Activity Report 2018

Team MEPHYSTO-POST

Quantitative methods for stochastic models in physics

Inria teams are typically groups of researchers working on the definition of a common project, and objectives, with the goal to arrive at the creation of a project-team. Such project-teams may include other partners (universities or research institutions).

RESEARCH CENTER
Lille - Nord Europe

THEME
Numerical schemes and simulations

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Team MEPHYSTO-POST

Creation of the Team: 2017 October 01

Keywords:

Computer Science and Digital Science:

A6.1.1. - Continuous Modeling (PDE, ODE)
A6.1.2. - Stochastic Modeling
A6.1.4. - Multiscale modeling
A6.2.1. - Numerical analysis of PDE and ODE

Other Research Topics and Application Domains:

B9.5.2. - Mathematics

1. Team, Visitors, External Collaborators

Research Scientists

Guillaume Dujardin [Team leader, Inria Researcher, HDR]
Marielle Simon [Inria Researcher]

Faculty Members

Denis Bonheure [Université Libre de Bruxelles, Professor, until Mar 2018]
Stephan de Bievre [Université de Lille, Professor, HDR]
Stefano Olla [Univ de Dauphine, Professor, until Aug 2018, HDR]
Andre de Laire [Université de Lille, Associate Professor]
Adrien Hardy [Université de Lille, Associate Professor, from Mar 2018]

Post-Doctoral Fellows

Matthias Ruf [Université Libre de Bruxelles, until Jan 2018]
Christopher Shirley [Université Libre de Bruxelles, until Aug 2018]

PhD Student

Pierre Mennuni [Université de Lille]

Administrative Assistant

Karine Lewandowski [Inria]

Visiting Scientist

Michele Triestino [Univ de Bourgogne, from Sep 2018 until Oct 2018]

2. Overall Objectives

2.1. Overall Objectives

The MEPHYSTO-POST team is a follow up of the MEPHYSTO project-team. Since the former scientific leader, Antoine Gloria, left in September 2017, the scientific objectives have been modified.

The MEPHYSTO-POST team gathers mathematicians from different communities with the same motivation: to provide a better understanding of dynamical phenomena involving particles. These phenomena are described by fundamental models arising from several fields of physics. We focus on model derivation, study of stationary states and asymptotic behaviors, as well as links between different levels of description (e.g. micro and macro models) and numerical methods to simulate such models. Applications include nonlinear optics, thermodynamics and ferromagnetism.

3. Research Program

3.1. Time asymptotics: Stationary states, solitons, and stability issues

The team investigates existence of solitons and their link with the global dynamical behavior for nonlocal problems such as that of the Gross–Pitaevskii (GP) equation which arises in models of dipolar gases. These models, in general, also introduce nonzero boundary conditions which constitute an additional theoretical and numerical challenge. Numerous results are proved for local problems, and numerical simulations allow to verify and illustrate them, as well as making a link with physics. However, most fundamental questions are still open at the moment for nonlocal problems.

The nonlinear Schrödinger (NLS) equation finds applications in numerous fields of physics. We concentrate, in a continued collaboration with our colleagues from the physics department (PhLAM) of the Université de Lille (UdL), in the framework of the Laboratoire d'Excellence CEMPI, on its applications in nonlinear optics and cold atom physics. Issues of orbital stability and modulational instability are central here.

Another typical example of problems that the team wishes to address concerns the LL equation, which describes the dynamics of the spin in ferromagnetic materials. This equation is a fundamental model in the magnetic recording industry [33] and solitons in magnetic media are of particular interest as a mechanism for data storage or information transfer [34]. It is a quasilinear PDE involving a function that takes values on the unit sphere $\mathbb{S}^2$ of $\mathbb{R}^3$. Using the stereographic projection, it can be seen as a quasilinear Schrödinger equation and the questions about the solitons, their dynamics and potential blow-up of solutions evoked above are also relevant in this context. This equation is less understood than the NLS equation: even the Cauchy theory is not completely done [28], [25]. In particular, the geometry of the target sphere imposes nonvanishing boundary conditions; even in dimension one, there are kink-type solitons having different limits at $\pm\infty$.

3.2. Derivation of macroscopic laws from microscopic dynamics

The team investigates, from a microscopic viewpoint, the dynamical mechanism at play in the phenomenon of relaxation towards thermal equilibrium for large systems of interacting particles. For instance, a first step consists in giving a rigorous proof of the fact that a particle repeatedly scattering of random obstacles through a Hamiltonian scattering process will eventually reach thermal equilibrium, thereby completing previous work in this direction by the team. As a second step, similar models as the ones considered classically will be defined and analysed in the quantum mechanical setting, and more particularly in the setting of quantum optics.

Another challenging problem is to understand the interaction of large systems with the boundaries, which is responsible for most energy exchanges (forcing and dissipation), even though it is concentrated in very thin layers. The presence of boundary conditions to evolution equations sometimes lacks understanding from a physical and mathematical point of view. In order to legitimate the choice done at the macroscopic level of the mathematical definition of the boundary conditions, we investigate systems of atoms (precisely chains of oscillators) with different local microscopic defects. We apply our recent techniques to understand how anomalous (in particular fractional) diffusive systems interact with the boundaries. For instance, the powerful tool given by Wigner functions that we already used has been successfully applied to the derivation of anomalous behaviors in open systems (for instance in [67]). The next step consists in developing an extension of that tool to deal with bounded systems provided with fixed boundaries. We also intend to derive anomalous diffusion by adding long range interactions to diffusive models. There are very few rigorous results in this direction. Finally, we aim at obtaining from a microscopic description the fractional porous medium equation (FPME), a nonlinear variation of the fractional diffusion equation, involving the fractional Laplacian instead of the usual one. Its rigorous study carries out many mathematical difficulties in treating at the same time the nonlinearity and fractional diffusion.

3.3. Numerical methods: analysis and simulations

The team addresses both questions of precision and numerical cost of the schemes for the numerical integration of nonlinear evolution PDEs, such as the NLS equation. In particular, we to develop, study and implement numerical schemes with high order that are more efficient. We also to contribute to the design and analysis of schemes with appropriate qualitative properties. These properties may as well be "asymptotic preserving" properties, energy-preserving properties, or convergence to an equilibrium properties. Other numerical goals of the team include the numerical simulation of standing waves of nonlinear nonlocal GP equations. We also keep on developing numerical methods to efficiently simulate and illustrate theoretical results on instability, in particular in the context of the modulational instability in optical fibers, where we study the influence of randomness in the physical parameters of the fibers.

4. New Results

4.1. Exponential time-decay for discrete Fokker–Planck equations

G. Dujardin and his coauthors proposed and studied in [22] several discrete versions of homogeneous and inhomogeneous one-dimensional Fokker-Planck equations. They proved in particular, for these discretizations of velocity and space, the exponential convergence to the equilibrium of the solutions, for time-continuous equations as well as for time-discrete equations. Their method uses new types of discrete Poincaré inequalities for a "two-direction" discretization of the derivative in velocity. For the inhomogeneous problem, they adapted hypocoercive methods to the discrete level.

4.2. Energy preserving methods for nonlinear Schrödinger equations

G. Dujardin and his coauthors have revisited and extended relaxation methods for nonlinear Schrödinger equations (NLS). The classical relaxation method for NLS is an energy preserving method and a mass preserving method. Moreover, it is only linearly implicit. A first proof of the second order accuracy was achieved in [14]. Moreover, the method was extended to enable to treat noncubic nonlinearities, nonlocal nonlinearities, as well as rotation terms. The resulting methods are still energy preserving and mass preserving. Moreover, they are shown to have second order accuracy numerically. These new methods are compared with fully implicit, mass and energy preserving methods of Crank and Nicolson.

4.3. Diffusive and superdiffusive behavior in one-dimensional chains of oscillators

In order to understand abnormally diffusive phenomena which are physically observed in nanotube technologies, one mathematical approach consists in starting from deterministic system of Newtonian particles, and then perturb this system with a stochastic component which provides enough ergodicity to the dynamics. It is already well known that these stochastic chains model correctly the behavior of the conductivity [24]. In [1], [2] (published in Communications in Mathematical Physics) M. Simon with her coauthors C. Bernardin, P. Gonçalves, M. Jara, T. Komorowski, S. Olla and M. Sasada have observed both behaviors, normal and anomalous diffusion, in the context of low dimensional asymmetric systems. They manage to describe the microscopic phenomena at play which are responsible for each one of these phenomena, and they go beyond the predictions that have recently been done in [31], [32]. Moreover, in [2], the authors manage to treat rigorously, for the first time, the case of an anharmonic potential: more precisely, they consider a small quartic anharmonicity and show that the result obtained in the harmonic (linear) case persists up to some small critical value of the nonlinear perturbation.

4.4. Microscopic description of moving interfaces

A large variety of models has been introduced to describe the evolution of a multiphase medium, *e.g.* the joint evolution of liquid and solid phases. These complex physical phenomena often feature absorbing phase transitions. For instance, the porous medium equation (PME)

$$\partial_t \rho = \text{div}(\rho^{m-1} \nabla \rho), \tag{1}$$

where $m > 1$ is a constant and div and ∇ are the divergence and gradient operators in $\mathbb{R}^d$, describes the evolution of the density $\rho : \mathbb{R}^d \times \mathbb{R}_+ \to [0,1]$ of an ideal gas flowing in a homogeneous medium. It is known that, starting from an initial density ρ_0 with compact support, the solution $\rho(x,t)$ is nonnegative and has compact support in the space variable for each positive t. Thus there are interfaces separating the regions where ρ is positive from those where it is zero.

In one submitted paper in collaboration with O. Blondel, C. Cancès, and M. Sasada, we have derived the PME (1) from a degenerate and conservative dynamics in [15], for any integer $m > 1$. More precisely we improved the results previously obtained in [26], since we allow the solutions to feature moving interfaces, namely the initial condition may vanish. This moving boundary was not well apprehended at the microscopic level. Its rigorous definition is indeed very delicate, and its behavior (such that its speed, or fluctuation), as well as the relationship between the microscopic and macroscopic boundaries, are challenging questions that we aim to tackle in a near future.

When $m < 1$, equation (1) is called fast diffusion equation. In a recent collaborative work (submitted) with O. Blondel, C. Erignoux and M. Sasada [16], we derive such a fast diffusion equation in dimension one from an interacting particle system belonging to the class of conserved lattice gases with active-absorbing phase transition [30]. The microscopic dynamics is very constrained: in a few words, a particle can jump to the right (resp. left) empty neighboring site if and only if it has a particle to its left (resp. right) neighboring site. This model is really complex: the state space is divided into transient states, absorbing states and ergodic states. Depending on the initial number of particles, the transient good configurations will lead to the ergodic component and the transient bad configurations will be absorbed to an inactive state. Because of the jump constraint, there are two distinct regimes for the macroscopic behavior. Either the macroscopic density is larger than $\frac{1}{2}$, in which case the system behaves diffusively, or the density is lower than $\frac{1}{2}$, in which case the system freezes rapidly.

The interfaces between these two phases propagate as particles from the supercritical phase ($\rho > \frac{1}{2}$) diffuse towards the subcritical phase ($\rho < \frac{1}{2}$). We expect that the macroscopic density profile evolves under the diffusive scaling according to the Stefan problem

$$\partial_t \rho = \Delta\left(G(\rho)\right) \qquad \text{where } G(\rho) = \tfrac{2\rho - 1}{\rho}\, \mathbf{1}_{\rho > \frac{1}{2}}. \tag{2}$$

The microscopic derivation of such Stefan problems is a well known difficult problem, only partially solved [27], [29]. In [16] we treat the liquid part of the problem (*i.e.* when the initial profiles ρ_0 are uniformly larger than the critical density $\frac{1}{2}$) and we provide a refined estimation of the time needed by the system to enter into the ergodic state. Then, we show that the macroscopic density profile evolves under the diffusive time scaling according to (1) with $m = -1$. The extension to more general initial profiles is our next goal.

4.5. Stability analysis of a Vlasov-Wave system

S. De Bièvre and his co-authors introduced and studied a kinetic equation of the Vlasov-Wave type, which arises in the description of the behavior of a large number of particles interacting weakly with an environment, composed of an infinite collection of local vibrational degrees of freedom, modeled by wave equations. They use variational techniques to establish the existence of large families of stationary states for this system, and analyze their stability [8].

4.6. Orbital stability in the presence of symmetries

With S. Rota Nodari, S. De Bièvre considered the orbital stability of relative equilibria of Hamiltonian dynamical systems on Banach spaces, in the presence of a multi-dimensional invariance group for the dynamics [9]. They proved a persistence result for such relative equilibria, presented a generalization of the Vakhitov-Kolokolov slope condition to this higher dimensional setting, and showed how it allows to prove the local coercivity of the Lyapunov function, which in turn implies orbital stability. The method was applied to study the orbital stability of relative equilibria of nonlinear Schrödinger and Manakov equations. It extends and clarifies the approach of Grillakis-Shatah-Strauss.

4.7. Measuring nonclassicality of bosonic field quantum state

S. De Bièvre and his collaborators introduced a new distance-based measure for the nonclassicality of the states of a bosonic field, which outperforms the existing such measures in several ways [17]. They defined for that purpose the operator ordering sensitivity of the state which evaluates the sensitivity to operator ordering of the Renyi entropy of its quasi-probabilities and which measures the oscillations in its Wigner function. Through a sharp control on the operator ordering sensitivity of classical states they obtained a precise geometric image of their location in the density matrix space allowing them to introduce a distance-based measure of nonclassicality. They analyze the link between this nonclassicality measure and a recently introduced quantum macroscopicity measure, showing how the two notions are distinct.

4.8. The Cauchy problem for the Landau–Lifshitz–Gilbert equation in BMO and self-similar solutions

A. de Laire and S. Gutierrez established in [19] a global well-posedness result for the Landau–Lifshitz equation with Gilbert damping, provided that the BMO semi-norm of the initial data is small. As a consequence, they deduced the existence of self-similar solutions in any dimension. Moreover, in the one-dimensional case, they characterized the self-similar solutions when the initial data is given by some ($\S^2$-valued) step function and established their stability. They also showed the existence of multiple solutions if the damping is strong enough.

4.9. The Sine–Gordon regime of the Landau–Lifshitz equation with a strong easy-plane anisotropy

It is well-known that the dynamics of biaxial ferromagnets with a strong easy-plane anisotropy is essentially governed by the Sine-Gordon equation. A. de Laire and P. Gravejat provided in [10] a rigorous justification to this observation. More precisely, they showed the convergence of the solutions to the Landau-Lifshitz equation for biaxial ferromagnets towards the solutions to the Sine-Gordon equation in the regime of a strong easy-plane anisotropy. This result holds for solutions to the Landau–Lifshitz equation in high order Sobolev spaces. They also provided an alternative proof for local well-posedness in this setting by introducing high order energy quantities with better symmetrization properties. Then they derived the convergence from the consistency of the Landau–Lifshitz equation with the Sine-Gordon equation by using well-tailored energy estimates. As a by-product, they also obtained a further derivation of the free wave regime of the Landau–Lifshitz equation.

4.10. Mutual information of wireless channels and block-Jacobi ergodic operators

In telecommunication models the quality of the transferred data is assessed through the entropy of the channel, a theoretical quantity that is usually not computable in practice. W. Hachem, A. Hardy and S. Shamai prove in [23] that one can relate this quantity for a large class of models involving several antennas (MIMO) to the equilibrium measure of a matrix valued Markov chain associated with the model, and so does its asymptotic behavior when the signal-noise-ratio parameter becomes large. By means of ergodicity results, this yields estimates for these quantities that are implementable faster than the naive estimators.

4.11. DLR equations and rigidity for the Sine-beta process

The Sine-beta process is a universal object appearing in the study of large Hermitian random matrices and statistical systems in a logarithmic interaction, such as low dimensional Coulomb gases. However, the only description available yet relied on a rather complicated and non-physical system of coupled stochastic differential equations. In [21], D. Dereudre, A. Hardy, T. Leblé and M. Maïda obtain a statistical physic interpretation of the Sine-beta process as probability measure on infinite configurations of points described by means of the DLR formalism. This allows to obtain more information on the Sine-beta process: for instance, it is rigid, it is tolerant, and the number of particles in a compact box has gaussian fluctuations as the box becomes large.

4.12. Time-frequency transforms of white noises and Gaussian analytic functions

In signal processing, an important challenge is to be able to separate signals from ambient noises. In time-frequency analysis, this problem reduces to identify what is the spectrogram of a white noise to derive statistical tests in order to decide if some partial signal is noise or not. P. Fandrin recently put forward that the understanding of the zeros of the spectrograms would be already an important step by analyticity of the spectrograms. R. Bardenet and A. Hardy observed in [13] that there is a canonical way to identify the zeros of the usual white noise transforms associated to classical spectrograms and zeroes of Gaussian analytic functions associated with classical orthogonal polynomials in the background. In particular the zeros satisfy some invariance properties leading to computable correlation functions. In specific cases, one can identify some transforms whose zeros form a determinantal point process, in which case all the statistics of interests can be computed explicitly and this allows an exact numerical treatment.

4.13. Energy of the Coulomb gas on the sphere at low temperature

In relation to the 7th Smale problem, which is about finding polynomial time algorithm to produce well spread configuration of points on the sphere in a quantified manner, C. Beltran and A. Hardy proved in [4] that the Coulomb gas on the sphere at a temperature proportional to the inverse number of points in a configuration reaches the numerical precision required by this problem. We however did not discuss yet the algorithmic procedure, which is currently in investigation by A. Hardy and M. Simon.

4.14. Polynomial ensembles and recurrence coefficients

Determinantal point processes can be of important use in applications as soon as one is interested in producing configurations of well spread points on an arbitrary space. A class of determinantal point processes on the real line that has been extensively studied recently are the so-called polynomial ensembles. A. Hardy gathered in [11] several results concerning these models in relation to the recurrent coefficients associated with the orthogonal polynomials hidden in the background.

4.15. Concentration for Coulomb gases and Coulomb transport inequalities

The convergence of the Coulomb gas, which is a statistical gas of charged particles in an electrostatic interaction, towards its limiting distribution as the number of particles goes to infinity is a result which is part of the folklore of potential theory. The speed at which this convergence arise, which can be assessed through concentration of measure estimates in, say, the Wasserstein-Kantorovich metric, are however new results obtained by D. Chafaï, A. Hardy and M. Maïda in [7]. One of the main ingredient was to develop transport inequalities associated with the Coulomb interaction.

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. ANR

A. de Laire is a member of the ANR ODA project.

Title: Dispersive and random waves.

ANR reference : ANR-18-CE40-0020-01.

Coordinator: Nikolay Tzvetkov, Université de Cergy-Pontoise.

A. Hardy is a member of the ANR BoB project.

Title: Inférence bayésienne à ressources limitées - données massives et modèles coûteux.

Programme ANR: (DS0705) 2016.

ANR reference: ANR-16-CE23-0003.

Coordinator: R. Bardenet, CNRS & Université de Lille.

Duration: October 2016 - October 2020.

M. Simon is a member of the ANR EDNHS project.

Title: Diffusion de l'énergie dans des système hamiltoniens bruités.

Type: Défi de tous les savoirs (DS10) 2014.

ANR reference: ANR-14-CE25-0011.

Coordinator: C. Bernardin, Université de Nice.

Duration: October 2014 - October 2019.

5.2. European Initiatives

M. Simon is a collaborator of the ERC Starting Grant HyLEF project.

Title: Hydrodynamic Limits and Equilibrium Fluctuations: universality from stochastic systems

Duration: May 2017 - April 2022

Coordinator: P. Gonçalves, Instituto Superior Técnico, Lisbon.

5.3. International Research Visitors

5.3.1. Visits to International Teams

5.3.1.1. Research Stays Abroad

S. De Bièvre spent two months at the Centre de Recherche Mathématiques in Montréal as Simons Professor.
M. Simon has been invited as Junior Scientific Leader of the Simons Semester "PDEs/SPDEs and Functional Inequalities" at IMPAN in Warsaw, Poland, for one month.

6. Dissemination

6.1. Promoting Scientific Activities

6.1.1. Scientific Events Organisation

6.1.1.1. Member of the Organizing Committees

A. Hardy co-organized the "Semaine d'Etude Math-Entreprise Hauts de France 2018" (Lille).

6.1.2. Journal

6.1.2.1. Reviewer - Reviewing Activities

- S. De Bièvre served as reviewer for J. Math. Phys., Ann. Institut H. Poincaré, J. Stat. Phys. in 2018.
- G. Dujardin served as reviewer for APNUM and Numer. Math. in 2018.
- A. Hardy served as reviewer for Communications in Pure and Applied Mathematics and Annals of Applied Probability in 2018.
- M. Simon was reviewer for Markov Processes and Related Fields, and Annales de L'I.H.P. Probabilités et Statistiques in 2018.

6.1.3. Invited Talks

A. Hardy was invited to give several talks in 2018, including:

- (May 2018) Workshop "random matrices and their applications", Kyoto university (Japan)
- (April 2018) Groupe de travail "Probas du vendredi" de Jussieu, Paris
- A. Hardy was invited at a "réunion interne de l'Académie des Science" entitled "Le renouveau des processus ponctuels déterminantaux, des fermions à la statistique appliquée".

M. Simon was invited to give several talks in 2018, including:

- (April 2018) Workshop of the Simons Semester "PDE/SPDE-s, Functional Inequalities", Banach Center, Poznan (Poland)
- (August 2018) Journées "Modélisation Aléatoire et Statistique" of the "Société de Mathématiques Appliquées et Industrielles", Dijon (France)
- (November 2018) Weekly Probability Seminar at University of Bath (England)
- (December 2018) Weekly Probability Seminar in Lyon (France).

6.1.4. Research Administration

G. Dujardin is a member of Inria Evaluation Committee.

6.2. Teaching - Supervision - Juries

6.2.1. Teaching

Licence: G. Dujardin, "Calcul Différentiel et Intégral", 30h, L2, Université Libre de Bruxelles, Belgique.

Master: G. Dujardin, "Analyse Fonctionelle", 30h, M1, Université Libre de Bruxelles, Belgique.

Master: G. Dujardin, "Vortex dans les condensats de Bose–Einstein en rotation", 20h, M2, Université de Lille, France.

6.2.2. Supervision

HdR: Guillaume Dujardin, Contribution à l'analyse numérique de problèmes d'évolution : comportements asymptotiques et applications à l'équation de Schrödinger, Université de Lille, November 12th 2018 [3].

6.2.3. Juries

G. Dujardin and M. Simon participated in the jury of the "Agrégation externe de mathématiques" in 2018.
G. Dujardin took part in the hiring committees of Junior Scientists for Inria Paris, Inria Saclay and in the final admission committee in 2018.
M. Simon was member of the jury of the PhD thesis of J. Roussel which was defended in November 2018 at École des Ponts (Marne-la-Vallée, France) and is entitled *Theoretical and numerical analysis of non-reversible dynamics in computational statistical physics*.

6.3. Popularization

6.3.1. Interventions

- M. Simon participated in the local program “Chercheurs itinérants”, and gave several lectures directed to high-school students.

7. Bibliography

Major publications by the team in recent years

[1] C. BERNARDIN, P. GONÇALVES, M. JARA, M. SIMON. *Interpolation process between standard diffusion and fractional diffusion*, August 2017, to appear in AIHP B, https://hal.archives-ouvertes.fr/hal-01348503

[2] C. ´. BERNARDIN, P. GONÇALVES, M. JARA, M. SIMON. *Nonlinear Perturbation of a Noisy Hamiltonian Lattice Field Model: Universality Persistence*, August 2017, working paper or preprint, https://hal.archives-ouvertes.fr/hal-01491433

Publications of the year

Doctoral Dissertations and Habilitation Theses

[3] G. DUJARDIN. *Contribution à l'analyse numérique de problèmes d'évolution : comportements asymptotiques et applications à l'équation de Schrödinger*, Universite de Lille, November 2018, Habilitation à diriger des recherches, https://hal.archives-ouvertes.fr/tel-01950160

Articles in International Peer-Reviewed Journals

[4] C. BELTRÁN, A. HARDY. *Energy of the Coulomb Gas on the Sphere at Low Temperature*, in "Archive for Rational Mechanics and Analysis", October 2018 [*DOI :* 10.1007/s00205-018-1316-3], https://hal.archives-ouvertes.fr/hal-01890125

[5] C. BERNARDIN, P. GONÇALVES, M. JARA, M. SIMON. *Interpolation process between standard diffusion and fractional diffusion*, in "Annales de l'Institut Henri Poincaré (B) Probabilités et Statistiques", 2018, https://hal.archives-ouvertes.fr/hal-01348503

[6] C. BERNARDIN, P. GONÇALVES, M. JARA, M. SIMON. *Nonlinear Perturbation of a Noisy Hamiltonian Lattice Field Model: Universality Persistence*, in "Communications in Mathematical Physics", 2018, https://hal.archives-ouvertes.fr/hal-01491433

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[9] S. DE BIÈVRE, S. ROTA NODARI. *Orbital stability via the energy-momentum method: the case of higher dimensional symmetry groups*, in "Archive for Rational Mechanics and Analysis", 2018, https://arxiv.org/abs/1605.02523 [*DOI :* 10.1007/s00205-018-1278-5], https://hal.archives-ouvertes.fr/hal-01312534

[10] A. DE LAIRE, P. GRAVEJAT. *The Sine-Gordon regime of the Landau-Lifshitz equation with a strong easy-plane anisotropy*, in "Annales de l'Institut Henri Poincare (C) Analyse Non Lineaire", November 2018, vol. 35, n^{o} 7, pp. 1885-1945, https://hal.archives-ouvertes.fr/hal-01518483

[11] A. HARDY. *Polynomial Ensembles and Recurrence Coefficients*, in "Constructive Approximation", August 2018, vol. 48, n^{o} 1, pp. 137 - 162 [*DOI :* 10.1007/s00365-017-9413-3], https://hal.archives-ouvertes.fr/hal-01890050

[12] T. KOMOROWSKI, S. OLLA, M. SIMON. *Macroscopic evolution of mechanical and thermal energy in a harmonic chain with random flip of velocities*, in "Kinetic and Related Models ", 2018, vol. 11, n^{o} 3, pp. 615-645, https://hal.archives-ouvertes.fr/hal-01358979

Other Publications

[13] R. BARDENET, A. HARDY. *Time-frequency transforms of white noises and Gaussian analytic functions*, August 2018, working paper or preprint, https://hal.archives-ouvertes.fr/hal-01855678

[14] C. BESSE, S. DESCOMBES, G. DUJARDIN, I. LACROIX-VIOLET. *Energy preserving methods for nonlinear schrodinger equations*, December 2018, working paper or preprint, https://hal.archives-ouvertes.fr/hal-01951527

[15] O. BLONDEL, C. CANCÈS, M. SASADA, M. SIMON. *Convergence of a Degenerate Microscopic Dynamics to the Porous Medium Equation*, April 2018, working paper or preprint, https://hal.archives-ouvertes.fr/hal-01710628

[16] O. BLONDEL, C. ERIGNOUX, M. SASADA, M. SIMON. *Hydrodynamic limit for an activated exclusion process*, May 2018, working paper or preprint, https://hal.archives-ouvertes.fr/hal-01798051

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[18] A. DE LAIRE, P. GRAVEJAT. *The cubic Schrödinger regime of the Landau-Lifshitz equation with a strong easy-axis anisotropy*, December 2018, https://arxiv.org/abs/1812.05854 - working paper or preprint, https://hal.archives-ouvertes.fr/hal-01954762

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[22] G. DUJARDIN, F. HÉRAU, P. LAFITTE-GODILLON. *Coercivity, hypocoercivity, exponential time decay and simulations for discrete Fokker- Planck equations*, February 2018, working paper or preprint, https://hal.archives-ouvertes.fr/hal-01702545

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