

Daniel Yaacoub

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Research activities

In the vein of the probabilistic–deterministic duality introduced by Einstein and advanced by Feynman and Kac, probabilistic representations of nonlinear PDEs have, until recently, relied on forward-step approaches extending Feynman–Kac theory, originally based on superposition and linearity. Most of these extensions have brought renewed insights into path-space propagative pictures for first-class nonlinear physics. This has resulted in reactive nonlinearities, such as Boltzmann kinetic equation or Kolmogorov-Petrovsky-Piskunov (KPP) reaction-diffusion equations benefiting from a conceptual framework with a unique process propa-

gating toward sources, so-called branching stochastic process. I am currently working on extensions of Feynman–Kac representations to drift-involving nonlinear dynamics, including the Poisson–Nernst–Planck, Keller–Segel, and Navier–Stokes equations. These representations could also be extended to Poisson–Vlasov systems. The result is novel propagator formulations that bridge applied mathematics, computer graphics, and engineering communities addressing confined and complex geometries. Constructing such statistical estimators thus provides path-space Monte Carlo numerical implementations that are insensitive to geometric complexity and the coupling of diverse phenomena.

Education

PhD. - Institut Pascal, Université Clermont-Auvergne	2021-2025
<i>Branching Stochastic Processes and path-space Monte Carlo method for velocity-coupled advecto-diffusive transport models in artificial photosynthesis</i>	
M.Sc. (2nd y.) Fundamental Physics - Aix-Marseille Université [2/24], highest honours	2020-2021
<i>International Theoretical Physics Training - Complex Systems equilibrium and non-equilibrium statistical physics - CPT non-linear physics and dynamical systems - IRPHÉ out of equilibrium physics and complex systems - CENTURI</i>	
B.Sc. (3rd y.) Fundamental Physics - Université Toulouse III [1/56], highest honours	2018-2019

Research experiences

M.Sc. (2nd y.) research internship - LIPhy (5 m.), Grenoble, Dr. V. Lecomte
<i>Stationary states and correlations in active matter models</i>
M.Sc. (2nd y.) research project - CPT (3 m.), Marseille, Pr. M. Pettini
<i>Microcanonical Monte Carlo simulation of glass forming binary mixture</i>
M.Sc. (1st y.) research internship - IRHPÉ (2 m.), Marseille, Dr. M. Le Bars
<i>Mixed convective/diffusive layers in spherical shells configurations</i>
B.Sc. (3rd y.) research internship - LAPLACE (2 m.), Toulouse, Pr. O. Pascal
<i>Microwave electromechanical conversion</i>

Conference talks, attended Schools and Seminars

Invited talks

- CEA, LJLL(Sorbonne Université) Mathematics for neutronics workshop** - Paris, 1 d. 2025
Branching Stochastic Processes for Feynman-Kac representation of drift-involving nonlinearities, **D. Yaacoub**, S. Blanco, J.-F. Cornet, J. Dauchet, R. Fournier, T. Vourc'h

Congress with oral communications

- EUROMAGH Biocomposites international conference** - Djerba, 3 d. 2025
Electrochemical monitoring of oxidoreductases enzymatic kinetics: validation of a new method on a Laccase with model substrate, ABTS, E. Martin, F. Audonnet, **D. Yaacoub**, I. Agody, P. Dubessay, P. Michaud
- MCMET (ANR) annual workshop** - Toulouse, 3 d. 2024
Field coupling to velocity models, **D. Yaacoub**, S. Blanco, J.-F. Cornet, J. Dauchet, R. Fournier, T. Vourc'h
- STARDIS annual workshop** - Toulouse, 2 d. 2024
Path-space coupling to drift velocity models: probabilistic representation and statistical sampling, **D. Yaacoub**, S. Blanco, J.-F. Cornet, J. Dauchet, R. Fournier, T. Vourc'h
- STARDIS annual workshop** - Toulouse, 2 d. 2023
Monte Carlo gradient estimations in complex geometries, **D. Yaacoub**, S. Blanco, J.-F. Cornet, J. Dauchet, R. Fournier, T. Vourc'h
- LMBP - PhD seminar** - Clermont-Ferrand, 1 d. 2023
Path-space physics and statistical approaches to PDEs : Feynman-Kac and Monte Carlo
- FEDESOL national consortium annual congress** - Clermont-Ferrand, 2 d. 2023
Thermokinetic coupling : 0d vs 3d, linear vs non-linear, **D. Yaacoub**, J.-F. Cornet, J. Dauchet, F. Gros, T. Vourc'h
- TAMARYS national research group annual congress** - Lyon, 3 d. 2022
Photogeneration, transfer and conversion of electronic energy in path-space for solar processes inverse design, **D. Yaacoub**, T. Villemin, J.-F. Cornet, J. Dauchet, O. Farges, R. Vaillon, T. Vourc'h
- JNPV national research group annual congress** - Dourdan, 4 d. 2022
Multiphysics and multiscale modeling of a photovoltaic panel using Monte Carlo methods, T. Villemin, **D. Yaacoub**, R. Claverie, J.-F. Cornet, J. Dauchet, O. Farges, G. Parent, R. Vaillon, T. Vourc'h
- JNES national research group annual congress** - Albi, 3 d. 2022
Photovoltaic cell electrical modeling and renewed physical insights by use of path-spaces, T. Villemin, **D. Yaacoub**, J.-F. Cornet, J. Dauchet, O. Farges, R. Vaillon, T. Vourc'h
- JNES national research group annual congress** - Albi, 3 d. 2022
Solar hydrogen production by artificial photosynthesis, J. Dauchet, J.-F. Cornet, G. Foin, F. Gloaguen, F. Gros, T. Vourc'h, **D. Yaacoub**
- MELISSA international conference** - Toulouse, 2 d. 2022
Knowledge models of photobioreactors and their paths integral formulation, J. Dauchet, J.-F. Cornet, C.-G. Dussap, G. Foin, F. Gros, C. Laroche, L. Poughon, T. Vourc'h, **D. Yaacoub**

Attended schools and seminars

- TAMARYS national research group annual congress** - Bordeaux, 3 d. 2021
 Multi-scale and multi-physics approaches to thermal transfer and non-linear coupling
- ZIRCON national consortium annual workshop** - Clermont-Ferrand, 3 d. 2022
 Transfer Evolution Formalism for model partitioning, coupling and feedback analysis in non-linear systems
- EDSTAR national consortium annual school** - Saint-Front, 5 d. 2021-2024
 Statistical approaches to transport and multi-scale/multi-physics path-space Monte Carlo methods

Teaching activities 179h

INP teaching assistant - SIGMA engineering school Clermont-Ferrand	2021-2024
Out-of-equilibrium phenomena and balances [42h, <i>tutorials</i>] (Bachelor 3 rd y. level)	
Mass/heat transfer and chemical reactions.	
Energy/matter balances toward processes dimensionalization.	
Equilibrium thermodynamics and balances [28h, <i>tutorials</i>] (Bachelor 3 rd y. level)	
Principles and applications of equilibrium-state thermodynamics.	
Matter and energy balances.	
UCA teaching assistant - Life Sciences Bachelor Clermont-Ferrand	2022-2024
Radioactivity [24h, <i>lectures/tutorials</i>] (Bachelor 1 st y. level)	
Introduction to radioactivity basics, principles and exponential law.	
Electrostatics [36h, <i>tutorials</i>] (Bachelor 1 st y. level)	
Dipolar momentum, electric field, polarization of molecules, screening effect.	
IUT teaching assistant - Aeronautics Toulouse	2025
Thermodynamics [28h, <i>tutorials</i>] (Bachelor 2 nd y. level)	
Turboreactors [21h, <i>tutorials</i>] (Bachelor 3 rd y. level)	

Publications

International congress proceeding	
<i>Solar Hydrogen Production by Artificial Photosynthesis in Photoreactor for Sustainable Mobility</i> , G. Foin , J.-F. Cornet, F. Gros, J. Dauchet, T. Vourc'h, D. Yaacoub , Solar PACES	2022
Refereed Journal Publications	
<i>Coupling radiative, conductive and convective heat-transfers in a single monte carlo algorithm : A general theoretical framework for linear situations</i> , J.-M. Treagan, J.-L. Amestoy, M. Bati, J.-J. Bézian, [...], D. Yaacoub , PLOS ONE	2023
To be published	
<i>Nernst-Michaelis-Menten Framework Unlocks Electrochemical Kinetics for Laccases</i> E. Martin, F. Audonnet, D. Yaacoub , P. Dubessay, P. Michaud, Bioelectrochemistry	2025

Collective responsibilities and Seminars organization

GePEB - Institut Pascal PhD's representative	2022-2025
Creation and organization of GePEB PhD's seminars, workshop and website	2022-2024

Associative commitments, interests and hobbies

Organ player at Clermont-Ferrand's Cathedral.
Member of "Association des amis des orgues de Notre Dame de Clermont"
Organ player at Marseille.
Member of "Association des amis des orgues de Ste Marguerite"
Improvisation and interpretation, Epistemology, phenomenology, poetry, history.