745–757, 2012.

[286] S Zhang, L Berguiga, J Elezgaray, N Hugo, W X Li, T Roland, H Zeng, and F Argoul. Advances in surface plasmon resonance-based high throughput biochips. *Frontiers of Physics in China*, 4:469–480, 2009.

[287] Sanjun Zhang, Nicolas Hugo, Wenxue Li, Thibault Roland, Lotfi Berguiga, Juan Elezgaray, and Françoise Argoul. Impedance spectroscopy of the potential response of MUO and AUT self-assembled monolayers on polycrystalline thin gold films. *Journal of Electroanalytical Chemistry*, 629(1-2):138–146, 2009.

T4B. Mathematical Physics and Fundamental Interactions

[288] Andres Acena, Andres Anabalon, Dumitru Astefanesei, and Robert Mann. Hairy planar black holes in higher dimensions. *Journal of High Energy Physics*, (01), Jan 28 2014.

[289] Andres Anabalon and Dumitru Astefanesei. On attractor mechanism of AdS_4 black holes. *Physics Letters B*, 727(4-5):568–572, Dec 18 2013.

[290] Andres Anabalon, Thomas Ortiz, and Henning Samtleben. Rotating D0-branes and consistent truncations of supergravity. *Physics Letters B*, 727(4-5):516–523, Dec 18 2013.

[291] Remi C. Avohou, Joseph Ben Geloun, and Etera R. Livine. On terminal forms for topological polynomials for ribbon graphs: The N-petal flower. *European Journal of Combinatorics*, 36:348–366, Feb 2014.

[292] Valentina Baccetti, Etera R. Livine, and James P. Ryan. The particle interpretation of N=1 supersymmetric spin foams. *Classical and Quantum Gravity*, 27(22), Nov 21 2010.

[293] Igor Bandos, Henning Samtleben, and Dmitri Sorokin. Duality-symmetric actions for non-Abelian tensor fields. *Physical Review D*, 88(2), Jul 16 2013.

[294] Niklas Beisert, Changrim Ahn, Luis F. Alday, Zoltan Bajnok, James M. Drummond, Lisa Freyhult, Nikolay Gromov, Romuald A. Janik, Vladimir Kazakov, Thomas Klose, Gregory P. Korchemsky, Charlotte Kristjansen, Marc Magro, Tristan Mcloughlin, Joseph A. Minahan, Rafael I. Nepomechie, Adam Rej, Radu Roiban, Sakura Schaefer-Nameki, Christoph Sieg, Matthias Staudacher, Alessandro Torrielli, Arkady A. Tseytlin, Pedro Vieira, Dmytro Volin, and Konstantinos Zoubos. Review of AdS/CFT Integrability: An Overview. *Letters in Mathematical Physics*, 99(1-3):3–32, Jan 2012.

[295] Joseph Ben Geloun and Etera R. Livine. Some classes of renormalizable tensor models. *Journal of Mathematical Physics*, 54(8), Aug 2013.

[296] Quentin Berger and Fabio Lucio Toninelli. On the critical point of the Random Walk Pinning Model in dimension d=3. *Electronic Journal of Probability*, 15:654–683, May 17 2010.

[297] Quentin Berger and Fabio Lucio Toninelli. Hierarchical pinning model in correlated random environment. *Annales de l'Institut Henri Poincaré-Probabilités et Statistiques*, 49(3):781–816, Aug

2013.

[298] E. Bergshoeff, S. Cecotti, H. Samtleben, and E. Sezgin. Superconformal sigma models in three dimensions. *Nuclear Physics B*, 838(3):266–297, Oct 21 2010.

[299] Cedric Bernardin and Fabio Lucio Toninelli. A one-dimensional coagulation-fragmentation process with a dynamical phase transition. *Stochastic Processes and their Applications*, 122(4):1672–1708, Apr 2012.

[300] Valentin Bonzom and Etera R. Livine. Lagrangian approach to the Barrett-Crane spin foam model. *Physical Review D*, 79(6), Mar 2009.

[301] Valentin Bonzom and Etera R. Livine. A new Hamiltonian for the topological BF phase with spinor networks. *Journal of Mathematical Physics*, 53(7), Jul 2012.

[302] Valentin Bonzom and Etera R. Livine. A New Recursion Relation for the 6j-Symbol. *Annales Henri Poincaré*, 13(4):1083–1099, May 2012.

[303] Valentin Bonzom and Etera R. Livine. Generating functions for coherent intertwiners. *Classical and Quantum Gravity*, 30(5), Mar 7 2013.

[304] Valentin Bonzom, Etera R. Livine, and Simone Speziale. Recurrence relations for spin foam vertices. *Classical and Quantum Gravity*, 27(12), Jun 21 2010.

[305] Enrique F. Borja, Jacobo Diaz-Polo, Inaki Garay, and Etera R. Livine. Dynamics for a 2-vertex quantum gravity model. *Classical and Quantum Gravity*, 27(23), Dec 7 2010.

[306] Enrique F. Borja, Laurent Freidel, Inaki Garay, and Etera R. Livine. U(N) tools for loop quantum gravity: the return of the spinor. *Classical and Quantum Gravity*, 28(5), Mar 7 2011.

[307] Freddy Bouchet and Hidetoshi Morita. Large time behavior and asymptotic stability of the 2D Euler and linearized Euler equations. *Physica D*, 239(12):948–966, JUN 15 2010.

[308] E. Buffenoir, Ph. Roche, and V. Terras. Universal vertex-IRF transformation for quantum affine algebras. *Journal of Mathematical Physics*, 53(10), Oct 2012.

[309] David Burke and Robert Wimmer. Quantum energies and tensorial central charges of confined monopoles. *Journal of High Energy Physics*, (10), Oct 2011.

[310] Pietro Caputo, Hubert Lacoin, Fabio Martinelli, Francois Simenhaus, and Fabio Lucio Toninelli. Polymer dynamics in the depinned phase: metastability with logarithmic barriers. *Probability Theory and Related Fields*, 153(3-4):587–641, Aug 2012.

[311] Pietro Caputo, Eyal Lubetzky, Fabio Martinelli, Allan Sly, and Fabio Lucio Toninelli. The shape of the (2+1)D SOS surface above a wall. *Comptes Rendus Mathématique*, 350(13-14):703–706, Jul 2012.

[312] Pietro Caputo, Fabio Martinelli, Francois Simenhaus, and Fabio Lucio Toninelli. "Zero" Temperature Stochastic 3D Ising Model and Dimer Covering Fluctuations: A First Step Towards Interface Mean Curvature Motion. *Communicatons on Pure and Applied Mathematics*, 64(6):778–831, Jun 2011.

[313] Pietro Caputo, Fabio Martinelli, and Fabio Lucio Toninelli. Convergence to Equilibrium of Biased Plane Partitions. *Random Structures & Algorithms*, 39(1):83–114, Aug 2011.

[314] Pietro Caputo, Fabio Martinelli, and Fabio Lucio Toninelli. Mixing Times of Monotone Surfaces and SOS Interfaces: A Mean Curvature Approach. *Communications in Mathematical Physics*, 311(1):157–189, Apr 2012.

[315] Davide Cassani, Sergio Ferrara, Alessio Marrani, Jose F. Morales, and Henning Samtleben. A special road to AdS vacua. *Journal of High Energy Physics*, (2), Feb 2010.

[316] J. Daniel Christensen, Igor Khavkine, Etera R. Livine, and Simone Speziale. The sub-leading asymptotic behaviour of area correlations in the Barrett-Crane model. *Classical and Quantum Gravity*, 27(3), Feb 7 2010.

[317] J. Daniel Christensen, Etera R. Livine, and Simone Speziale. Numerical evidence of regularized correlations in spin foam gravity. *Physics Letters B*, 670(4-5):403–406, Jan 5 2009.

[318] Eoin O. Colgain and Henning Samtleben. $3D$ gauged supergravity from wrapped M5-branes with AdS/CMT applications. *Journal of High Energy Physics*, (2), Feb 2011.

[319] Christoph Dankert, Richard Cleve, Joseph Emerson, and Etera Livine. Exact and approximate unitary 2-designs and their application to fidelity estimation. *Physical Review A*, 80(1), Jul 2009.

[320] Paul de Fromont, K. Gawedzki, and Clement Tauber. Global gauge anomalies in coset models of conformal field theory. *Communications in Mathematical Physics*, 328(3), Jun 2014.

[321] Nihat Sadik Deger, Henning Samtleben, and Ozgur Sarioglu. On the supersymmetric solutions of $D = 3$ half-maximal supergravities. *Nuclear Physics B*, 840(1-2):29–53, Nov 21 2010.

[322] S Deger, A Kaya, H Samtleben, and E Sezgin. Supersymmetric warped ads in extended topologically massive supergravity. *Nuclear Physics B*, 884:106, 2014.

[323] F. Delduc, M. Magro, and B. Vicedo. A lattice Poisson algebra for the Pohlmeyer reduction of the $AdS_5 \times S^5$ superstring. *Physics Letters B*, 713(3):347–349, Jul 9 2012.

[324] F. Delduc, M. Magro, and B. Vicedo. Alleviating the non-ultralocality of coset sigma-models through a generalized Faddeev-Reshetikhin procedure. *Journal of High Energy Physics*, (8), Aug 2012.

[325] F. Delduc, M. Magro, and B. Vicedo. Alleviating the non-ultralocality of the $AdS_5 \times S^5$ superstring. *Journal of High Energy Physics*, (10), Oct 2012.

[326] F. Delduc, M. Magro, and B. Vicedo. Generalized sine-Gordon models and quantum braided groups. *Journal of High Energy Physics*, (3), Mar 2013.

[327] F. Delduc, M. Magro, and B. Vicedo. On classical q-deformations of integrable sigma-models. *Journal of High Energy Physics*, (11), Nov 26 2013.

[328] F. Delduc, M. Magro, and B. Vicedo. Integrable deformation of the $AdS_5 \times S^5$ superstring action. *Physical Review Letters*, 112(5), Feb 5 2014.

[329] Bernard Derrida, Giambattista Giacomin, Hubert Lacoin, and Fabio Lucio Toninelli. Fractional Moment Bounds and Disorder Relevance for Pinning Models. *Communications in Mathematical Physics*, 287(3):867–887, May 2009.

[330] Maiete Dupuis and Etera R. Livine. Lifting SU(2) spin networks to projected spin networks. *Physical Review D*, 82(6), Sep 30 2010.

[331] Maite Dupuis, Laurent Freidel, Etera R. Livine, and Simone Speziale. Holomorphic Lorentzian simplicity constraints. *Journal of Mathematical Physics*, 53(3), Mar 2012.

[332] Maite Dupuis, Florian Girelli, and Etera R. Livine. Spinors group field theory and Voros star product: First contact. *Physical Review D*, 86(10), Nov 20 2012.

[333] Maite Dupuis and Etera R. Livine. Pushing the asymptotics of the 6j-symbol further. *Physical Review D*, 80(2), Jul 2009.

[334] Maite Dupuis and Etera R. Livine. The 6j-symbol: recursion, correlations and asymptotics. *Classical and Quantum Gravity*, 27(13), Jul 7 2010.

[335] Maite Dupuis and Etera R. Livine. Boundary state stability under spinfoam evolution for the quantum 4-simplex. *Classical and Quantum Gravity*, 28(21), Nov 7 2011.

[336] Maite Dupuis and Etera R. Livine. Holomorphic simplicity constraints for 4D spinfoam models. *Classical and Quantum Gravity*, 28(21), Nov 7 2011.

[337] Maite Dupuis and Etera R. Livine. Revisiting the simplicity constraints and coherent intertwiners. *Classical and Quantum Gravity*, 28(8), Apr 21 2011.

[338] Sergio Ferrara, Alessio Marrani, Jose F. Morales, and Henning Samtleben. Intersecting attractors. *Physical Review D*, 79(6), Mar 2009.

[339] Laurent Freidel, Kirill Krasnov, and Etera R. Livine. Holomorphic Factorization for a Quantum Tetrahedron. *Communications in Mathematical Physics*, 297(1):45–93, Jul 2010.

[340] Laurent Freidel and Etera R. Livine. The fine structure of SU(2) intertwiners from U(N) representations. *Journal of Mathematical Physics*, 51(8), Aug 2010.

[341] Laurent Freidel and Etera R. Livine. U(N) coherent states for loop quantum gravity. *Journal of Mathematical Physics*, 52(5), May 2011.

[342] Krzysztof Gawedzki, Rafal R. Suszek, and Konrad Waldorf. Bundle gerbes for orientifold sigma models. *Advances in Theoretical and Mathematical Physics*, 15(3):621–687, Jun 2011.

[343] Krzysztof Gawedzki, Rafal R. Suszek, and Konrad Waldorf. Global Gauge Anomalies in Two-Dimensional Bosonic Sigma Models. *Communications in Mathematical Physics*, 302(2):513–580, Mar 2011.

[344] Krzysztof Gawedzki, Rafal R. Suszek, and Konrad Waldorf. The gauging of two-dimensional bosonic sigma models on world-sheets with defects. *Reviews in Mathematical Physics*, 25(6), Jul 2013.

[345] Krzysztof Gawedzki and Konrad Waldorf. Polyakov-Wiegmann formula and multiplicative gerbes. *Journal of High Energy Physics*, (9), Sep 2009.

[346] Giambattista Giacomin, Hubert Lacoin, and Fabio Toninelli. Marginal Relevance of Disorder for Pinning Models. *Communicatons on Pure and Applied Mathematics*, 63(2):233–265, Feb 2010.

[347] Giambattista Giacomin, Hubert Lacoin, and Fabio Lucio Toninelli. Hierarchical pinning models, quadratic maps and quenched disorder. *Probability Theory and Related Fields*, 147(1-2):185–216, May 2010.

[348] Giambattista Giacomin, Hubert Lacoin, and Fabio Lucio Toninelli. Disorder relevance at marginality and critical point shift. *Annales de l'Institut Henri Poincaré - Probabilités et Statistiques*, 47(1):148–175, Feb 2011.

[349] Giambattista Giacomin and Fabio Lucio Toninelli. On the irrelevant disorder regime of pinning models. *Annals of Probability*, 37(5):1841–1875, Sep 2009.

[350] Florian Girelli and Etera R. Livine. A deformed Poincare invariance for group field theories. *Classical and Quantum Gravity*, 27(24), Dec 21 2010.

[351] Florian Girelli and Etera R. Livine. Special relativity as a noncommutative geometry: Lessons for deformed special relativity. *Physical Review D*, 81(8), Apr 15 2010.

[352] Florian Girelli and Etera R. Livine. Scalar field theory in Snyder space-time: alternatives. *Journal of High Energy Physics*, (3), Mar 2011.

[353] Florian Girelli, Etera R. Livine, and Daniele Oriti. Four-dimensional deformed special relativity from group field theories. *Physical Review D*, 81(2), Jan 15 2010.

[354] N. Grosjean, J. M. Maillet, and G. Niccoli. On the form factors of local operators in the lattice sine-Gordon model. *Journal of Statistical Mechanics-Theory and Experiment*, Oct 2012.

[355] N. Grosjean and G. Niccoli. The tau(2)-model and the chiral Potts model revisited: completeness of Bethe equations from Sklyanin's SOV method. *Journal of Statistical Mechanics-Theory and Experiment*, Nov 2012.

[356] M. Gunaydin, H. Samtleben, and E. Sezgin. On the magical supergravities in six dimensions. *Nuclear Physics B*, 848(1):62–89, Jul 1 2011.

[357] Olaf Hohm and Henning Samtleben. Exceptional Form of $D = 11$ Supergravity. *Physical Review Letters*, 111(23), Dec 4 2013.

[358] Olaf Hohm and Henning Samtleben. Gauge theory of Kaluza-Klein and winding modes. *Physical Review D*, 88(8), Oct 4 2013.

[359] Olaf Hohm and Henning Samtleben. U-duality covariant gravity. *Journal of High Energy Physics*, (9), Sep 16 2013.

[360] Olaf Hohm and Henning Samtleben. Exceptional field theory. I. $E_{6(6)}$-covariant form of M-theory and type IIB. *Physical Review D*, 89, Mar 27 2014.

[361] Olaf Hohm and Henning Samtleben. Exceptional field theory. II. $E_{7(7)}$. *Physical Review D*, 89, Mar 27 2014.

[362] N. Kitanine, K. K. Kozlowski, J. M. Maillet, N. A. Slavnov, and V. Terras. Algebraic Bethe ansatz approach to the asymptotic behavior of correlation functions. *Journal of Statistical Mechanics-Theory and Experiment*, Apr 2009.

[363] N. Kitanine, K. K. Kozlowski, J. M. Maillet, N. A. Slavnov, and V. Terras. On the thermodynamic limit of form factors in the massless XXZ Heisenberg chain. *Journal of Mathematical Physics*, 50(9), Sep 2009. Workshop on Integrable Quantum Systems and Solvable Statistical Mechanics Models, CRM, Montreal, Canada, Jun 30-Jul 05, 2008.

[364] N. Kitanine, K. K. Kozlowski, J. M. Maillet, N. A. Slavnov, and V. Terras. Riemann-Hilbert Approach to a Generalised Sine Kernel and Applications. *Communications in Mathematical Physics*, 291(3):691–761, Nov 2009.

[365] N. Kitanine, K. K. Kozlowski, J. M. Maillet, N. A. Slavnov, and V. Terras. A form factor approach to the asymptotic behavior of correlation functions in critical models. *Journal of Statistical Mechanics-Theory and Experiment*, Dec 2011.

[366] N. Kitanine, K. K. Kozlowski, J. M. Maillet, N. A. Slavnov, and V. Terras. The thermodynamic limit of particle-hole form factors in the massless XXZ Heisenberg chain. *Journal of Statistical Mechanics-*

Theory and Experiment, May 2011.

[367] N. Kitanine, K. K. Kozlowski, J. M. Maillet, N. A. Slavnov, and V. Terras. Form factor approach to dynamical correlation functions in critical models. *Journal of Statistical Mechanics-Theory and Experiment*, Sep 2012.

[368] N Kitanine, K K Kozlowski, J M Maillet, and V Terras. Large-distance asymptotic behaviour of multi-point correlation functions in massless quantum models. *Journal of Statistical Mechanics: Theory and Experiment*, 2014(5):P05011, 2014.

[369] N Kitanine, J M Maillet, and G Niccoli. Open spin chains with generic integrable boundaries: Baxter equation and bethe ansatz completeness from separation of variables. *Journal of Statistical Mechanics: Theory and Experiment*, 2014(5):P05015, 2014.

[370] Dmitry Korotkin and Henning Samtleben. Generalization of Okamoto's Equation to Arbitrary 2 x 2 Schlesinger System. *Advances in Mathematical Physics*, 2009.

[371] K. K. Kozlowski, J. M. Maillet, and N. A. Slavnov. Correlation functions for one-dimensional bosons at low temperature. *Journal of Statistical Mechanics-Theory and Experiment*, Mar 2011.

[372] K. K. Kozlowski, J. M. Maillet, and N. A. Slavnov. Long-distance behavior of temperature correlation functions in the one-dimensional Bose gas. *Journal of Statistical Mechanics-Theory and Experiment*, Mar 2011.

[373] K. K. Kozlowski and V. Terras. Long-time and large-distance asymptotic behavior of the current-current correlators in the non-linear Schrodinger model. *Journal of Statistical Mechanics-Theory and Experiment*, Sep 2011.

[374] Arnaud Le Diffon and Henning Samtleben. Supergravities without an action: Gauging the trombone. *Nuclear Physics B*, 811(1-2):1–35, Apr 11 2009.

[375] Arnaud Le Diffon, Henning Samtleben, and Mario Trigiante. $N = 8$ supergravity with local scaling symmetry. *Journal of High Energy Physics*, (4), Apr 2011.

[376] D. Levy-Bencheton and V. Terras. An algebraic Bethe ansatz approach to form factors and correlation functions of the cyclic eight-vertex solid-on-solid model. *Journal of Statistical Mechanics-Theory and Experiment*, Apr 2013.

[377] D. Levy-Bencheton and V. Terras. Spontaneous staggered polarizations of the cyclic solid-on-solid model from the algebraic Bethe Ansatz. *Journal of Statistical Mechanics-Theory and Experiment*, Oct 2013.

[378] D Levy-Bencheton and V Terras. Multi-point local height probabilities of the csos model within the algebraic bethe ansatz framework. *Journal of Statistical Mechanics-Theory and Experiment*, Apr 2014.

[379] Etera Livine and Johannes Tambornino. Spinor representation for loop quantum gravity. *Journal of Mathematical Physics*, 53(1), Jan 2012.

[380] Etera R. Livine. Matrix models as non-commutative field theories on R-3. *Classical and Quantum Gravity*, 26(19), Oct 7 2009.

[381] Etera R. Livine. Notes on qubit phase space and discrete symplectic structures. *Journal of Physics A-Mathematical and Theoretical*, 43(7), Feb 19 2010.

[382] Etera R. Livine. Deformations of polyhedra and polygons by the unitary group. *Journal of Mathematical Physics*, 54(12), Dec 2013.

[383] Etera R. Livine. Deformation operators of spin networks and coarse-graining. *Classical and Quantum Gravity*, 31(7), Apr 7 2014.

[384] Etera R. Livine and Mercedes Martin-Benito. Group theoretical quantization of isotropic loop cosmology. *Physical Review D*, 85(12), Jun 22 2012.

[385] Etera R. Livine and Mercedes Martin-Benito. Classical setting and effective dynamics for spinfoam cosmology. *Classical and Quantum Gravity*, 30(3), Feb 7 2013.

[386] Etera R. Livine, Daniele Oriti, and James P. Ryan. Effective Hamiltonian constraint from group field theory. *Classical and Quantum Gravity*, 28(24), Dec 21 2011.

[387] Etera R. Livine and James P. Ryan. A note on B-observables in Ponzano-Regge 3D quantum gravity. *Classical and Quantum Gravity*, 26(3), Feb 7 2009.

[388] Etera R. Livine, Simone Speziale, and Johannes Tambornino. Twistor networks and covariant twisted geometries. *Physical Review D*, 85(6), Mar 2 2012.

[389] Etera R. Livine and Johannes Tambornino. Holonomy operator and quantization ambiguities on spinor space. *Physical Review D*, 87(10), May 10 2013.

[390] Etera R. Livine and Daniel R. Terno. The entropic boundary law in BF theory. *Nuclear Physics B*, 806(3):715–734, Jan 11 2009.

[391] Etera R. Livine and Daniel R. Terno. Entropy in the classical and quantum polymer black hole models. *Classical and Quantum Gravity*, 29(22), Nov 21 2012.

[392] Eyal Lubetzky, Fabio Martinelli, Allan Sly, and Fabio Lucio Toninelli. Quasi-polynomial mixing of the 2D stochastic Ising model with "plus" boundary up to criticality. *Journal of the European Mathematical Society*, 15(2):339–386, 2013.

[393] Marc Magro. The classical exchange algebra of $AdS_5 \times S^5$ string theory. *Journal of High Energy Physics*, (1), Jan 2009.

[394] Marc Magro. Review of AdS/CFT Integrability, Chapter II.3: Sigma Model, Gauge Fixing. *Letters in Mathematical Physics*, 99(1-3):149–167, Jan 2012.

[395] Fabio Martinelli and Fabio Lucio Toninelli. On the Mixing Time of the 2D Stochastic Ising Model with "Plus" Boundary Conditions at Low Temperature. *Communications in Mathematical Physics*, 296(1):175–213, May 2010.

[396] Thomas Ortiz and Henning Samtleben. $SO(9)$ supergravity in two dimensions. *Journal of High Energy Physics*, (1), Jan 2013.

[397] A. Rebhan, P. van Nieuwenhuizen, and R. Wimmer. Quantum corrections to solitons and BPS saturation. In Daniel Grumiller, Anton Rebhan, and Dimitri Vassilevich, editors, *Fundamental Interactions: A Memorial Volume for Wolfgang Kummer*. World Scientific, Sep 2009.

[398] Diederik Roest and Henning Samtleben. Twin supergravities. *Classical and Quantum Gravity*, 26(15), Aug 7 2009.

[399] Christian Saemann, Robert Wimmer, and Martin Wolf. A twistor description of six-dimensional N = (1,1) super Yang-Mills theory. *Journal of High Energy Physics*, (5), May 2012.

[400] Henning Samtleben. Actions for non-abelian twisted self-duality. *Nuclear Physics B*, 851(2):298–313, Oct 11 2011.

[401] Henning Samtleben. Action principle for non-

abelian twisted self-duality. *Fortschritte der Physik-Progress of Physics*, 60(9-10, SI):1093–1097, Sep 2012.

[402] Henning Samtleben, Ergin Sezgin, and Dimitrios Tsimpis. Rigid 6D supersymmetry and localization. *Journal of High Energy Physics*, (3), Mar 2013.

[403] Henning Samtleben, Ergin Sezgin, and Robert Wimmer. (1,0) superconformal models in six dimensions. *Journal of High Energy Physics*, (12), Dec 2011.

[404] Henning Samtleben, Ergin Sezgin, and Robert Wimmer. Six-dimensional superconformal couplings of non-abelian tensor and hypermultiplets. *Journal of High Energy Physics*, (3), Mar 2013.

[405] Henning Samtleben and Dimitrios Tsimpis. Rigid supersymmetric theories in 4d Riemannian space. *Journal of High Energy Physics*, (5), May 2012.

[406] Henning Samtleben and Robert Wimmer. $N = 6$ superspace constraints, SUSY enhancement and monopole operators. *Journal of High Energy Physics*, (10), Oct 2010.

[407] Henning Samtleben and Robert Wimmer. $N = 8$ superspace constraints for three-dimensional gauge theories. *Journal of High Energy Physics*, (2), Feb 2010.

[408] Fabio Lucio Toninelli. Coarse graining, fractional moments and the critical slope of random copolymers. *Electronic Journal of Probability*, 14:531–547, Feb 23 2009.

[409] Fabio Lucio Toninelli. Localization Transition in Disordered Pinning Models. In Biskup, M, editor, *Methods of Contemporary Mathematical Statistical Physics*, volume 1970 of *Lecture Notes in Mathematics*, pages 129–176. Springer, 2009.

[410] Robert Wimmer. An index for confined monopoles. *Communications in Mathematical Physics*, 327:117–149, Apr 2014.

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[411] P. Adroguer, C. Grenier, D. Carpentier, J. Cayssol, P. Degiovanni, and E. Orignac. Probing the helical edge states of a topological insulator by Cooper-pair injection. *Physical Review B*, 82(8), Aug 5 2010.

[412] Pierre Adroguer, David Carpentier, Jerome Cayssol, and Edmond Orignac. Diffusion at the surface of topological insulators. *New Journal of Physics*, 14, Oct 17 2012.

[413] A. Alastuey and V. Ballenegger. Exact asymptotic expansions for the thermodynamics of hydrogen gas in the Saha regime. *Journal of Physics A-Mathematical and Theoretical*, 42(21), May 29 2009. International Conference on Strongly Coupled Coulomb Systems, Univ Camerino, Camerino, Italy, Jul 29-Aug 02, 2008.

[414] A. Alastuey and V. Ballenegger. Pressure of a Partially Ionized Hydrogen Gas: Numerical Results from Exact Low Temperature Expansions. *Contributions to Plasma Physics*, 50(1, SI):46–53, Jan 2010. 13th International Conference on Physics of Non-Ideal Plasmas, Chemogolovka, Russia, SEP 13-18, 2009.

[415] A. Alastuey and V. Ballenegger. Atomic Ionization and Molecular Dissociation in a Hydrogen Gas within the Physical Picture. *Contributions to Plasma Physics*, 52(1):95–99, Jan 2012.

[416] A. Alastuey and V. Ballenegger. Thermodynamics of atomic and ionized hydrogen: Analytical results versus equation-of-state tables and Monte Carlo data. *Physical Review E*, 86(5, 2), Dec 6 2012.

[417] A. Alastuey and J. Piasecki. Interacting Bose gas: Mean field and fluctuations revisited. *Physical Review E*, 84(4, 1), Oct 17 2011.

[418] Christopher Bauerle, Pascal Degiovanni, and Laurent Saminadayar. Quantum coherence and magnetic scattering. *International Journal of Nanotechnology*, 7(4-8, SI):403–419, 2010.

[419] J.-S. Bernier, R. Citro, C. Kollath, and E. Orignac. Correlation dynamics during a slow interaction quench in a one-dimensional Bose gas. *Physical Review Letters*, 112(6), Feb 12 2014.

[420] E. Bocquillon, V. Freulon, J. M Berroir, P. Degiovanni, B. Placais, A. Cavanna, Y. Jin, and G. Feve. Coherence and Indistinguishability of Single Electrons Emitted by Independent Sources. *Science*, 339(6123):1054–1057, Mar 1 2013.

[421] E. Bocquillon, V. Freulon, J. M. Berroir, P. Degiovanni, B. Placais, A. Cavanna, Y. Jin, and G. Feve. Separation of neutral and charge modes in one-dimensional chiral edge channels. *Nature Communications*, 4, May 2013.

[422] E. Bocquillon, V. Freulon, F.D. Parmentier, J.-M. Berroir, B. Plaçais, C. Wahl, J. Rech, T. Jonckheere, T. Martin, C. Grenier, D. Ferraro, P. Degiovanni, and G. Fève. Electron quantum optics in ballistic chiral conductors. *Annalen des Physik (Berlin)*, 526:1–30, 2014.

[423] E. Bocquillon, F. D. Parmentier, C. Grenier, J. M. Berroir, P. Degiovanni, D. C. Glattli, B. Placais, A. Cavanna, Y. Jin, and G. Feve. Electron Quantum Optics: Partitioning Electrons One by One. *Physical Review Letters*, 108(19), May 8 2012.

[424] Pierre Bouillot, Corinna Kollath, Andreas M. Laeuchli, Mikhail Zvonarev, Benedikt Thielemann, Christian Ruegg, Edmond Orignac, Roberta Citro, Martin Klanjsek, Claude Berthier, Mladen Horvatic, and Thierry Giamarchi. Statics and dynamics of weakly coupled antiferromagnetic spin-1/2 ladders in a magnetic field. *Physical Review B*, 83(5), Feb 9 2011.

[425] L. Bovo, L. D. C. Jaubert, P. C. W. Holdsworth, and S. T. Bramwell. Crystal shape-dependent magnetic susceptibility and Curie law crossover in the spin ices Dy2Ti2O7 and Ho2Ti2O7. *Journal of Physics-Condensed Matter*, 25(38), Sep 25 2013.

[426] M. E. Brooks-Bartlett, S. T. Banks, L. D. C. Jaubert, A. Harman-Clarke, and P. C. W. Holdsworth. Magnetic-moment fragmentation and monopole crystallization. *Phys. Rev. X*, 4:011007, Jan 2014.

[427] T. Capron, G. Forestier, A. Perrat-Mabilon, C. Peaucelle, T. Meunier, C. Bäuerle, L. P. Lévy, D. Carpentier, and L. Saminadayar. Magnetic dephasing in mesoscopic spin glasses. *Physical Review Letters*, 111(187203), 2013.

[428] T. Capron, A. Perrat-Mabilon, C. Peaucelle, T. Meunier, D. Carpentier, L. P. Lévy, C. Bauerle, and L. Saminadayar. Remanence effects in the electrical resistivity of spin glasses. *Europhysics Letters*, 27001, 2011.

[429] D. Carpentier, E. Orignac, G. Paulin, and T. Roscilde. Disorder in low dimensions: localisation effects in spin glass wires and cold atoms. *International Journal of Nanotechnology*, 7(4-8, SI):420–437, 2010.

[430] David Carpentier, Andrei A. Fedorenko, and Edmond Orignac. Effect of disorder on 2D topological merging transition from a Dirac semi-metal to a normal insulator. *Europhysics Letters*, 102(6), Jun 2013.

[431] M. A. Cazalilla, R. Citro, T. Giamarchi, E. Orignac, and M. Rigol. One dimensional bosons: From condensed matter systems to ultracold gases. *Reviews of Modern Physics*, 83(4):1405–1466, Dec 1 2011.

[432] Roberta Citro, Adele Naddeo, and Edmond Orignac. Quantum dynamics of a binary mixture of BECs in a double-well potential: a Holstein-Primakoff approach. *Journal of Physics B-Atomic Molecular and Optical Physics*, 44(11), Jun 14 2011.

[433] O. Crauste, Y. Ohtsubo, P. Ballet, P. Delplace, C. Carpentier, C. Bouvier, T. Meunier, A. Taleb-Ibrahimi, and L. Lévy. Topological surface states of strained mercury-telluride probed by ARPES. arXiv:1307.2008.

[434] M. Dalmonte, K. Dieckmann, T. Roscilde, C. Hartl, A. E. Feiguin, U. Schollwoeck, and F. Heidrich-Meisner. Dimer, trimer, and Fulde-Ferrell-Larkin-Ovchinnikov liquids in mass- and spin-imbalanced trapped binary mixtures in one dimension. *Physical Review A*, 85(6), Jun 8 2012.

[435] P. Degiovanni, Ch. Grenier, and G. Feve. Decoherence and relaxation of single-electron excitations in quantum Hall edge channels. *Physical Review B*, 80(24), Dec 2009.

[436] P. Degiovanni, Ch. Grenier, G. Feve, C. Altimiras, H. le Sueur, and F. Pierre. Plasmon scattering approach to energy exchange and high-frequency noise in nu=2 quantum Hall edge channels. *Physical Review B*, 81(12), Mar 2010.

[437] J. Y. P. Delannoy, A. G. Del Maestro, M. J. P. Gingras, and P. C. W. Holdsworth. Site dilution in the half-filled one-band Hubbard model: Ring exchange, charge fluctuations, and application to La2Cu1-x(Mg/Zn)(x)O-4. *Physical Review B*, 79(22), Jun 2009.

[438] J-Y. P. Delannoy, M. J. P. Gingras, P. C. W. Holdsworth, and A. M. S. Tremblay. Low-energy theory of the t-t '-t ''-U Hubbard model at half-filling: Interaction strengths in cuprate superconductors and an effective spin-only description of La2CuO4. *Physical Review B*, 79(23), Jun 2009.

[439] P. Delplace, J. Li, and D. Carpentier. Topological weyl semi-metal from a lattice model. *Europhysics Letters*, 97(67004), 2012.

[440] X. Deng, R. Citro, E. Orignac, and A. Minguzzi. Superfluidity and Anderson localisation for a weakly interacting Bose gas in a quasiperiodic potential. *European Physical Journal B*, 68(3):435–443, 2009.

[441] Xiaolong Deng, Roberta Citro, Edmond Orignac, Anna Minguzzi, and Luis Santos. Bosonization and entanglement spectrum for one-dimensional polar bosons on disordered lattices. *New Journal of Physics*, 15, Apr 26 2013.

[442] Xiaolong Deng, Roberta Citro, Edmond Orignac, Anna Minguzzi, and Luis Santos. Polar bosons in one-dimensional disordered optical lattices. *Physical Review B*, 87(19), May 2 2013.

[443] J. Dubois, T. Jullien, C. Grenier, P. Degiovanni, P. Roulleau, and D. C. Glattli. Integer and fractional charge Lorentzian voltage pulses analyzed in the framework of photon-assisted shot noise. *Physical Review B*, 88(8), Aug 1 2013.

[444] Maria Eckholt and Tommaso Roscilde. Comment on "Feshbach-Einstein Condensates". *Physical Review Letters*, 105(19), Nov 5 2010.

[445] G. M. Falco, A. A. Fedorenko, J. Giacomelli, and M. Modugno. Density of states in an optical speckle potential. *Physical Review A*, 82(5), Nov 8 2010.

[446] A. A. Fedorenko and D. Carpentier. Nonlinear sigma-model study of magnetic dephasing in a mesoscopic spin glass. *Europhysics Letters*, 88(5), 2009.

[447] Andrei A. Fedorenko, David Carpentier, and Edmond Orignac. Two-dimensional Dirac fermions in the presence of long-range correlated disorder. *Physical Review B*, 85(12), Mar 28 2012.

[448] D. Ferraro, A. Feller, A. Ghibaudo, E. Thibierge, E. Bocquillon, G. Feve, Ch Grenier, and P. Degiovanni. Wigner function approach to single electron coherence in quantum Hall edge channels. *Physical Review B*, 88(20), Nov 11 2013.

[449] M. Fruchart and D. Carpentier. An introduction to topological insulators. *Comptes Rendus Physique*, 14:779, 2013.

[450] Michel Fruchart, David Carpentier, and Krzysztof Gawedzki. Parallel transport and band theory in crystals. arXiv:1403.2836.

[451] S. R. Giblin, S. T. Bramwell, P. C. W. Holdsworth, D. Prabhakaran, and I. Terry. Creation and measurement of long-lived magnetic monopole currents in spin ice. *Nature Physics*, 7(3):252–258, Mar 2011.

[452] Ch Grenier, J. Dubois, T. Jullien, P. Roulleau, D. C. Glattli, and P. Degiovanni. Fractionalization of minimal excitations in integer quantum Hall edge channels. *Physical Review B*, 88(8), Aug 1 2013.

[453] Ch Grenier, R. Herve, E. Bocquillon, F. D. Parmentier, B. Placais, J. M. Berroir, G. Feve, and P. Degiovanni. Single-electron quantum tomography in quantum Hall edge channels. *New Journal of Physics*, 13, Sep 6 2011.

[454] Charles Grenier, Remy Herve, Gwendal Feve, and Pascal Degiovanni. Electron quantum optics in quantum Hall edge channels. *Modern Physics Letters B*, 25(12-13, SI):1053–1073, May 30 2011. International Conference on Frustrated Spin Systems, Cold Atoms and Nanomaterials, Hanoi, Vietnam, JUL 14-16, 2010.

[455] Philipp Hauke, Tommaso Roscilde, Valentin Murg, J. Ignacio Cirac, and Roman Schmied. Modified spin-wave theory with ordering vector optimization: frustrated bosons on the spatially anisotropic triangular lattice. *New Journal of Physics*, 12, 2010.

[456] Philipp Hauke, Tommaso Roscilde, Valentin Murg, J. Ignacio Cirac, and Roman Schmied. Modified spin-wave theory with ordering vector optimization: spatially anisotropic triangular lattice and J(1)J(2)J(3) model with Heisenberg interactions. *New Journal of Physics*, 13, Jul 29 2011.

[457] Louis-Paul Henry, Peter C. W. Holdsworth, Frederic Mila, and Tommaso Roscilde. Spin-wave analysis of the transverse-field Ising model on the checkerboard lattice. *Physical Review B*, 85(13), Apr 16 2012.

[458] C. Hernandez, C. Consejo, P. Degiovanni, and C. Chaubet. Admittance of multiterminal quantum hall conductors at kilohertz frequencies. *Journal of Applied Physics*, 115:123710, 2014.

[459] Peter Holdsworth. SPIN ICE Flaws curb the flow. *Nature Physics*, 9(1):8–9, Jan 2013.

[460] Birger Horstmann, Stephan Duerr, and Tommaso Roscilde. Localization of Cold Atoms in State-Dependent Optical Lattices via a Rabi Pulse. *Physical Review Letters*, 105(16), Oct 12 2010.

[461] Stephan Humeniuk and Tommaso Roscilde. Quantum Monte Carlo calculation of entanglement Renyi entropies for generic quantum systems. *Physical Review B*, 86(23), Dec 12 2012.

[462] Thibaut Jacqmin, Bess Fang, Tarik Berrada, Tommaso Roscilde, and Isabelle Bouchoule. Momentum distribution of one-dimensional Bose gases at the quasicondensation crossover: Theoretical and experimental investigation. *Physical Review A*, 86(4), 2012.

[463] L. D. C. Jaubert, J. T. Chalker, P. C. W. Holdsworth, and R. Moessner. Spin Ice under Pressure: Symmetry Enhancement and Infinite Order Multicriticality. *Physical Review Letters*, 105(8), 2010.

[464] L. D. C. Jaubert, M. J. Harris, T. Fennell, R. G. Melko, S. T. Bramwell, and P. C. W. Holdsworth. Topological-Sector Fluctuations and Curie-Law Crossover in Spin Ice. *Physical Review X*, 3(1), Feb 21 2013.

[465] L. D. C. Jaubert and P. C. W. Holdsworth. Signature of magnetic monopole and Dirac string dynamics in spin ice. *Nature Physics*, 5(4):258–261, 2009.

[466] L. D. C. Jaubert and P. C. W. Holdsworth. Magnetic monopole dynamics in spin ice. *Journal of Physics-Condensed Matter*, 23(16, SI), 2011.

[467] Vassilios Kapaklis, Unnar B. Arnalds, Adam Harman-Clarke, Evangelos Th Papaioannou, Masoud Karimipour, Panagiotis Korelis, Andrea Taroni, Peter C. W. Holdsworth, Steven T. Bramwell, and Bjorgvin Hjorvarsson. Melting artificial spin ice. *New Journal of Physics*, 14, Mar 16 2012.

[468] Tassilo Keilmann, Ignacio Cirac, and Tommaso Roscilde. Dynamical Creation of a Supersolid in Asymmetric Mixtures of Bosons. *Physical Review Letters*, 102(25), Jun 26 2009.

[469] Andrew J. Macdonald, Peter C. W. Holdsworth, and Roger G. Melko. Classical topological order in kagome ice. *Journal of Physics-Condensed Matter*, 23(16, SI), Apr 27 2011.

[470] E. Orignac and S. Burdin. Kondo screening by the surface modes of a strong topological insulator. *Physical Review B*, 88(3), Jul 8 2013.

[471] E. Orignac and R. Citro. Response functions in multicomponent Luttinger liquids. *Journal of Statistical Mechanics-Theory and Experiment*, Dec 2012.

[472] E. Orignac, R. Citro, S. De Palo, and M. L. Chiofalo. Light scattering in inhomogeneous Tomonaga-Luttinger liquids. *Physical Review A*, 85(1), Jan 25 2012.

[473] E. Orignac, M. Tsuchiizu, and Y. Suzumura. Competition of superfluidity and density waves in one-dimensional Bose-Fermi mixtures. *Physical Review A*, 81(5), May 2010.

[474] E. Orignac, M. Tsuchiizu, and Y. Suzumura. Spectral functions of two-band spinless fermion and single-band spin-1/2 fermion models. *Physical Review B*, 84(16), Oct 25 2011.

[475] Edoardo Pasca, Tommaso Roscilde, Marco Evangelisti, Enrique Burzuri, Fernando Luis, L. Jos de Jongh, and Stefania Tanase. Realization of the one-dimensional anisotropic XY model in a Tb(III)-W(V) chain compound. *Physical Review B*, 85(18), May 30 2012.

[476] G. Paulin and D. Carpentier. Cross-over between universality classes in a magnetically disordered metallic wire. *New Journal of Physics*, 14(023026), 2012.

[477] P. E. Roche, C. F. Barenghi, and E. Leveque. Quantum turbulence at finite temperature: The two-fluids cascade. *Europhysics Letters*, 87(5), 2009.

[478] T. Roscilde, C. Degli Esposti Boschi, and M. Dalmonte. Pairing, crystallization and string correlations of mass-imbalanced atomic mixtures in one-dimensional optical lattices. *Europhysics Letters*, 97(2), Jan 2012.

[479] T. Roscilde, M. Rodriguez, K. Eckert, O. Romero-Isart, M. Lewenstein, E. Polzik, and A. Sanpera. Quantum polarization spectroscopy of correlations in attractive fermionic gases. *New Journal of Physics*, 11, May 14 2009.

[480] Tommaso Roscilde. Probing correlated phases of bosons in optical lattices via trap squeezing. *New Journal of Physics*, 11, Feb 11 2009.

[481] Tommaso Roscilde. Exploring the grand-canonical phase diagram of interacting bosons in optical lattices by trap squeezing. *Physical Review A*, 82(2), 2010.

[482] Tommaso Roscilde. Thermometry of cold atoms in optical lattices via artificial gauge fields. *Physical Review Letters*, 112:110403, Mar 2014.

[483] Tommaso Roscilde and Massimo Boninsegni. Off-diagonal correlations in a one-dimensional gas of dipolar bosons. *New Journal of Physics*, 12, 2010.

[484] Guillaume Roux, Anna Minguzzi, and Tommaso Roscilde. Dynamic structure factor of one-dimensional lattice bosons in a disordered potential: a spectral fingerprint of the Bose-glass phase. *New Journal of Physics*, 15, May 1 2013.

[485] J. Salort, C. Baudet, B. Castaing, B. Chabaud, F. Daviaud, T. Didelot, P. Diribarne, B. Dubrulle, Y. Gagne, F. Gauthier, A. Girard, B. Hebral, B. Rousset, P. Thibault, and P. E. Roche. Turbulent velocity spectra in superfluid flows. *Physics of Fluids*, 22(12), Dec 2010.

[486] J. Salort, B. Chabaud, E. Leveque, and P. E. Roche. Energy cascade and the four-fifths law in superfluid turbulence. *Europhysics Letters*, 97(3), Feb 2012.

[487] J. Salort, P-E Roche, and E. Leveque. Mesoscale equipartition of kinetic energy in quantum turbulence. *Europhysics Letters*, 94(2), Apr 2011.

[488] O. Shevtsov, P. Carmier, C. Groth, X. Waintal, and D. Carpentier. Tunable thermopower in a graphene-based topological insulator. *Phys. Rev. B*, 85(245441), 2012.

[489] O. Shevtsov, P. Carmier, C. Petitjean, C. Groth, D. Carpentier, and X. Waintal. Graphene based heterojunction between two topological insulators. *Phys. Rev. X*, 2(031004), 2012.

[490] B. Thielemann, Ch. Rueegg, K. Kiefer, H. M. Ronnow, B. Normand, P. Bouillot, C. Kollath, E. Orignac, R. Citro, T. Giamarchi, A. M. Laeuchli, D. Biner, K. W. Kraemer, F. Wolff-Fabris, V. S. Zapf, M. Jaime, J. Stahn, N. B. Christensen, B. Grenier, D. F. McMorrow, and J. Mesot. Field-controlled magnetic order in the quantum spin-ladder system (Hpip)(2)CuBr4. *Physical Review B*, 79(2), Jan 2009.

[491] Kien Trinh, Stephan Haas, Rong Yu, and Tommaso

Roscilde. Correlations in quantum spin ladders with site and bond dilution. *Physical Review B*, 85(3), Jan 31 2012.

[492] S. Villerot, B. Castaing, and L. Chevillard. Static Spectroscopy of a Dense Superfluid. *Journal of Low Temperature Physics*, 169(1-2):1–14, Oct 2012.

[493] R. Yu, S. Haas, and T. Roscilde. Revealing novel quantum phases in quantum antiferromagnets on random lattices. *Condensed Matter Physics*, 12(3):519–530, 2009.

[494] R. Yu, S. Haas, and T. Roscilde. Universal phase diagram of disordered bosons from a doped quantum magnet. *Europhysics Letters*, 89(1), Jan 2010.

[495] Rong Yu, Corneliu F. Miclea, Franziska Weickert, Roman Movshovich, Armando Paduan-Filho, Vivien S. Zapf, and Tommaso Roscilde. Quantum critical scaling at a Bose-glass/superfluid transition: Theory and experiment for a model quantum magnet. *Physical Review B*, 86(13), Oct 23 2012.

[496] Rong Yu, Omid Nohadani, Stephan Haas, and Tommaso Roscilde. Magnetic Bose glass phases of coupled antiferromagnetic dimers with site dilution. *Physical Review B*, 82(13), Oct 22 2010.

[497] Rong Yu, Liang Yin, Neil S. Sullivan, J. S. Xia, Chao Huan, Armando Paduan-Filho, Nei F. Oliveira, Jr., Stephan Haas, Alexander Steppke, Corneliu F. Miclea, Franziska Weickert, Roman Movshovich, Eun-Deok Mun, Brian L. Scott, Vivien S. Zapf, and Tommaso Roscilde. Bose glass and Mott glass of quasiparticles in a doped quantum magnet. *Nature*, 489(7416):379–384, 2012.

[498] Andrey Zheludev and Tommaso Roscilde. Dirty-boson physics with magnetic insulators. *Comptes Rendus Physique*, 14(8):740–756, Oct 2013.

[499] M. E. Zhitomirsky, M. V. Gvozdikova, P. C. W. Holdsworth, and R. Moessner. Quantum Order by Disorder and Accidental Soft Mode in Er2Ti2O7. *Physical Review Letters*, 109(7), Aug 16 2012.

T6B. Infophysics, Signal and Systems

For this theme, regular articles and proceedings ones have been listed, since the latter category is often prestigious and difficult.

[500] P Abry. Wavelet leader multifractal analysis for heart rate variability. In *35th Annual International Conference of the IEEE EMBS*, page xx, 2013.

[501] P. Abry, M. Clausel, S. Jaffard, S.G. Roux, and B. Vedel. Hyperbolic wavelet transform: an efficient tool for multifractal analysis of anisotropic textures. *Revista Matematica Iberoamericana,*, accepted for publication, October 2013.

[502] P. Abry, P. Flandrin, and D. Veitch. Phénomènes d'invariance d'échelle dans l'internet. *Les Dossiers de La Recherche*, (46):52–55, 2011.

[503] P. Abry, H. Helgason, P. Goncalves, E. Pereira, P. Gaucherand, and M. Doret. Multifractal analysis of ECG for intrapartum diagnosis of fetal asphyxia. In *2010 IEEE International Conference on Acoustics, Speech, and Signal Processing*, International Conference on Acoustics Speech and Signal Processing ICASSP, pages 566–569. IEEE Signal Proc Soc, 2010. 2010 IEEE International Conference on Acoustics, Speech, and Signal Processing, Dallas, TX, Mar 10-19, 2010.

[504] P. Abry, S. Jaffard, and H. Wendt. Bruegel's drawings under the multi fractal microscope. In *2012 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, pages 3909–3912. Inst Elect & Elect Engineers, Signal Processing Soc; IEEE, 2012. IEEE International Conference on Acoustics, Speech and Signal Processing, Kyoto, Japan, Mar 25-30, 2012.

[505] P Abry, S Roux, V Chudacek, P Borgnat, P Goncalves, and M Doret. Hurst exponent and intrapartum fetal heart rate: Impact of decelerations. In *The 26th IEEE International Symposium on Computer-Based Medical Systems (CBMS 2013)*, 2013.

[506] P. Abry, H. Wendt, and S. Jaffard. When Van Gogh meets Mandelbrot: Multifractal classification of painting's texture. *Signal Processing*, 93(3, SI):554–572, Mar 2013.

[507] P. Abry, H. Wendt, S. Jaffard, H. Helgason, P. Goncalves, E. Pereira, Cl Gharib, P. Gaucherand, and M. Doret. Methodology for Multifractal Analysis of Heart Rate Variability: From LF/HF Ratio to Wavelet Leaders. In *2010 Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, IEEE Engineering in Medicine and Biology Society Conference Proceedings, pages 106–109. IEEE Engn Med & Biol Soc (EMBS), 2010. 32nd Annual International Conference of the IEEE Engineering-in-Medicine-and-Biology-Society (EMBC 10), Buenos Aires, Argentina, Aug 30-Sep 04, 2010.

[508] Patrice Abry, Pierre Borgnat, Fabio Ricciato, Antoine Scherrer, and Darryl Veitch. Revisiting an old friend: on the observability of the relation between long range dependence and heavy tail. *Telecommunication Systems*, 43(3-4):147–165, Apr 2010.

[509] Patrice Abry, Pierre Chainais, Laure Coutin, and Vladas Pipiras. Multifractal Random Walks as Fractional Wiener Integrals. *IEEE Transactions on Information Theory*, 55(8):3825–3846, Aug 2009.

[510] Patrice Abry, Jim Coddington, Ingrid Daubechies, Ella Hendriks, Shannon Hughes, Don H. Johnson, and Eric Postma. Special Issue: Image Processing for Digital Art Work Foreword. *Signal Processing*, 93(3, SI):525–526, Mar 2013.

[511] Patrice Abry, Hannes Helgason, and Vladas Pipiras. Wavelet-Based Analysis of non-gaussian long-range dependent processes and estimation of the Hurst parameter. *Lithuanian Mathematical Journal*, 51(3):287–302, Jul 2011.

[512] Patrice Abry, Stephane Jaffard, Stephane Roux, Beatrice Vedel, and Herwig Wendt. Wavelet Decomposition of Measures: Application to Multifractal Analysis of Images. In Byrnes, J, editor, *Unexplored ordnance detection and mitigation*, NATO Science for Peace and Security Series B - Physics and Biophysics, pages 1–20. NATO Adv Study Inst, 2009. Conference of the NATO-Advances-Study-Institute on Unexploded Ordnance Detection and Mitigation, Ciocco, Italy, Jul 20-Aug 02, 2008.

[513] Patrice Abry, Stephane G. Roux, and Stephane Jaf-

fard. Detecting oscillating singularities in multifractal analysis: application to hydrodynamic turbulence. In *2011 IEEE International Conference on Acoustics, Speech, and Signal Processing*, International Conference on Acoustics Speech and Signal Processing ICASSP, pages 4328–4331. Inst Elect & Elect Engineers Signal Processing Soc; IEEE, 2011. IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Prague Congress Ctr, Prague, Czech Republic, May 22-27, 2011.

[514] Hassan Amoud, Paul Honeine, Cedric Richard, Pierre Borgnat, and Patrick Flandrin. Sur la caracérisation de non-stationnariés par la méthode des substituts. In *Actes du XXIIème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2009. Dijon.

[515] Hassan Amoud, Paul Honeine, Cedric Richard, Pierre Borgnat, and Patrick Flandrin. Time-frequency learning machines for nonstationarity detection using surrogates. In *IEEE/SP 15th Workshop on Statistical Signal Processing SSP-2009, Vols. 1 and 2*, pages 565–568, Aug. 31-Sep. 03, 2009. Cardiff, Wales.

[516] Elmer Andres Fernandez, E. P. Souza Neto, P. Abry, R. Macchiavelli, M. Balzarini, B. Cuzin, C. Baude, J. Frutoso, and C. Gharib. Assessing erectile neurogenic dysfunction from heart rate variability through a Generalized Linear Mixed Model framework. *Computer Methods and Programs in Biomedicine*, 99(1):49–56, Jul 2010.

[517] F. Angeletti, H. Touchette, E. Bertin, and P. Abry. Large deviations for correlated random variables described by a matrix product ansatz. *Journal of Statistical Mechanics-Theory and Experiment*, 2014(2):P02003, 2014.

[518] Florian Angeletti, Eric Bertin, and Patrice Abry. Critical moment definition and estimation, for finite size observation of log-exponential-power law random variables. *Signal Processing*, 92(12):2848–2865, Dec 2012.

[519] Florian Angeletti, Eric Bertin, and Patrice Abry. Matrix products for the synthesis of stationary time series with a priori prescribed joint distributions. In *2012 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, pages 3897–3900. Inst Elect & Elect Engineers, Signal Processing Soc; IEEE, 2012. IEEE International Conference on Acoustics, Speech and Signal Processing, Kyoto, Japan, Mar 25-30, 2012.

[520] Florian Angeletti, Eric Bertin, and Patrice Abry. Renormalization flow for extreme value statistics of random variables raised to a varying power. *Journal of Physics A-Mathematical and Theoretical*, 45(11), Mar 23 2012.

[521] Florian Angeletti, Eric Bertin, and Patrice Abry. On the existence of a glass transition in a random energy model. *Journal of Physics A-Mathematical and Theoretical*, 46(31), Aug 9 2013.

[522] Florian Angeletti, Eric Bertin, and Patrice Abry. Random Vector and Time Series Definition and Synthesis From Matrix Product Representations: From Statistical Physics to Hidden Markov Models. *IEEE Transactions on Signal Processing*, 61(21):5389–5400, Nov 2013.

[523] Florian Angeletti, Eric Bertin, and Patrice Abry. Statistics of sums of correlated variables described by a matrix product ansatz. *Europhysics Letters*, 104(5), Dec 2013.

[524] Florian Angeletti, Marc Mezard, Eric Bertin, and Patrice Abry. Linearization effect in multifractal analysis: Insights from the Random Energy Model. *Physica D*, 240(16):1245–1253, AUG 1 2011.

[525] Andrea Apolloni, Jean-Baptiste Rouquier, and Pablo Jensen. Collaboration range: Effects of geographical proximity on article impact. *European Physics Journal-Special Topics*, 222(6):1467–1478, Sep 2013.

[526] A. Arneodo, B. Audit, E.-B. Brodie of Brodie, S. Nicolay, M. Touchon, Y. d'Aubenton-Carafa, M. Huvet, and C. Thermes. Fractals and wavelets: what can we learn on transcription and replication from wavelet-based multifractal analysis of DNA sequences? In R. A. Meyers, editor, *Encyclopedia of Complexity and Systems Science*, pages 3893–3924. Springer, New York, 2009.

[527] H. Asai, K. Fukuda, P. Abry, P. Borgnat, and H. Esaki. Network application profiling with traffic causality graphs. *International Journal of Network Management*, 24(4):289–303, 2014.

[528] B. Audit, A. Baker, R. E. Boulos, H. Julienne, A. Arneodo, C. L. Chen, Y. d'Aubenton Carafa, C. Thermes, A. Goldar, G. Guilbaud, A. Rappailles, and O. Hyrien. Relating mammalian replication program to large-scale chromatin folding. In *ACM Conference on Bioinformatics, Computational Biology and Biomedical Informatics*, pages 800–811. ACM BCB, Washington DC, 2013.

[529] Benjamin Audit, Antoine Baker, Chun-Long Chen, Aurélien Rappailles, Guillaume Guilbaud, Hanna Julienne, Arach Goldar, Yves d'Aubenton Carafa, Olivier Hyrien, Claude Thermes, and Alain Arneodo. Multiscale analysis of genome-wide replication timing profiles using a wavelet-based signal-processing algorithm. *Nature Protocols*, 8(1):98–110, Dec 2013.

[530] Benjamin Audit, Lamia Zaghloul, Antoine Baker, Alain Arneodo, Chun-Long Chen, Yves d'Aubenton Carafa, and Claude Thermes. Megabase replication domains along the human genome: relation to chromatin structure and genome organisation. *Subcellular Biochemistry*, 61:57–80, 2012.

[531] Francois Auger, Eric Chassande-Mottin, and Patrick Flandrin. Réallocation de Levenberg-Marquardt. In *Actes du XXIIIème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2011. Bordeaux.

[532] Francois Auger, Eric Chassande-Mottin, and Patrick Flandrin. On phase-magnitude relationships in the Short-Time Fourier Transform. *IEEE Signal Processing Letters*, 19(5):267–270, May 2012.

[533] Francois Auger, Patrick Flandrin, Yu-Ting Lin, Stephen McLaughlin, Sylvain Meignen, Thomas Oberlin, and Hau-Tieng Wu. Time-frequency reassignment and synchrosqueezing. *IEEE Signal Processing Magazine*, 30(6):32–41, November 2013.

[534] Changryong Baek, Vladas Pipiras, Herwig Wendt, and Patrice Abry. Second order properties of distribution tails and estimation of tail exponents in random difference equations. *Extremes*, 12(4):361–400, Dec 2009.

[535] A. Baker, S. Nicolay, L. Zaghloul, Y. d'Aubenton-Carafa, C. Thermes, B. Audit, and A. Arneodo. Wavelet-based method to disentangle transcription- and replication-associated strand asymmetries in mammalian genomes. *Appl. Comput. Harmon.*

Anal., 28:150–170, 2010.

[536] A. Barrat, C. Cattuto, V. Colizza, F. Gesualdo, L. Isella, E. Pandolfi, J-F Pinton, L. Rava, C. Rizzo, M. Romano, J. Stehle, A. E. Tozzi, and W. Van den Broeck. Empirical temporal networks of face-to-face human interactions. *European Physical Journal-Special Topics*, 222(6):1295–1309, Sep 2013.

[537] Martin W. Bauer and Pablo Jensen. The mobilization of scientists for public engagement. *Public Understanding of Science*, 20(1):3–11, Jan 2011.

[538] Sueleyman Baylcut, Paulo Goncalves, Pierre-Herve Luppi, Patrice Abry, Edmundo Pereira de Souza Neto, and Damien Gervasoni. EMD-based analysis of rat EEG data for sleep state classification. In Encarnacao, P and Veloso, A, editor, *Biosignals 2009: Proceedings of the International Conference on Bio-inspired Systems and Signal Processing*, pages 115–123. Inst Syst & Technologies Informat, Control & Commun; IEEE Engn Med & Biol Soc; IEEE Circuits & Syst Soc; Assoc Advancement Artificial Intelligence; ACM SIGART, 2009. 2nd International Conference on Bio-Inspired Systems and Signal Processing, Oporto, Portugal, JAN 14-17, 2009.

[539] Elyes Ben Hamida, Pierre Borgnat, Hiroshi Esaki, Patrice Abry, and Eric Fleury. Live E! Sensor Network: Correlations in Time and Space. In *Actes du XXIIème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2009. Dijon.

[540] Elyes Ben Hamida, Hideya Ochiai, Hiroshi Esaki, Pierre Borgnat, Patrice Abry, and Eric Fleury. Measurement Analysis of the Live E! Sensor Network: Spatial-Temporal Correlations and Data Aggregation. In *2009 9TH Annual International Symposium on Applications and the Internet*, pages 263–266, 2009. 9th Annual International Symposium on Applications and the Internet (SAINT 2009), Bellevue, Wa, Jul 20-24, 2009.

[541] Eric Bertin and Geza Györgyi. Renormalization flow in extreme value statistics. *Journal of Statistical Mechanics-Theory and Experiment*, Aug 2010.

[542] Pierre Borgnat, Patrice Abry, and Patrick Flandrin. Studying Lyon's Vélo'v : A statistical cyclic model. In *Proc. of the European Conference on Complex Systems ECCS-09*, September 2009. Warwick (UK).

[543] Pierre Borgnat, Patrice Abry, and Patrick Flandrin. Using surrogates and optimal transport for synthesis of stationary multivariate series with prescribed covariance function and non-Gaussian joint-distribution. In *Proc. of the IEEE International Conference on Acoustics, Speech and Signal Processing ICASSP-2012*, pages 3729–3732, Mar. 25-30, 2012. Kyoto, Japan.

[544] Pierre Borgnat, Patrice Abry, Patrick Flandrin, Celine Robardet, Jean-Baptiste Rouquier, and Eric Fleury. Shared bicycles in a city: A signal processing and data analysis perspective. *Advances in Complex Systems*, 14(3):415–438, June 2011.

[545] Pierre Borgnat, Patrice Abry, Patrick Flandrin, and Jean-Baptiste Rouquier. Modélisation statistique cyclique des locations de Vélo'v à Lyon. In *Actes du XXIIème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2009. Dijon.

[546] Pierre Borgnat, Guillaume Dewaele, Kensuke Fukuda, Patrice Abry, and Kenjiro Cho. Seven Years and One Day: Sketching the Evolution of Internet Traffic. In *IEEE INFOCOM 2009 - IEEE Conference on Computer Communications, Vols 1-5*, IEEE INFOCOM, pages 711–719. IEEE, 2009. IEEE INFOCOM Conference 2009, Rio de Janeiro, Brazil, Apr 19-25, 2009.

[547] Pierre Borgnat and Patrick Flandrin. Stationarization via surrogates. *Journal of Statistical Mechanics-Theory and Experiments*, :, January 2009.

[548] Pierre Borgnat, Patrick Flandrin, Andre Ferrari, and Cedric Richard. Transitional surrogates. In *Proc. of the IEEE International Conference on Acoustics, Speech and Signal Processing ICASSP-2011*, pages 3600–3603, May 22-27 2011. Prague, CZ.

[549] Pierre Borgnat, Patrick Flandrin, Paul Honeine, Cedric Richard, and Jun Xiao. Testing stationarity with surrogates: A time-frequency approach. *IEEE Transactions on Signal Processing*, 58(7):3459–3470, July 2010.

[550] Pierre Borgnat, Eric Fleury, Jean-Loup Guillaume, and Celine Robardet. Characteristics of the Dynamic of Mobile Networks. In Altman, E and Carrera, I and ElAzouzi, R and Hart, E and Hayel, Y, editor, *Bioinspired models of network, information, and computing systems*, volume 39 of *Lecture Notes of the Institute for Computer Sciences Social Informatics and Telecommunications Engineering*, pages 130–139. ICST; Createnet; PerAda; INRIA; Univ Avignon; Bionets, 2010. 4th International Conference on Bio-Inspired Models of Network, Information, and Computing Systems, Avignon, France, Dec 09-11, 2009.

[551] Pierre Borgnat, Eric Fleury, Céline Robardet, and Antoine Scherrer. Spatial analysis of dynamic movements of Vélo'v, Lyon's shared bicycle program. In *Proc. of the European Conference on Complex Systems ECCS-09*, September 2009. Warwick (UK).

[552] Borgnat, P. and Flandrin, P. and Richard, C. and Ferrari, A. and Hamoud, H. and Honeine, P. Time-frequency learning machines for nonstationarity detection using surrogates. In M.J. Way, J.D. Scargle, K. Ali and A.N. Srivastava, editor, *Data Mining and Machine Learning for Astronomical Applications*, chapter 22, pages 487–504. CRC Press, Boca Raton, LA, 2012.

[553] J. Boulanger, N. Pustelnik, and L. Condat. Non-smooth convex optimization for an efficient reconstruction in structured illumination microscopy. In *2014 IEEE International Symposium on Biomedical Imaging (ISBI)*, 2014. IEEE International Symposium on Biomedical Imaging, Beijing, China, Apr 22- May 2, 2014.

[554] R. E. Boulos, A. Arneodo, P. Jensen, and B. Audit. Graph analysis of chromatin conformation data in relation with the human replication program. In *14ième Journées Ouvertes en Biologie, Informatique et Mathématiques*, page 35. JOBIM, Toulouse, 2013.

[555] R. E. Boulos, A. Arneodo, P. Jensen, and B. Audit. Revealing long-range interconnected hubs in human chromatin interaction data using graph theory. *Physical Review Letters*, 111:118102, 2013.

[556] C. Canonne and N. B. Garnier. A model for collective free improvisation. In C. Agon, E. Amiot, G. Andreatta, M.and Assayag, J. Bresson, and J. Manderau, editors, *Mathematics and Computation in Music*, pages 29–41. Springer, 2011.

[557] C. Canonne and N. B. Garnier. Cognition and segmentation in collective free improvisation:

An exploratory study. In E. Cambouropoulos, C. Tsougras, P. Mavromatis, and K. Pastiadis, editors, *International Conference on Music Perception and Cognition ICMPC 2012*, pages 197–204. School of Music Studies, Aristotle University, 2012.

[558] Ciro Cattuto, Wouter Van den Broeck, Alain Barrat, Vittoria Colizza, Jean-Francois Pinton, and Alessandro Vespignani. Dynamics of Person-to-Person Interactions from Distributed RFID Sensor Networks. *PLOS ONE*, 5(7), Jul 15 2010.

[559] Laurent Chevillard, Remi Rhodes, and Vincent Vargas. Gaussian Multiplicative Chaos for Symmetric Isotropic Matrices. *Journal of Statistical Physics*, 150(4):678–703, Feb 2013.

[560] G. Chierchia, N. Pustelnik, J. C. Pesquet, and B. Pesquet-Popescu. A proximal approach for constrained cosparse modelling. In *2012 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, pages 3433–3436. Inst Elect & Elect Engineers, Signal Processing Soc; IEEE, 2012. IEEE International Conference on Acoustics, Speech and Signal Processing, Kyoto, Japan, Mar 25-30, 2012.

[561] G. Chierchia, N. Pustelnik, J.-C. Pesquet, and B. Pesquet-Popescu. An epigraphical convex optimization approach for multicomponent image restoration using non-local structure tensor. In *2013 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, International Conference on Acoustics Speech and Signal Processing ICASSP, pages 1359–1363. Inst Elect & Elect Engineers; Inst Elect & Elect Engineers Signal Proc Soc, 2013. IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Vancouver, Canada, May 26-31, 2013.

[562] G. Chierchia, N. Pustelnik, J. C. Pesquet, and B. Pesquet-Popescu. Epigraphic proximal projection for sparse multiclass SVM. In *2014 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*. Inst Elect & Elect Engineers, Signal Processing Soc; IEEE, 2014. IEEE International Conference on Acoustics, Speech and Signal Processing, Florence, Italy, May 4-9, 2014.

[563] G. Chierchia, N. Pustelnik, J.-C. Pesquet, and B. Pesquet-Popescu. Epigraphical splitting for solving constrained convex formulations of inverse problems with proximal tools. *Signal, Image and Video Processing*, to appear, 2014.

[564] V Chudacek, J Anden, S Mallat, P Abry, and M Doret. Scattering transform for intrapartum fetal heart rate characterization and acidosis detection. In *35th Annual International Conference of the IEEE EMBS*, pages 2898–2901, 2013.

[565] V Chudacek, J Anden, S Mallat, P Abry, and M Doret. Scattering transform for intrapartum fetal heart rate variability fractal analysis: a case-control study. *Eng. Med. and Biol., IEEE Transactions on*, xx(xx):xx, 2013.

[566] P. Ciuciu, B. He, and P. Abry. Interplay between functional connectivity and scale-free dynamics in intrinsic fmri networks. *NeuroImage*, (to appear), 2014.

[567] P. Ciuciu, G. Varoquaux, P. Abry, S. Sadaghiani, and A. Kleinschmidt. Scale-free and multifractal dynamic properties of fmri signals during rest and task. *Frontiers in Physiology*, 3(186), 2012.

[568] Philippe Ciuciu, Gael Varoquaux, Patrice Abry, and Moty Almog. Multifractal Analysis of resting state networks in functional MRI. In *2011 8TH IEEE International Symposium on Biomedical Imaging from Nano to Macro*, IEEE International Symposium on Biomedical Imaging, pages 473–478. Inst Elect & Electron Engn; Engn Med & Biol Soc (EMBS); IEEE Signal Proc Soc (SPS), 2011. 8th IEEE International Symposium on Biomedical Imaging (ISBI) - From Nano to Macro, Chicago, IL, Mar 30-Apr 02, 2011.

[569] Marcelo Colominas, Gaston Schlotthauer, Maria-Eugenia Torres, and Patrick Flandrin. Noise-assisted EMD methods in action. *Advances in Adaptive Data Analysis*, 4(4):1250025–1–1250025–1, October 2012.

[570] L. Condat, J. Boulanger, N. Pustelnik, S. Sahnoun, and L. Sengmanivong. A 2-d spectral analysis method to estimate the modulation parameters in structured illumination microscopy. In *2014 IEEE International Symposium on Biomedical Imaging (ISBI)*, 2014. IEEE International Symposium on Biomedical Imaging, Beijing, China, Apr 22- May 2, 2014.

[571] A. Costard, S. Achard, O. Michel, P. Borgnat, and P. Abry. Encadrement du paramètre de pénalisation dans l'estimation bayésienne asymptotique de la structure d'un graphe initialisée par graphical lasso. In *Actes du XXIVème Colloque GRETSI sur le Traitement du Signal et des Images,*, September 2013. Brest, France.

[572] Douglas Baptista de Souza, Jocelyn Chanussot, Anne-Catherine Favre, and Pierre Borgnat. A modified time-frequency method for testing wide-sense stationarity. In *2012 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, pages 3409–3412. Inst Elect & Elect Engineers, Signal Processing Soc; IEEE, 2012. IEEE International Conference on Acoustics, Speech and Signal Processing, Kyoto, Japan, Mar 25-30, 2012.

[573] Douglas Baptista de Souza, Jocelyn Chanussot, Anne-Catherine Favre, and Pierre Borgnat. A new nonparametric method for testing stationarity based on trend analysis in the time marginal distribution. In *2014 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*. Inst Elect & Elect Engineers, Signal Processing Soc; IEEE, 2014. IEEE International Conference on Acoustics, Speech and Signal Processing, Florence, Italy, May 4-9, 2014.

[574] Edmundo Pereira de Souza Neto, Elmer Andres Fernandez, Patrice Abry, Beatrice Cuzin, Patrick Loiseau, Christian Baude, Jean Frutoso, Claude Gharib, and Xavier Martin. Application of Cardiac Autonomous Indices in the Study of Neurogenic Erectile Dysfunction. *Urologia Internationalis*, 86(3):290–297, 2011.

[575] Guillaume Dewaele, Yosuke Himura, Pierre Borgnat, Kensuke Fukuda, Patrice Abry, Olivier Michel, Romain Fontugne, Kenjiro Cho, and Hiroshi Esaki. Unsupervised host behavior classification from connection patterns. *International Journal of Network Management*, 20(5, SI):317–337, Sep-Oct 2010.

[576] Muriel Doret, Hannes Helgason, Patrice Abry, Paulo Goncalves, Claude Gharib, and Pascal Gaucherand. Multifractal Analysis of Fetal Heart Rate Variability in Fetuses with and without Severe Acidosis during Labor. *American Journal of Perinatology*, 28(4):259–266, Apr 2011.

[577] E. Pereira de Souza Neto, P. Abry, J. Frutoso, P. Flandrin, C. Gharib. Heart Rate Variability Analyses. In J.J. Lehot et M. Cannesson, editor, *Monitorage des paramètres physiologiques en situation clinique*, pages 42–59. Arnette, Rueil-Malmaison, 2004.

[578] Sebastien Equis, Patrick Flandrin, and Pierre Jacquot. Extraction de phase en interférométrie speckle par encerclement du signal analytique associé. In *Actes du XXIIIème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2011. Bordeaux.

[579] Sebastien Equis, Patrick Flandrin, and Pierre Jacquot. Phase extraction in speckle interferometry by a circle fitting procedure in the complex plane. *Optics Letters*, 36(23):4617–4619, December 2011.

[580] Patrick Flandrin. An empirical model for electronic submissions to conferences. In *Proc. of the European Conference on Complex Systems ECCS-09*, September 2009. Warwick (UK).

[581] Patrick Flandrin. Un modèle empirique pour la soumission de communications aux conférences. In *Actes du XXIIème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2009. Dijon.

[582] Patrick Flandrin. An empirical model for electronic submissions to conferences. *Advances in Complex Systems*, 13(3, SI):439–449, June 2010.

[583] Patrick Flandrin. A note on reassigned Gabor spectrograms of Hermite functions. *Journal of Fourier Analysis and Applications*, 19(2):285–295, April 2013.

[584] Patrick Flandrin, Moeness Amin, Stephen McLaughlin, and Bruno Torresani. Time-Frequency Analysis and Applications. *IEEE Signal Processing Magazine*, 30(6), November 2013.

[585] Patrick Flandrin and Pierre Borgnat. Revisiting and testing stationarity. *Journal of Physics: Conference Series*, 139, 2009.

[586] Patrick Flandrin and Pierre Borgnat. Time-frequency energy distributions meet compressed sensing. *IEEE Transactions on Signal Processing*, 58(6):2974–2982, June 2010.

[587] Patrick Flandrin, Eric Chassande-Mottin, and Francois Auger. Uncertainty and spectrogram geometry. In *Proc. of the 20th European Signal Processing Conference EUSIPCO-2012*, pages 794–798, Aug. 27-31 2012. Bucharest, Romania.

[588] Patrick Flandrin, Antonio Napolitano, Haldun M. Ozaktas, and David J. Thomson. Recent Advances in Theory and Methods for Nonstationary Signal Analysis. *EURASIP Journal on Advances in Signal Processing*, 2011.

[589] Patrick Flandrin, Cedric Richard, Pierre-Olivier Amblard, Pierre Borgnat, Paul Honeine, Hassan Amoud, Andre Ferrari, Jun Xiao, Azadeh Moghtaderi, and Pepa Ramirez-Cobo. Relative stationarity and connected approaches. *Traitement du Signal*, 28(6):691–716, 2011.

[590] Romain Fontugne, Pierre Borgnat, Patrice Abry, and Kensuke Fukuda. MAWILab : Combining Diverse Anomaly Detectors for Automated Anomaly Labeling and Performance Benchmarking. In *ACM CoNEXT 2010*, 2010. Philadelphia (PA), Nov. 30-Dec. 3 2010.

[591] Romain Fontugne, Pierre Borgnat, Patrice Abry, and Kensuke Fukuda. Uncovering Relations between Traffic Classifiers and Anomaly Detectors via Graph Theory. In Ricciato, F and Mellia, M and Biersack, E, editor, *Traffic monitoring and analysis, Proceedings*, volume 6003 of *Lecture Notes in Computer Science*, pages 101–114. COST IC0703, 2010. 2nd International Workshop on Traffic Monitoring and Analysis, Zurich, Switzerland, Apr 07, 2010.

[592] Romain Fontugne, Jorge Ortiz, Nicolas Tremblay, Pierre Borgnat, Patrick Flandrin, Kensuke Fukuda, D. Culler, and Hiroshi Esaki. Strip, Bind, and Search: A Method for Identifying Abnormal Energy Consumption in Buildings. In *IEEE/ACM Information Processing in Sensor Networks, ISPN'13*, 8-11 April, 2013. Philadelphia (PN, USA).

[593] Romain Fontugne, Nicolas Tremblay, Pierre Borgnat, Patrick Flandrin, and Hiroshi Esaki. Mining anomalous electricity consumption using Ensemble Empirical Mode Decomposition. In *Proc. of the IEEE International Conference on Acoustics, Speech and Signal Processing ICASSP-2013*, pages 5238–5242, May 26-31, 2013. Vancouver, Canada.

[594] E. Gerasimova, B. Audit, S. G. Roux, A. Khalil, F. Argoul, O. Naimark, and A. Arneodo. Multifractal analysis of dynamic infrared imaging of breast cancer. *Europhysics Letters*, 104:68001, 2013.

[595] E. Gerasimova, B. Audit, S.G. Roux, A. Khalil, O. Gileva, F. Argoul, O. Naimark, and A. Arneodo. A wavelet-based method for multifractal analysis of medical signals:application to dynamic infrared thermograms of breast cancer. *Communications in Computer and Information Science (CCIS)*, 438:288–300, 2014.

[596] Evgeniya Gerasimova, Benjamin Audit, Stephane G. Roux, André Khalil, Olga Gileva, Françoise Argoul, Oleg Naimark, and Alain Arneodo. Wavelet-based multifractal analysis of dynamic infrared thermograms to assist in early breast cancer diagnosis. *Front. Physiol.*, 5:176, 2014.

[597] Sergio Gomez, Pablo Jensen, and Alex Arenas. Analysis of community structure in networks of correlated data. *Physical Review E*, 80(1, 2), Jul 2009.

[598] Sebastian Grauwin, Guillaume Beslon, Eric Fleury, Sara Franceschelli, Celine Robardet, Jean-Baptiste Rouquier, and Pablo Jensen. Complex Systems Science: Dreams of Universality, Interdisciplinarity Reality. *Journal of the American Society for Information Science and Technology*, 63(7):1327–1338, Jul 2012.

[599] Sebastian Grauwin and Pablo Jensen. Mapping scientific institutions. *Scientometrics*, 89(3):943–954, Dec 2011.

[600] Ronan Hamon, Pierre Borgnat, Patrick Flandrin, and Céline Robardet. Networks as signals, with an application to bike sharing systems. In *Proc. of IEEE-GlobalSIP*, December 2013. Austin (TX).

[601] Ronan Hamon, Pierre Borgnat, Patrick Flandrin, and Céline Robardet. Tracking of a dynamic graph using a signal theory approach : application to the study of a bike sharing system. In *European Conference of Complex Systems, ECCS 2013*, September 2013. Barcelona (Spain).

[602] Ronan Hamon, Pierre Borgnat, Patrick Flandrin, and Céline Robardet. Nonnegative matrix factorization to find features in temporal networks. In *2014 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*. Inst Elect & Elect Engineers, Signal Processing Soc; IEEE, 2014. IEEE International Conference on Acoustics, Speech and

Signal Processing, Florence, Italy, May 4-9, 2014.

[603] Ronan Hamon, Pierre Borgnat, Céline Robardet, and Patrick Flandrin. Transformation de graphes dynamiques en signaux non stationnaires. In *Actes du XXIVème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2013. Brest.

[604] H. Helgason, P. Abry, P. Goncalves, Cl. Gharib, P. Gaucherand, and M. Doret. Adaptive Multiscale Complexity Analysis of Fetal Heart Rate. *IEEE Transactions on Biomedical Engineering*, 58(8), Aug 2011.

[605] Hannes Helgason, Jay Bartroff, and Patrice Abry. Framework for Adaptive Multiscale Analysis of Nonhomogeneous Point Processes. In *2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, IEEE Engineering in Medicine and Biology Society Conference Proceedings, pages 7727–7730. IEEE; Engn Med & Biol Soc (EMBS), 2011. 33rd Annual International Conference of the IEEE Engineering-in-Medicine-and-Biology-Society (EMBS), Boston, Aug 30-Sep 03, 2011.

[606] Hannes Helgason, Vladas Pipiras, and Patrice Abry. Fast and exact synthesis of stationary multivariate Gaussian time series using circulant embedding. *Signal Processing*, 91(5):1123–1133, May 2011.

[607] Hannes Helgason, Vladas Pipiras, and Patrice Abry. Synthesis of multivariate stationary series with prescribed marginal distributions and covariance using circulant matrix embedding. *Signal Processing*, 91(8):1741–1758, Aug 2011.

[608] Hannes Helgason, Vladas Pipiras, and Patrice Abry. Smoothing windows for the synthesis of Gaussian stationary random fields using circulant matrix embedding. *Journal of Computational and Graphical Statistics*, xx(x):xx, 2013.

[609] Yosuke Himura, Kensuke Fukuda, Patrice Abry, Kenjiro Cho, and Hiroshi Esaki. Characterization of Host-Level Application Traffic with Multi-Scale Gamma Model. *IEICE Transactions on Communications*, E93B(11):3048–3057, Nov 2010.

[610] Yosuke Himura, Kensuke Fukuda, Kenjiro Cho, Pierre Borgnat, Patrice Abry, and Hiroshi Esaki. Synoptic Graphlet: Bridging the Gap Between Supervised and Unsupervised Profiling of Host-Level Network Traffic. *IEEE-ACM Transactions on Networking*, 21(4):1284–1297, Aug 2013.

[611] Lorenzo Isella, Juliette Stehle, Alain Barrat, Ciro Cattuto, Jean-Francois Pinton, and Wouter Van den Broeck. What's in a crowd? Analysis of face-to-face behavioral networks. *Journal of Theoretical Biology*, 271(1):166–180, Feb 21 2011.

[612] Stephane Jaffard, Patrice Abry, and Stephane Roux. Function Spaces Vs. Scaling Functions: Tools for Image Classification. In Bergounioux, M, editor, *Mathematical Image Processing*, volume 5 of *Springer Proceedings in Mathematics*, pages 1–39. Res Federat Denis Poisson Orleans; Tours Univ; Region Ctr; Conseil Gen Loiret; Mairie Orleans; Univ Orleans; Federat Denis Poisson & Lab MAPMO Orleans; Commissariat Energie Atom, 2011. 2nd Conference on Mathematics and Image Processing, Univ Orleans, Orleans, France, Mar 29-Apr 01, 2010.

[613] Pablo Jensen. Analyzing the Localization of Retail Stores with Complex Systems Tools. In Adams, NM and Robardet, C and Siebes, A and Boulicaut, JF, editor, *Advances in intelligent Data Analysis VIII, Proceedings*, volume 5772 of *Lecture Notes in Computer Science*, pages 10–20. Inst Natl Sci Appl Lyon; Rhibe-Alpes Reg Complex System Inst; Reg Rhone-Alpes; Minist Enseignement Super Rech, 2009. 8th International Symposium on Intelligent Data Analysis, Lyon, France, Aug 31-Sep 02, 2009.

[614] Pablo Jensen. A statistical picture of popularization activities and their evolutions in France. *Public Understanding of Science*, 20(1):26–36, Jan 2011.

[615] Pablo Jensen. The benefits of reaching out. *Physics World*, 25(11):17, Nov 2012.

[616] Pablo Jensen and Katsiaryna Lutkouskaya. The many dimensions of laboratories' interdisciplinarity. *Scientometrics*, 98(1):619–631, Jan 2014.

[617] Pablo Jensen and Julien Michel. Measuring spatial dispersion: exact results on the variance of random spatial distributions. *Annals of Regional Science*, 47(1):81–110, Aug 2011.

[618] Pablo Jensen, Jean-Baptiste Rouquier, and Yves Croissant. Testing bibliometric indicators by their prediction of scientists promotions. *Scientometrics*, 78(3):467–479, Mar 2009.

[619] Pablo Jensen, Jean-Baptiste Rouquier, Nicolas Ovtracht, and Celine Robardet. Characterizing the speed and paths of shared bicycle use in Lyon. *Transportation Research Part D- Transport and Environment*, 15(8):522–524, Dec 2010.

[620] P. Kestener, P. A. Conlon, A. Khalil, L. Fennell, R. T. J. McAteer, P. T. Gallagher, and A. Arneodo. Characterizing complexity in solar magnetogram data using a wavelet-based segmentation method. *Astrophysical Journal*, 717(2):995–1005, Jul 10 2010.

[621] Pablo Kreimer, Luciano Levin, and Pablo Jensen. Popularization by Argentine researchers: the activities and motivations of CONICET scientists. *Public Understanding of Science*, 20(1):37–47, Jan 2011.

[622] Hernan Larralde, Juliette Stehle, and Pablo Jensen. Analytical solution of a multi-dimensional Hotelling model with quadratic transportation costs. *Regional Science and Urban Economics*, 39(3):343, May 2009.

[623] Bruno Latour, Pablo Jensen, Tommaso Venturini, Sebastian Grauwin, and Dominique Boullier. 'The whole is always smaller than its parts' - a digital test of Gabriel Tardes' monads. *British Journal of Sociology*, 63(4):590–615, Dec 2012.

[624] Ming Li and Pierre Borgnat. Foreword to the special issue on traffic modeling, its computations and applications. *Telecommunication Systems*, 43(3-4):145–146, Apr 2010.

[625] Patrick Loiseau, Paulo Goncalves, Guillaume Dewaele, Pierre Borgnat, Patrice Abry, and Pascale Vicat-Blanc Primet. Investigating Self-Similarity and Heavy-Tailed Distributions on a Large-Scale Experimental Facility. *IEEE-ACM Transactions on Networking*, 18(4):1261–1274, Aug 2010.

[626] Remi Louf, Pablo Jensen, and Marc Barthelemy. Emergence of hierarchy in cost-driven growth of spatial networks. *Proceedings of the National Academy of Science of the United States of America*, 110(22):8824–8829, May 28 2013.

[627] R. T. James McAteer, Pierre Kestener, Alain Arneodo, and Andre Khalil. Automated detection of coronal loops using a wavelet transform modulus maxima method. *Solar Phys.*, 262(2):387, Apr 2010.

[628] G. Michau, A. Nantes, E. Chung, P. Borgnat, and P. Abry. Retrieving Dynamic Origin-Destination Matrices from Bluetooth Data'. In *Transporta-*

tion Research Board, 93rd Annual Meeting, January 2014. Bordeaux.

[629] Gabriel Michau, Céline Robardet, Luc Merchez, Pablo Jensen, Patrice Abry, Patrick Flandrin, and Pierre Borgnat. Peut-on attraper les utilisateurs de Vélo'v au Lasso ? In *Actes du XXIIIème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2011. Bordeaux.

[630] Azadeh Moghtaderi, Pierre Borgnat, and Patrick Flandrin. Trend filtering: Empirical Mode Decompositions versus l1 and Hodrick-Prescott. *Advances in Adaptive Data Analysis*, 3(1-2):41–61, April 2011.

[631] Azadeh Moghtaderi, Pierre Borgnat, and Patrick Flandrin. Gap-filling by the Empirical Mode Decomposition. In *Proc. of the IEEE International Conference on Acoustics, Speech and Signal Processing ICASSP-2012*, pages 3821–3824, Mar. 25-30 2012. Kyoto, Japan.

[632] Azadeh Moghtaderi, Patrick Flandrin, and Pierre Borgnat. Time-varying spectrum estimation of uniformly modulated processes by means of surrogate data and Empirical Mode Decomposition. In *Proc. of the IEEE International Conference on Acoustics, Speech and Signal Processing ICASSP-2010*, pages 3678–3681, Mar. 14-19 2010. Dallas, TX.

[633] Azadeh Moghtaderi, Patrick Flandrin, and Pierre Borgnat. Trend filtering via Empirical Mode Decompositions. *Computational Statistics & Data Analysis*, 58:114–126, February 2013.

[634] Michele Orini, Raquel Bailon, Luca T. Mainardi, Pablo Laguna, and Patrick Flandrin. Characterization of dynamic interactions between cardiovascular signals by time-frequency coherence. *IEEE Transactions on Biomedical Engineering*, 59(3):663–673, March 2012.

[635] P. Borgnat, C. Robardet, P. Abry, P. Flandrin, J.-B. Rouquier, N. Tremblay. A dynamical network view of Lyon's Vélo'v shared bicycle system. In A. Mukherjee et al., editor, *Dynamics on and of Complex Networks, Vol. 2*, pages 267. Springer, 2013.

[636] P. Flandrin. Des signaux stationnaires en quel sens ? In A. Appriou et O. Macchi, editor, *Le traitement de l'information en interaction avec les mathématiques et la physique*, pages 105–127. CNRS Éditions, Paris, 2010.

[637] P. Flandrin. Écrire un article. In É. Guichard, editor, *Écritures : sur les traces de Jack Goody*. Presses de l'ENSSIB, Villeurbanne, 2012.

[638] P. Honeine, P. Borgnat, C. Richard, P. Flandrin. Nonstationary signal analysis with kernel machines. In E. Soria, J.D. Martin, R. Magdanela, M. Martinez and A.J. Serrano, editor, *Handbook of Research on Machine Learning Applications and Trends: Algorithms, Methods and Techniques*. ICI Global, 2012.

[639] J.-C. Pesquet and N. Pustelnik. A parallel inertial proximal optimization method. *Pacific Journal of Optimization*, 8(2):273–306, Apr 2012.

[640] N. Pustelnik, P. Borgnat, and P. Flandrin. Empirical mode decomposition revisited by multicomponent non smooth convex optimization. *Signal Processing*, 102:x+45, September 2014.

[641] N. Pustelnik, J.-C. Pesquet, and C. Chaux. Relaxing tight frame condition in parallel proximal methods for signal restoration. *IEEE Transactions on Signal Processing*, 60(2):968–973, Feb 2012.

[642] N. Pustelnik, H. Wendt, and P. Abry. Régularité locale pour l'analyse de texture : le mariage des *coefficients dominants* et de la *minimisation proximale*. In *Actes du XXIVème Colloque GRETSI sur le Traitement du Signal et des Images,*, September 2013. Brest, France.

[643] Nelly Pustelnik, Pierre Borgnat, and Patrick Flandrin. A multicomponent proximal algorithm for Empirical Mode Decomposition. In *Proc. of the 20th European Signal Processing Conference EUSIPCO-2012*, pages 1880–1884, Aug. 27-31, 2012. Bucharest, Romania.

[644] Fabio Ricciato, Angelo Coluccia, Alessandro D'Alconzo, Darryl Veitch, Pierre Borgnat, and Patrice Abry. On the role of flows and sessions in Internet traffic modeling: an explorative toy-model. In Ulema, M, editor, *GLOBECOM 2009 - 2009 IEEE Global Telecommunications Conference, Vols 1-8*, IEEE Global Telecommunications Conference (Globecom), pages 2880–2887. IEEE, 2009. IEEE Global Telecommunications Conference (GLOBECOM 09), Honolulu, HI, NOV 30-DEC 04, 2009.

[645] Cedric Richard, Andre Ferrari, Hassan Amoud, Paul Honeine, Patrick Flandrin, and Pierre Borgnat. Statistical hypothesis testing with time-frequency surrogates to check signal stationarity. In *Proc. of the IEEE International Conference on Acoustics, Speech and Signal Processing ICASSP-2010*, pages 3666, Mar. 14-19, 2010. Dallas, TX.

[646] Gabriel Rilling and Patrick Flandrin. Sampling effects on the Empirical Mode Decomposition. *Advances in Adaptive Data Analysis*, 1(1):43–59, January 2009.

[647] J.-B. Rouquier and P. Borgnat. Cartographie des pratiques du vélo'v : le regard de physiciens et d'informaticiens. *Revue Sciences/Lettres*, 2, 2014.

[648] S. Roux, M. Clausel, B. Vedel, S. Jaffard, and P. Abry. Transformée hyperbolique en ondelettes 2d pour la caractérisation d'images autosimilaires anisotropes. In *Actes du XXIIIème Colloque GRETSI sur le Traitement du Signal et des Images,*, September 2011. Bordeaux, France.

[649] S. Roux, B. Vedel, S. Jaffard, and P. Abry. Coefficients dominants de la transformée hyperbolique en ondelettes 2d: Application à l'analyse de textures invariantes d'échelle, multifractales et anisotropes. In *Actes du XXIVème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2013. Brest, France.

[650] S. G. Roux, V. Venugopal, K. Fienberg, A. Arneodo, and E. Foufoula-Georgiou. Evidence for inherent nonlinearity in temporal rainfall. *Adv. Water Resourc.*, 32(1):41–48, January 2009.

[651] Stephane G. Roux, Patrice Abry, Petra Koucka Knizova, and Zbysek Mosna. Scale-dependent analysis of ionosphere fluctuations. In *2011 IEEE International Conference on Acoustics, Speech, and Signal Processing*, International Conference on Acoustics Speech and Signal Processing ICASSP, pages 3836–3839. Inst Elect & Elect Engineers Signal Processing Soc; IEEE, 2011. IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Prague Congress Ctr, Prague, Czech Republic, May 22-27, 2011.

[652] Stephane G. Roux, Marianne Clausel, Beatrice Vedel, Stephane Jaffard, and P. Abry. Self-Similar Anisotropic Texture Analysis: The Hyperbolic Wavelet Transform Contribution. *IEEE Transactions on Image Processing*, 22(11):4353, Nov 2013.

[653] Johan Sandberg, Maria Hansson-Sandsten, Tomi

Kinnunen, Rahim Saeidi, Patrick Flandrin, and Pierre Borgnat. Multitaper estimation of frequency-warped cepstra with application to speaker verification. *IEEE Signal Processing Letters*, 17(4):343–346, April 2010.

[654] Ginette Saracco, Alain Arneodo, and Gregory Beylkin. Special issue on continuous wavelet transform in memory of Jean Morlet, part I preface. *Appl. Comput. Harmon. Anal.*, 28(2, SI):129–130, Mar 2010.

[655] Ginette Saracco, Alain Arneodo, and Gregory Beylkin. Special issue on continuous wavelet transform in memory of Jean Morlet, part II preface. *Appl. Comput. Harmon. Anal.*, 28(3, SI):249–250, May 2010.

[656] Nicoletta Saulig, Nelly Pustelnik, Pierre Borgnat, Patrick Flandrin, and Victor Sucic. Instantaneous counting of components in nonstationary signals. In *Proc. of the 21st European Signal Processing Conference EUSIPCO-2013*, Sep. 9-13, 2013. Marrakech, Morocco.

[657] A. Scherrer and P. Abry. Synthèse de processus bivariés non gaussiens à mémoires longues. In *Actes du XXIIIème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2009. Dijon, France.

[658] A. Scherrer, P. Abry, S. Jaffard, H. Ji, and Z. Shen. Wavelet leader multifractal analysis for texture classification. In *International Conference on Image processing,*, 2009. Cairo, Egypt.

[659] Gaston Schlotthauer, Maria-Eugenia Torres, Hugo Rufiner, and Patrick Flandrin. EMD of Gaussian white noise: Effects of signal length and Ssifting number on the statistical properties of Intrinsic Mode Functions. *Advances in Adaptive Data Analysis*, 1(4):517–527, October 2009.

[660] J. Schmitt, N. Pustelnik, P. Borgnat, and P. Flandrin. 2D Hilbert-Huang transform. In *2014 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*. Inst Elect & Elect Engineers, Signal Processing Soc; IEEE, May 4-9, 2014. IEEE International Conference on Acoustics, Speech and Signal Processing, Florence, Italy.

[661] Juliette Stehle, Nicolas Voirin, Alain Barrat, Ciro Cattuto, Vittoria Colizza, Lorenzo Isella, Corinne Regis, Jean-Francois Pinton, Nagham Khanafer, Wouter Van den Broeck, and Philippe Vanhems. Simulation of an SEIR infectious disease model on the dynamic contact network of conference attendees. *BMC Medicine*, 9, Jul 19 2011.

[662] Juliette Stehle, Nicolas Voirin, Alain Barrat, Ciro Cattuto, Lorenzo Isella, Jean-Francois Pinton, Marco Quaggiotto, Wouter Van den Broeck, Corinne Regis, Bruno Lina, and Philippe Vanhems. High-Resolution Measurements of Face-to-Face Contact Patterns in a Primary School. *PLOS ONE*, 6(8), Aug 16 2011.

[663] Maria E. Torres, Marcelo A. Colominas, Gaston Schlotthauer, and Patrick Flandrin. A complete Ensemble Empirical Mode Decomposition with adaptive noise. In *Proc. of the IEEE International Conference on Acoustics, Speech and Signal Processing ICASSP-2011*, pages 4144–4147, May 22-27, 2011. Prague, CZ.

[664] Nicolas Tremblay, Alain Barrat, Cary Forest, Mark Nornberg, Jean-François Pinton, and Pierre Borgnat. Bootstrapping under constraint for the assessment of group behavior in human contact networks. *Physical Review E*, 88(5), Nov. 25 2013.

[665] Nicolas Tremblay and Pierre Borgnat. Community Mining in Large Networks using Graph Wavelet Transform of Random Vectors. In *Proc. of IEEE-GlobalSIP*, December 2013. Austin (TX).

[666] Nicolas Tremblay and Pierre Borgnat. Multiscale community mining in networks using spectral graph wavelets. In *Proc. of the 21st European Signal Processing Conference EUSIPCO-2012*, Sep. 9-13, 2013. Marrakech, Morocco.

[667] Nicolas Tremblay and Pierre Borgnat. Multiscale Detection of Stable Communities Using Wavelets on Networks. In *European Conference of Complex Systems, ECCS 2013*, September 2013. Barcelona (Spain).

[668] Nicolas Tremblay and Pierre Borgnat. Partitionnement multi-échelle d'un graphe en communautés: détection des échelles pertinentes. In *Actes du XXIVème Colloque GRETSI sur le Traitement du Signal et des Images*, September 2013. Brest, France.

[669] Nicolas Tremblay, Pierre Borgnat, Jean-François Pinton, Alain Barrat, Mark Nornberg, and Cary Forest. Constrained graph resampling for group assessment in human social networks. In *European Conference of Complex Systems, ECCS 2012*, September 2012. Bruxelles (Belgique).

[670] Philippe Vanhems, Alain Barrat, Ciro Cattuto, Jean-Francois Pinton, Nagham Khanafer, Corinne Regis, Byeul-a Kim, Brigitte Comte, and Nicolas Voirin. Estimating Potential Infection Transmission Routes in Hospital Wards Using Wearable Proximity Sensors. *PLOS ONE*, 8(9), Sep 11 2013.

[671] M. Vogel, R. Hamon, G. Lozenguez, L. Merchez, P. Abry, J. Barnier, P. Borgnat, P. Flandrin, I. Mallon, and C. Robardet. From bicycle sharing system movements to users: A typology of vélo'v cyclists in lyon based on large-scale behavioural dataset. *Journal of Transport Geography*, to appear, 2014.

[672] H. Wendt, N. Dobigeon, J.-Y. Tourneret, and P. Abry. Estimation bayésienne du paramètre de multifractalité. In *Actes du XXIVème Colloque GRETSI sur le Traitement du Signal et des Images,*, September 2013. Brest, France.

[673] H. Wendt, S. Jaffard, and P. Abry. Multifractal analysis of self-similar processes. In *2012 IEEE Statistical Signal Processing Workshop (SSP)*, pages 69–72. IEEE, 2012. IEEE Statistical Signal Processing Workshop (SSP), Ann Arbor, Aug 05-08, 2012.

[674] H. Wendt, A. Scherrer, P. Abry, and S. Achard. Testing Fractal Connectivity in multivariate long memory processes. In *2009 IEEE International Conference on Acoustics, Speech, and Signal Processing, Vols 1- 8, Proceedings*, International Conference on Acoustics Speech and Signal Processing ICASSP, pages 2913–2916. IEEE; IEEE Signal Proc Soc, 2009. IEEE International Conference on Acoustics, Speech and Signal Processing, Taipei, Taiwan, Apr 19-24, 2009.

[675] Herwig Wendt, Patrice Abry, Stephane Jaffard, Hui Ji, and Zuowei Shen. Wavelet leader mutifractal analysis for texture classification. In *2009 16TH IEEE International Conference on Image Processing, VOLS 1-6*, pages 3785–3788. IEEE, 2009. 16th IEEE International Conference on Image Processing, Cairo, Egypt, Nov 07-10, 2009.

[676] Herwig Wendt, Patrice Abry, Stephane G. Roux, Stephane Jaffard, and Beatrice Vedel. Multifractal

Analysis for Images: The wavelet Leaders contribution. *Traitement du Signal*, 26(1):47–65, 2009.

[677] Herwig Wendt, Nicolas Dobigeon, Jean-Yves Tourneret, and Patrice Abry. Bayesian estimation for the multifractality parameter. In *2013 International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, International Conference on Acoustics Speech and Signal Processing ICASSP, pages 6556–6560. Inst Elect & Elect Engineers; Inst Elect & Elect Engineers Signal Proc Soc, 2013. IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Vancouver, Canada, May 26-31, 2013.

[678] Herwig Wendt, Stephane G. Roux, Stephane Jaffard, and Patrice Abry. Wavelet leaders and bootstrap for multifractal analysis of images. *Signal Processing*, 89(6):1100–1114, Jun 2009.

[679] Hau-Tieng Wu, Patrick Flandrin, and Ingrid Daubechies. One or two frequencies? The synchrosqueezing answers. *Advances in Adaptive Data Analysis*, 3(1-2):29–39, April 2011.

[680] Nicolas Zilber, Philippe Ciuciu, Patrice Abry, and Virginie van Wassenhove. Modulation of scale-free properties of brain activity in MEG. In *2012 9TH IEEE International Symposium on Biomedical Imaging (ISBI)*, pages 1531–1534. IEEE; IEEE Engn Med & Biol Soc (EMBS); IEEE Signal Proc Soc, 2012. 9th IEEE International Symposium on Biomedical Imaging (ISBI) - From Nano to Macro, Barcelona, Spain, May 02-05, 2012.

[681] Nicolas Zilber, Philippe Ciuciu, Patrice Abry, and Virginie van Wassenhove. Learning-induced modulation of scale-free properties of brain activity measured with MEG. In *2013 IEEE 10th International Symposium on Biomedical Imaging (ISBI)*, IEEE International Symposium on Biomedical Imaging, pages 998–1001. IEEE; IEEE Signal Processing Soc; Engn Med Biol Soc, 2013. IEEE 10th International Symposium on Biomedical Imaging - From Nano to Macro (ISBI), San Francisco, CA, Apr 07-11, 2013.

T7B. Statistical Physics

[682] Angel Alastuey and Jaroslaw Piasecki. Approach to a stationary state in an external field. *Journal of Statistical Physics*, 139(6):991–1012, Jun 2010.

[683] Erik Aurell, Krzysztof Gawedzki, Carlos Mejia-Monasterio, Roya Mohayaee, and Paolo Muratore-Ginanneschi. Refined Second Law of Thermodynamics for Fast Random Processes. *Journal of Statistical Physics*, 147(3):487–505, May 2012.

[684] R. Bachelard, T. Dauxois, G. De Ninno, S. Ruffo, and F. Staniscia. Vlasov equation for long-range interactions on a lattice. *Physical Review E*, 83(6, 1), Jun 21 2011.

[685] R. Bachelard, F. Staniscia, T. Dauxois, G. De Ninno, and S. Ruffo. Stability of inhomogeneous states in mean-field models with an external potential. *Journal of Statistical Mechanics-Theory and Experiment*, Mar 2011.

[686] Eric Bertin. Entropic aging and extreme value statistics. *Journal of Physics A-Mathematical and Theoretical*, 43(34), Aug 27 2010.

[687] Eric Bertin. How far can stochastic and deterministic views be reconciled? *Progress in Biophysics & Molecular Biology*, 110(1, SI):11–16, Sep 2012.

[688] Eric Bertin. On-off intermittency over an extended range of control parameter. *Physical Review E*, 85(4, 1), Apr 18 2012.

[689] Eric Bertin. Ageing in the trap model as a relaxation further away from equilibrium. *Journal of Physics A-Mathematical and Theoretical*, 46(9), Mar 8 2013.

[690] Eric Bertin, Hugues Chate, Francesco Ginelli, Guillaume Gregoire, Sebastien Leonard, and Anton Peshkov. Comment on "towards a quantitative kinetic theory of polar active matter" by t. ihle. *European Physical Journal Special Topics*, 223:1419, 2014.

[691] Eric Bertin, Hugues Chate, Francesco Ginelli, Shradha Mishra, Anton Peshkov, and Sriram Ramaswamy. Mesoscopic theory for fluctuating active nematics. *New Journal of Physics*, 15, Aug 28 2013.

[692] Eric Bertin and Olivier Dauchot. Far-from-Equilibrium State in a Weakly Dissipative Model. *Physical Review Letters*, 102(16), Apr 24 2009.

[693] Eric Bertin, Michel Droz, and Guillaume Gregoire. Hydrodynamic equations for self-propelled particles: microscopic derivation and stability analysis. *Journal of Physics A-Mathematical and Theoretical*, 42(44), Nov 6 2009.

[694] Eric Bertin, David Halley, Yves Henry, Nabil Najjari, Hicham Majjad, Martin Bowen, Victor DaCosta, Jacek Arabski, and Bernard Doudin. Random barrier double-well model for resistive switching in tunnel barriers. *Journal of Applied Physics*, 109(8), Apr 15 2011.

[695] Eric Bertin and Peter C. W. Holdsworth. Dissipation-induced non-Gaussian energy fluctuations. *Europhysics Letters*, 102(5), Jun 2013.

[696] A. Berut, A. Petrosyan, and S. Ciliberto. Detailed jarzynski equality applied to a logically irreversible procedure. *Europhysics Letters*, 103(6), 2013.

[697] Antoine Berut, Artak Arakelyan, Artyom Petrosyan, Sergio Ciliberto, Raoul Dillenschneider, and Eric Lutz. Experimental verification of landauer's principle linking information and thermodynamics. *Nature*, 483(7388):187–U1500, 2012.

[698] Freddy Bouchet and Marianne Corvellec. Invariant measures of the 2D Euler and Vlasov equations. *Journal of Statistical Mechanics-Theory and Experiment*, Aug 2010.

[699] Freddy Bouchet, Shamik Gupta, and David Mukamel. Thermodynamics and dynamics of systems with long-range interactions. *Physica A-Statistical Mechanics and its Applications*, 389(20, SI):4389–4405, Oct 15 2010. 12th International Summer School on Fundamental Problems in Statistical Physics, European Ctr Foresta, Leuven, Belgium, Aug 31-Sep 11, 2009.

[700] Freddy Bouchet, Jason Laurie, and Oleg Zaboronski. Langevin dynamics, large deviations and instantons for the quasi-geostrophic model and two-dimensional euler equations. *arXiv preprint arXiv:1403.0216*, 2014.

[701] Freddy Bouchet and Eric Simonnet. Random Changes of Flow Topology in Two-Dimensional and Geophysical Turbulence. *Physical Review Letters*, 102(9), Mar 6 2009.

[702] Freddy Bouchet and Hugo Touchette. Non-classical large deviations for a noisy system with non-isolated attractors. *Journal of Statistical Mechanics-Theory*

and Experiment, May 2012.

[703] O. M. Braun and M. Peyrard. Master equation approach to friction at the mesoscale. *Physical Review E*, 82(3, 2), Sep 28 2010.

[704] O. M. Braun and M. Peyrard. Dependence of kinetic friction on velocity: Master equation approach. *Physical Review E*, 83(4, 2), Apr 28 2011.

[705] O. M. Braun and M. Peyrard. Crack in the frictional interface as a solitary wave. *Physical Review E*, 85(2, 2), Feb 21 2012.

[706] O. M. Braun and Michel Peyrard. Role of aging in a minimal model of earthquakes. *Physical Review E*, 87(3), Mar 15 2013.

[707] O. M. Braun, Michel Peyrard, D. V. Stryzheus, and Erio Tosatti. Collective Effects at Frictional Interfaces. *Tribology Letters*, 48(1, SI):11–25, Oct 2012.

[708] Alessandro Campa, Thierry Dauxois, and Stefano Ruffo. Statistical mechanics and dynamics of solvable models with long-range interactions. *Physics Reports*, 480(3-6):57–159, Sep 2009.

[709] A. Caussarieu, A. Petrosyan, and S. Ciliberto. Accurate determination of the freedericksz transition threshold using a method based upon precise fluctuation measurements. *Applied Physics Letters*, 103(14), 2013.

[710] A. Caussarieu, A. Petrosyan, and S. Ciliberto. Dynamics of a liquid crystal close to the freedericksz transition. *Europhysics Letters*, 104(2), 2013.

[711] Jean-Baptiste Caussin and Denis Bartolo. Tailoring the interactions between self-propelled bodies. *European Physical Journal E*, 37:13, 2014.

[712] Jean-Baptiste Caussin, Alexandre Solon, Anton Peshkov, Hugues Chaté, Thierry Dauxois, Julien Tailleur, Vincenzo Vitelli, and Denis Bartolo. Emergent spatial structures in flocking models: A dynamical system insight. *Physical Review Letters*, 112:148102, 2014.

[713] Raphael Chetrite and Krzysztof Gawedzki. Eulerian and Lagrangian Pictures of Non-equilibrium Diffusions. *Journal of Statistical Physics*, 137(5-6):890–916, Dec 2009.

[714] S. Ciliberto, R. Gomez-Solano, and A. Petrosyan. Fluctuations, linear response, and currents in out-of-equilibrium systems. *Annual Review of Condensed Matter Physics, Vol 4*, 4:235–261, 2013. Langer, JS.

[715] S. Ciliberto, A. Imparato, A. Naert, and M. Tanase. Heat flux and entropy produced by thermal fluctuations. *Physical Review Letters*, 110(18), 2013.

[716] S. Ciliberto, A. Imparato, A. Naert, and M. Tanase. Statistical properties of the energy exchanged between two heat baths coupled by thermal fluctuations. *Journal of Statistical Mechanics-Theory and Experiment*, 2013.

[717] S. Ciliberto, S. Joubaud, and A. Petrosyan. Fluctuations in out-of-equilibrium systems: from theory to experiment. *Journal of Statistical Mechanics-Theory and Experiment*, Dec 2010.

[718] Olivier Dauchot and Eric Bertin. Subcritical transition to turbulence: What we can learn from the physics of glasses. *Physical Review E*, 86(3, 2), Sep 19 2012.

[719] Olivier Dauchot and Eric Bertin. The glass transition in a nutshell: a source of inspiration to describe the subcritical transition to turbulence. *European Physical Journal E*, 37:31, 2014.

[720] Thierry Dauxois, Pierre de Buyl, Leonardo Lori, and Stefano Ruffo. Models with short- and long-range interactions: the phase diagram and the reentrant phase. *Journal of Statistical Mechanics-Theory and Experiment*, Jun 2010.

[721] Thierry Dauxois, Francesca Di Patti, Duccio Fanelli, and Alan J. McKane. Enhanced stochastic oscillations in autocatalytic reactions. *Physical Review E*, 79(3), Mar 2009.

[722] Pietro de Anna, Francesca di Patti, Duccio Fanelli, Alan J. McKane, and Thierry Dauxois. Spatial model of autocatalytic reactions. *Physical Review E*, 81(5, 2), May 2010.

[723] Manlio De Domenico, Mariangela Settimo, Simone Riggi, and Eric Bertin. Reinterpreting the development of extensive air showers initiated by nuclei and photons. *Journal of Cosmology and Astroparticle Physics*, (7), Jul 2013.

[724] Andrei A. Fedorenko, Pierre Le Doussal, and Kay J. Wiese. Non-Gaussian effects and multifractality in the Bragg glass. *Europhysics Letters*, 105(1), Jan 2014.

[725] Andrei A. Fedorenko, Pierre Le Doussal, and Kay Joerg Wiese. Functional renormalization-group approach to decaying turbulence. *Journal of Statistical Mechanics-Theory and Experiment*, Apr 2013.

[726] J. R. Gomez-Solano, L. Bellon, A. Petrosyan, and S. Ciliberto. Steady-state fluctuation relations for systems driven by an external random force. *Europhysics Letters*, 89(6), 2010.

[727] J. R. Gomez-Solano, A. Petrosyan, and S. Ciliberto. Heat fluctuations in a nonequilibrium bath. *Physical Review Letters*, 106(20), 2011.

[728] J. R. Gomez-Solano, A. Petrosyan, and S. Ciliberto. Fluctuations, linear response and heat flux of an aging system. *Europhysics Letters*, 98(1), 2012.

[729] J. R. Gomez-Solano, A. Petrosyan, S. Ciliberto, R. Chetrite, and K. Gawedzki. Experimental verification of a modified fluctuation-dissipation relation for a micron-sized particle in a nonequilibrium steady state. *Physical Review Letters*, 103(4), 2009.

[730] Juan Ruben Gomez-Solano, Artyom Petrosyan, and Sergio Ciliberto. Finite sampling effects on generalized fluctuation-dissipation relations for steady states. *Statphys-Kolkata Vii*, 297, 2011. Bhattacharjee, JK Chakrabarti, BK Inoue, JI Sen, P International Conference on Statphys Kolkata VII Nov 26-30, 2010 Kolkata, India Saha Inst Nucl Phys, Ctr Appl Math and Computat Sci (CAMCS); Satyendra Nath Bose Natl Ctr Basic Sci.

[731] Juan Ruben Gomez-Solano, Artyom Petrosyan, Sergio Ciliberto, and Christian Maes. Fluctuations and response in a non-equilibrium micron-sized system. *Journal of Statistical Mechanics-Theory and Experiment*, 2011.

[732] Sebastian Grauwin, Eric Bertin, Remi Lemoy, and Pablo Jensen. Competition between collective and individual dynamics. *Proceedings of the National Academy of Science of the United States of America*, 106(49):20622–20626, Dec 8 2009.

[733] Sebastian Grauwin, Florence Goffette-Nagot, and Pablo Jensen. Dynamic models of residential segregation: An analytical solution. *Journal of Public Economics*, 96(1-2):124–141, Feb 2012.

[734] Sebastian Grauwin, Dominic Hunt, Eric Bertin, and Pablo Jensen. Efective free energy for individual dynamics. *Advances in Complex Systems*, 14(4):529–536, Aug 2011.

[735] Sebastian Grauwin and Pablo Jensen. Opinion group formation and dynamics: Structures that last

from nonlasting entities. *Physical Review E*, 85(6, 2), Jun 11 2012.

[736] Shamik Gupta, Thierry Dauxois, and Stefano Ruffo. A stochastic model of long-range interacting particles. *Journal of Statistical Mechanics-Theory and Experiment*, Nov 2013.

[737] Christian Borghesi Jean-Philippe Bouchaud and Pablo Jensen. On the emergence of an 'intention field' for socially cohesive agents. *J. Stat. Mech.*, ():P03010, 2014.

[738] Pierre Jop, Juan Ruben Gomez-Solano, Artyom Petrosyan, and Sergio Ciliberto. Experimental study of out-of-equilibrium fluctuations in a colloidal suspension of laponite using optical traps. *Journal of Statistical Mechanics-Theory and Experiment*, 2009.

[739] S. Joubaud, G. Huillard, A. Petrosyan, and S. Ciliberto. Work fluctuations in a nematic liquid crystal. *Journal of Statistical Mechanics-Theory and Experiment*, Jan 2009.

[740] S. Joubaud, B. Percier, A. Petrosyan, and S. Ciliberto. Aging and Effective Temperatures Near a Critical Point. *Physical Review Letters*, 102(13), Apr 3 2009.

[741] Sylvain Joubaud, Detlef Lohse, and Devaraj van der Meer. Fluctuation Theorems for an Asymmetric Rotor in a Granular Gas. *Physical Review Letters*, 108(21), May 24 2012.

[742] V. Kaiser, S. T. Bramwell, P. C. W. Holdsworth, and R. Moessner. Onsager's Wien effect on a lattice. *Nature Materials*, 12(11):1032–1036, Nov 2013.

[743] Gaultier Lambert, Guillaume Chevereau, and Eric Bertin. A symmetry-breaking phase transition in a dynamical decision model. *Journal of Statistical Mechanics-Theory and Experiment*, Jun 2011.

[744] Lasse Laurson, Xavier Illa, Stephane Santucci, Ken Tore Tallakstad, Knut Jorgen Maloy, and Mikko J. Alava. Evolution of the average avalanche shape with the universality class. *Nature Communications*, 4, Dec 2013.

[745] Lasse Laurson, Stephane Santucci, and Stefano Zapperi. Avalanches and clusters in planar crack front propagation. *Physical Review E*, 81(4, 2), Apr 2010.

[746] R. L.Bellon, A. Gomez-Solano, A. Petrosyan, and Ciliberto S. Measuring out of equilibrium fluctuations. *Book Chapter in "Nonequilibrium Statistical Physics of Small Systems: Fluctuation relations and beyond", Edited by R.Klages, W.Just, C.Jarzynski (Eds.), published by Wiley-VCH*, (2013).

[747] Remi Lemoy and Eric Bertin. Dynamical fluctuations in a simple housing market model. *Journal of Statistical Mechanics-Theory and Experiment*, Dec 2012.

[748] Remi Lemoy, Eric Bertin, and Pablo Jensen. Socioeconomic utility and chemical potential. *Europhysics Letters*, 93(3), Feb 2011.

[749] Jensen P. Lemoy R., Raux C. An agent-based model of residential patterns and social structure in urban area. *Cybergeo*, 512():, 2011.

[750] Kirsten Martens and Eric Bertin. The influence of flux balance on the generalized chemical potential in mass transport models. *Journal of Statistical Mechanics-Theory and Experiment*, Sep 2011.

[751] Kirsten Martens, Eric Bertin, and Michel Droz. Dependence of the Fluctuation-Dissipation Temperature on the Choice of Observable. *Physical Review Letters*, 103(26), Dec 31 2009.

[752] Kirsten Martens, Eric Bertin, and Michel Droz. Entropy-based characterizations of the observable dependence of the fluctuation-dissipation temperature. *Physical Review E*, 81(6, 1), Jun 2 2010.

[753] George Miloshevich, Thierry Dauxois, Ramaz Khomeriki, and Stefano Ruffo. Dipolar needles in the microcanonical ensemble: Evidence of spontaneous magnetization and ergodicity breaking. *Europhysics Letters*, 104(1), Oct 2013.

[754] Anne Mounier and Antoine Naert. The Hatano-Sasa equality: Transitions between steady states in a granular gas. *Europhysics Letters*, 100(3), Nov 2012.

[755] A. Naert. Experimental study of work exchange with a granular gas: The viewpoint of the Fluctuation Theorem. *Europhysics Letters*, 97(2), Jan 2012.

[756] Cesare Nardini, Shamik Gupta, Stefano Ruffo, Thierry Dauxois, and Freddy Bouchet. Kinetic theory for non-equilibrium stationary states in long-range interacting systems. *Journal of Statistical Mechanics-Theory and Experiment*, Jan 2012.

[757] Cesare Nardini, Shamik Gupta, Stefano Ruffo, Thierry Dauxois, and Freddy Bouchet. Kinetic theory of nonequilibrium stochastic long-range systems: phase transition and bistability. *Journal of Statistical Mechanics-Theory and Experiment*, Dec 2012.

[758] Alain Olivetti, Julien Barre, Bruno Marcos, Freddy Bouchet, and Robin Kaiser. Breathing Mode for Systems of Interacting Particles. *Physical Review Letters*, 103(22), Nov 27 2009.

[759] Alain Olivetti, Julien Barre, Bruno Marcos, Freddy Bouchet, and Robin Kaiser. Breathing dynamics for systems of interacting particles in the microcanonical and canonical descriptions. *Transport and Statistical Physics*, 39(5-7, SI):524–551, 2010.

[760] Anton Peshkov, Igor S. Aranson, Eric Bertin, Hugues Chate, and Francesco Ginelli. Nonlinear Field Equations for Aligning Self-Propelled Rods. *Physical Review Letters*, 109(26), Dec 27 2012.

[761] Anton Peshkov, Eric Bertin, Francesco Ginelli, and Hugues Chate. Boltzmann-ginzburg-landau approach for continuous descriptions of generic vicsek-like models. *European Physical Journal Special Topics*, 223:1315, 2014.

[762] Anton Peshkov, Sandrine Ngo, Eric Bertin, Hugues Chate, and Francesco Ginelli. Continuous Theory of Active Matter Systems with Metric-Free Interactions. *Physical Review Letters*, 109(9), Aug 28 2012.

[763] Ramon Planet, Stephane Santucci, and Jordi Ortin. Avalanches and Non-Gaussian Fluctuations of the Global Velocity of Imbibition Fronts. *Physical Review Letters*, 102(9), Mar 6 2009.

[764] Ramon Planet, Stephane Santucci, and Jordi Ortin. Comment on "Avalanches and Non-Gaussian Fluctuations of the Global Velocity of Imbibition Fronts" Reply. *Physical Review Letters*, 105(2), Jul 9 2010.

[765] Ramon Planet, Stephane Santucci, and Jordi Ortin. Roughness and intermittent dynamics of imbibition fronts due to capillary and permeability disorder. *Journal of Contaminant Hydrology*, 120-21(SI):157–169, Mar 1 2011.

[766] Max Potters, Timothee Vaillant, and Freddy Bouchet. Sampling microcanonical measures of the 2D Euler equations through Creutz's algorithm: a phase transition from disorder to order when energy is increased. *Journal of Statistical Mechanics-Theory and Experiment*, Feb 2013.

[767] S. Santucci, M. Grob, R. Toussaint, J. Schmittbuhl, A. Hansen, and K. J. Maloy. Fracture roughness scaling: A case study on planar cracks. *Europhysics Letters*, 92(4), Nov 2010.

[768] S. Santucci, R. Planet, K. Jorgen Maloy, and J. Ortin. Avalanches of imbibition fronts: Towards critical pinning. *Europhysics Letters*, 94(4), May 2011.

[769] Ken Tore Tallakstad, Renaud Toussaint, Stephane Santucci, and Knut Jorgen Maloy. Non-Gaussian Nature of Fracture and the Survival of Fat-Tail Exponents. *Physical Review Letters*, 110(14), Apr 2 2013.

[770] Simon Thalabard, Bérengère Dubrulle, and Freddy Bouchet. Statistical mechanics of the 3d axisymmetric euler equations in a taylor–couette geometry. *Journal of Statistical Mechanics: Theory and Experiment*, 2014(1):P01005, 2014.

[771] Antoine Venaille and Freddy Bouchet. Solvable Phase Diagrams and Ensemble Inequivalence for Two-Dimensional and Geophysical Turbulent Flows. *Journal of Statistical Physics*, 143(2):346–380, Apr 2011.

[772] M. E. Zhitomirsky, P. C. W. Holdsworth, and R. Moessner. Nature of finite-temperature transition in anisotropic pyrochlore $er_2ti_2o_7$. *Physical Review B*, 89:140403, Apr 2014.

T8B. Instrumentation and Imaging

[773] L Berguiga, F Argoul, and A Fahys. Microscope de plasmon de surface à haute résolution comportant un interféromètre heterodyne fibré. CNRS-ENS Lyon patent 09 50878, 2009.

[774] L Berguiga, E Provera, J Elezgaray, and F Argoul. Sensing Nanometer Depth of Focused Optical Fields with Scanning Surface Plasmon Microscopy. *Plasmonics*, 8:715–722, 2013.

[775] Y. Berthoumieu, C. Dossal, N. Pustelnik, P. Ricoux, and F. Turcu. An evaluation of the sparsity degree for sparse recovery with deterministic measurement matrices. *J. Math. Imaging. Vis.*, 48(2, SI):266–278, Feb 2014.

[776] Thomas Gallot, Christophe Perge, Vincent Grenard, Marc-Antoine Fardin, Nicolas Taberlet, and Sebastien Manneville. Ultrafast ultrasonic imaging coupled to rheometry: Principle and illustration. *Review of Scientific Instruments*, 84(4), Apr 2013.

[777] Justine Laurent, Audrey Steinberger, and Ludovic Bellon. Functionalized AFM probes for force spectroscopy: eigenmode shapes and stiffness calibration through thermal noise measurements. *Nanotechnology*, 24(22), Jun 7 2013.

[778] Kevin Mader, Rajmund Mokso, Christophe Raufaste, Benjamin Dollet, Stephane Santucci, Jerome Lambert, and Marco Stampanoni. Quantitative 3d characterization of cellular materials: Segmentation and morphology of foam. *Colloids and Surfaces A-Physicochemical and Engineering Aspects*, 415:230–238, DEC 5 2012.

[779] Sophie Miralles, Gautier Verhille, Nicolas Plihon, and Jean-Francois Pinton. The magnetic-distortion probe: Velocimetry in conducting fluids. *Review of Scientific Instruments*, 82(9), Sep 2011.

[780] Vitaly Noskov, Rodion Stepanov, Sergey Denisov, Peter Frick, Gautier Verhille, Nicolas Plihon, and Jean-Francois Pinton. Dynamics of a turbulent spin-down flow inside a torus. *Physics of Fluids*, 21(4), Apr 2009.

[781] Pierdomenico Paolino, Felipe A. Aguilar Sandoval, and Ludovic Bellon. Quadrature phase interferometer for high resolution force spectroscopy. *Review of Scientific Instruments*, 84(9), Sep 2013.

[782] Pierdomenico Paolino, Bruno Tiribilli, and Ludovic Bellon. Direct measurement of spatial modes of a microcantilever from thermal noise. *Journal of Applied Physics*, 106(9), Nov 1 2009.

[783] Nelly Pustelnik, Herwig Wendt, and Patrice Abry. Local regularity for texture segmentation: Combining wavelet leaders and proximal minimization. In *2013 IEEE Int. Conf. Acoust., Speech Signal Process (ICASSP)*, International Conference on Acoustics Speech and Signal Processing ICASSP, pages 5348–5352. Inst Elect & Elect Engineers; Inst Elect & Elect Engineers Signal Proc Soc, May 26-31 2013. IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Vancouver, Canada.

[784] Kian Rahbarnia, Benjamin P. Brown, Mike M. Clark, Elliot J. Kaplan, Mark D. Nornberg, Alex M. Rasmus, Nicholas Zane Taylor, Cary B. Forest, Frank Jenko, Angelo Limone, Jean-Francois Pinton, Nicolas Plihon, and Gautier Verhille. Direct observation of the turbulent emf and transport of magnetic field in a liquid sodium experiment. *Astrophysical Journal*, 759(2), Nov 10 2012.

[785] Julien Salort, Hervé Pabiou, Francesca Chillá, and Christophe Ménézo. Cross Ventilation Measurements in Buildings : small and full scales experimental models. *Proceedings of 15th International Heat Transfer Conference, Kyoto Japan* , 2014, to appear.

[786] A. Tantot, S. Santucci, O. Ramos, S. Deschanel, M. A. Verdier, E. Mony, Y. Wei, S. Ciliberto, L. Vanel, and P. C. F. Di Stefano. Sound and Light from Fractures in Scintillators. *Physical Review Letters*, 111(15), Oct 10 2013.

[787] R. Zimmermann, L. Fiabane, Y. Gasteuil, R. Volk, and J-F Pinton. Measuring Lagrangian accelerations using an instrumented particle. *Physica Scripta*, T155, Jul 2013.

[788] Robert Zimmermann, Lionel Fiabane, Yoann Gasteuil, Romain Volk, and Jean-Francois Pinton. Characterizing flows with an instrumented particle measuring Lagrangian accelerations. *New Journal of Physics*, 15, Jan 25 2013.

[789] Robert Zimmermann, Yoann Gasteuil, Mickael Bourgoin, Romain Volk, Alain Pumir, Jean-Francois Pinton, and Int Collaboration Turbulence. Tracking the dynamics of translation and absolute orientation of a sphere in a turbulent flow. *Review of Scientific Instruments*, 82(3), Mar 2011.