

# Antoine Boulet

ASSOCIATE PROFESSOR · THEORETICAL PHYSICS

ISMANS CESI, 44 avenue Frédéric Auguste Bartholdi, 72000 Le Mans, France

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*"I have doubts, do you have any?"*

## References

Available upon request.

## Personal Details

FRENCH CITIZEN

- Married
- Born on 30 March 1993 [31y/o]  
in Argentan (61), France

LANGUAGES *French (native), English (fluent)*

SPORTS *running, table tennis*

HOBBIES *chess, movies, musics, reading*

## Computer Skills

OPERATING SYSTEM *MacOS, Unix, Microsoft Windows*

PROGRAMMING *Python, C/C++, Fortran, Mathematica*

HPC CODE *Developer of W-SLDA Toolkit*

GITHUB *<https://github.com/AntoineBoulet>*

TECHNIQUES

- Monte Carlo methods (multi-dimensional integrals)
- numerical methods for optimization problems
- numerical methods for differential equations
- diagonalization of HFB-like kernel

## Research Interests

My research interests as theoretical physicist are mainly focused on the quantum many-body problems and the development of *ab initio* Density Functional Theories and their applications for nuclear, atomic, molecular, and condensed matter physics.

SYSTEMS

- infinite nuclear matter
- ultracold atomic Fermi systems
- atomic nuclei, neutron stars

METHODS

- diagrammatic resummation
- path integral and effective action
- regularisation in effective field theory

THEORIES

- static and time-dependent Density Functional Theory (DFT)
- Many-Body Perturbation Theory (MBPT)
- Variational Perturbation Theory (VPT)
- Superfluid Local Density Approximation (SLDA)

STUDIES

- equation of states and thermodynamics
- linear response and collective modes
- self-energy and Landau-Fermi liquid theory
- structure and dynamics of superfluid vortices
- quantum turbulence
- analogue gravity in fermionic superfluid

## Professional Experiences

### RESEARCH

#### Faculty of Physics, Warsaw University of Technology

*Warsaw, Poland*

RESEARCH ASSOCIATE

*Jan. 2021 – Aug. 2022*

- development and implementation of an extended SLDA functional
- numerical simulation of dissipation processes in superfluid vortices systems, quantum turbulence, Higgs modes, and quantum quenches

#### FRIB/NSCL, Michigan State University

*East Lansing, MI USA*

RESEARCH ASSOCIATE

*Nov. 2019 – Nov. 2020*

- development of microscopically-motivated DFT using *ab initio* theories and their implementation for large-scale calculations of nuclei

#### IPN Orsay, Paris-Sud University

*Orsay, France*

PH.D. STUDENT

*Oct. 2016 – Oct. 2019*

- development of the DFT for Fermi systems with large s-wave scattering length and application to atomic and nuclear physics

### TEACHING

#### ISMANS CESI engineering school

*Le Mans, France*

ASSOCIATE PROFESSOR

*Sep. 2022 – now*

- head teacher for the integrated preparatory cycle (undergraduate) [from may to august 2023]
- undergraduate and graduate physics, mathematics, and programming education

## IUT Orsay, Paris-Saclay University

GRADUATE TEACHING ASSISTANT

Orsay, France

Sep. 2017 – Aug. 2019

- Directed Studies: electromagnetism (36 h) and metrology, quality, statistics (12 h)
- Practical Works: metrology, quality, statistics (68 h) and chains of measurement, control, tests (12 h)

## Education & Diplomas

### Paris-Saclay University

IPN Orsay

PH.D. THEORETICAL PHYSICS

2019

- *Density Functional Theory for Fermi systems with large s-wave scattering length: application to atomic and nuclear physics*
- Advisor: D. Lacroix, Jury: G. Colò, D. Davesne, M. Grasso, D. Lacroix, D. Petrov, A. Rios Huguet, and V. Somà

### Paris-Saclay University

ENS Paris

M.SC. FUNDAMENTAL CONCEPTS OF PHYSICS

2016

- ICFP master program, condensed matter physics speciality

### Paris-Sud University

UFR sciences Orsay

B.SC. FUNDAMENTAL PHYSICS

2014

- *Magistère* of fundamental physics

## Outreach & Professional Developments

### PRESIDENT OF THE END-OF-STUDIES INTERNSHIP JURY

#### ISMANS CESI - Mechanics engineering cycle,

- 2022 • Fredy Tadjouzem Zomo, *confidential*

Le Mans, France

### MEMBER OF THE END-OF-STUDIES INTERNSHIP JURY

#### ISMANS CESI - Materials engineering cycle,

- 2023 • Clément Jililiot, *Développement de nouvelles technologies en matériaux pour le spatial*  
• Guy Terence Prévot, *Développement de biocapteurs électrochimiques fonctionnels à base d'aptamères pour un suivi thérapeutique de la théophylline dans le sang*

Le Mans, France

#### ISMANS CESI - Materials engineering cycle,

- 2022 • Paul Cornueil, *Analyse de surface de conversions et mesures des performances de résistance decontact*  
• Alexandre Derouet, *Studying Phonons and Magnons in a Multiferroic Dy<sub>0.7</sub>Tb<sub>0.3</sub>FeO<sub>3</sub>*  
• Florent Rosier, *Recuits Thermiques pour la Compréhension des Transformations Morphologiques de Bicouches de Germanium Poreux*

Le Mans, France

### SERVICE AND OUTREACH

#### 2022 Committee Member,

International Experience at WUT

#### 2018 Organizer,

Welcome day for new entrants at IPN Orsay

#### 2017 Organizing Committee Member,

PHENIICS doctoral school conference

### DOCTORAL SCHOOLS

#### 2018 Doctoral School of the GGI for Theoretical Physics,

Frontiers in Nuclear and Hadronic Physics

Florence, Italy

#### 2017 ECT\* Doctoral Training Program,

Microscopic Theories of Nuclear Structure, Dynamics, and Electroweak Currents

Trento, Italy

### RESEARCH INTERNSHIPS

## LPTMS, Paris-Sud University

M.Sc. TRAINING STUDIES

- *Separation of Variables and Correlation Functions of Quantum Integrable Systems*
- Advisor: V. Terras

Orsay, France

2 months, 2016

## QGLab, University of Nottingham

M.Sc. TRAINING STUDIES

- *Hydrodynamic simulation of rotating black holes*
- Advisor: S. Weinfurter

Nottingham, UK

3 months, 2015

## LPT, Paris-Sud University

B.Sc. TRAINING STUDIES

- *Weak interaction and CP symmetry violation: mesons mixing*
- Advisor: S. Descotes-Genons

Orsay, France

2 months, 2014

## GANIL

B.Sc. TRAINING STUDIES

- *Persistence of magic numbers far from stability*
- Advisor: J.-C. Thomas

Caen, France

2 weeks, 2013

## Publications

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### PUBLISHED

- A. Barresi, **A. Boulet**, G. Włazłowski, and P. Magierski, *Sci. Rep.* **13**, 11285 (2023).  
*Generation and decay of Higgs mode in a strongly interacting Fermi gas*
- A. Barresi, **A. Boulet**, P. Magierski, and G. Włazłowski, *Phys. Rev. Lett.* **130**, 043001 (2023).  
*Dissipative Dynamics of Quantum Vortices in Fermionic Superfluid*
- A. Boulet**, G. Włazłowski, and P. Magierski, *Phys. Rev. A* **106**, 013306 (2022).  
*Local energy density functional for superfluid Fermi gases from effective field theory*
- A. Boulet**, Ph.D. thesis, Paris-Saclay University (2019). ⟨NNT: 2019SACLS212⟩ ⟨tel-02355418⟩  
*Density functional theory for Fermi systems with large s-wave scattering length:  
Application to atomic and nuclear physics*
- A. Boulet** and D. Lacroix, *J. Phys. G: Nucl. Part. Phys.* **46**, 105104 (2019).  
*Approximate self-energy for Fermi systems with large s-wave scattering length:  
A step towards density functional theory*
- A. Boulet** and D. Lacroix, *Phys. Rev. C* **97**, 6337 (2018).  
*Static response, collective frequencies, and ground-state thermodynamical properties  
of spin-saturated two-component cold atoms and neutron matter*
- D. Lacroix, **A. Boulet**, M. Grasso, and C.-J. Yang, *Phys. Rev. C* **95**, 22726 (2017).  
*From bare interactions, low-energy constants, and unitary gas to nuclear density functionals without free parameters:  
Application to neutron matter*

### IN PREPARATION AND/OR CURRENT PROJECTS

- A. Boulet et al.**  
*Local energy density functional for superfluid Fermi gases from effective field theory:  
s-wave effective range and p-wave interaction*
- A. Boulet et al.**  
*About the possibility to study emergent analogue gravity in fermionic superfluid*
- A. Boulet et al.**  
*Variational Perturbation Theory for Density Functional Theory:*  
I. Towards a systematic improvement of the Hartree-Fock-Bogoliubov approximation  
II. Local approximation of the Green-Gorkov functions through gradient expansion: application to the Unitary Fermi Gas  
III. Application to close-shell nuclei  
IV. Application to open-shell nuclei
- A. Boulet et al.**  
*Restoration of broken symmetry in Green-Gorkov formalism: application to open-shell nuclei*
- A. Boulet et al.**  
*Beyond mean-field effective interaction via the many-body perturbation theory:  
Application to the pairing Hamiltonian and unitary Fermi gas*

## Presentations

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### CONFERENCES

#### INT program, University of Washington

Seattle, WA USA

NUCLEAR STRUCTURE AT THE CROSSROADS

2019

*Approximate self-energy for Fermi systems with large s-wave scattering length: A step towards density functional theory*

#### GANIL symposium

Caen, France

NUCLEAR STRUCTURE AND REACTIONS: THE NEXT SIGNIFICANT BREAKTHROUGHS

2019

*Quasi-particle properties of Fermi gas from low density to unitary limits*

### WORKSHOPS

#### IPN Orsay, Paris-Sud University

Orsay, France

BRIDGING NUCLEAR AB-INITIO AND EDF THEORIES

2017

*Static and dynamical responses of neutron systems*

## SEMINARS

### Hadron and Nuclear Theory group, University of Barcelona

Barcelona, Spain

[VISIO-]SEMINAR

2022

*Towards ab initio Density Functional Theory from atomic to nuclear systems*

### Nuclear Theory Group, Warsaw University of Technology

Warsaw, Poland

[VISIO-]SEMINAR

2020

*Density Functional Theory for Fermi systems with large s-wave scattering length: application to nuclear and atomic physics*

### FRIB/NSCL, Michigan State University

East Lansing, MI USA

[VISIO-]RESEARCH DISCUSSION

2020

*Variational Perturbation Theory for Density Functional Theory:*

*Towards a systematic improvement of the Hartree-Fock-Bogoliubov approximation*

### DPhN/IRFU, CEA Saclay

Orme des Merisiers, France.

SNIF MEETING

2019

*Connecting EFT to DFT for strongly interacting fermions*

### IPN Orsay, Paris-Sud University

Orsay, France.

THEORY GROUP SEMINAR

2019

*Quasi-particle properties of Fermi gas from low density to unitary limits*