Tangchao Liu

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Education

École Polytechnique **09/2023 - present**

Master second year (M2) High Energy Physics

Main courses: **Cosmology**, **Gravitational Waves**, Quantum Field Theory II&III, Electroweak Theory, QCD

Université Paris-Saclay (joint Master 2 program with École Normale Supérieure) **09/2022 - 07/2023**

M2 International Centre for Fundamental Physics, Theoretical Physics track *GPA: 13.14/20*

Main courses: **General Relativity** (14.40/20), **Differential Geometry and Gauge Theory** (15.50/20), **Cosmology** (15.00/20), Quantum Field Theory I&II, Lie Groups Lie Algebras and Representations

Université Paris-Saclay **09/2021 - 07/2022**

Master first year (M1) General Physics *GPA: 17.945/20, ranking: 1/31*

Main courses: **General Relativity&Cosmology** (19.00/20), **Advanced Mathematics for Physicists (19.65/20)**, Quantum Solid State Physics (17.75/20), Quantum Field Theory&Statistical Physics (18.67/20)

Huazhong University of Science and Technology (HUST) **09/2017 - 06/2021**

Bachelor of Science, school of Physics *GPA: 88.6/100* *ranking: 30/168*

Research & Internships

The first law of mechanics in General Relativity for spinning binary systems **03/2024 – 09/2024**

Master Thesis, Laboratoire Univers et Théories, l'Observatoire de Paris, Meudon, France

- **Supervisor : Alexandre Le Tiec**

- Derivations of equation of motion for extended body in General Relativity developed by Dixon *et al.* Calculations for establishing geometric properties for skeletonized point particle binary in *Class. Quantum Grav. 38 135022.*
- Re-derivations of black hole thermodynamic first law by Wald's differential form method in *Phys. Rev. D 48, R3427(R)* and the first law for dipolar particle binary system in *Phys. Rev. D 106, 044057.*
- Envisaged goal: Extend the first law in *Phys. Rev. D 106, 044057* to quadrupole order and account for the physics brought by the internal structure of the particles, e.g., spin polarizability and tidal deformations.

Quantum noise reduction in new-generation gravitational wave detectors **04/2023 – 07/2023**

M2 internship, Laboratoire Astroparticule et Cosmologie, Université Paris Cité, Paris, France

- **Supervisors : Eleonora Capocasa & Matteo Barsuglia**

- Analytic calculations on quantum noise, especially squeezed state and frequency dependent squeezing. Numerical optimization for Advanced Virgo+ and Einstein Telescope by Matlab and Python packages `MatGwinc` and `PyGwinc`.
- Oral presentation on July 4, 2023 as assessment. **Overall score: 16.00/20**.

Bound state in Dirac materials **04/2022 – 06/2022**

M1 internship, Laboratoire de Physique des Solides, Université Paris-Saclay, Orsay, France

- **Supervisors: Andrej Meszaros & Pascal Simon**

- Analytic calculations of Källén–Lehmann spectral density of gapped graphene with atomic impurity based on quantum many-body theory and Mathematica, reproducing the results of Dutreix *et al.* in *Nature 574, 219–222 (2019).*
- Numerical computation by Python of tight-binding Hamiltonian spectrum for demonstrating the existence of a bound state and the study of its properties. Certain agreements with analytic methods are found.
- Oral presentation on July 2, 2022 as assessment. **Overall score: 17.80/20**.

Primordial gravitational radiation from first order phase transition in early universe **06/2020 – 08/2020**

Summer Internship, Centre for Gravitational Experiment, HUST, Wuhan, China *continued to Bachelor thesis*

- **Supervisor : Yiqiu Ma**

- Numerical simulation of field dynamics induced from Coleman's false vacuum decay in the internship stage. Confirmation of results established by Coleman, Kosowsky, Watkins and Turner around 1980s.
- Computation of GW power spectrum, following the strategy by J. Garcia-Bellido *et al.* in *Phys.Rev.D 77, 043517 (2008)*, in the extension to (unpublished) Bachelor thesis from January to May 2021.
- Oral presentation for the Bachelor thesis project on May 30, 2021 as assessment. **Overall score: 94/100**.

Skills

Programming

- Python: Coding and solving the Hamiltonian in position space for gapped graphene with atomic impurity in 2022 internship. Numerical optimisation for GW detectors with package `PyGwinc` in 2023 internship.
- Matlab: Numerical computation for Coleman's bounce solution in *Phys. Rev. D 15, 2929 (1977)*, and animations of vacuum bubble collisions in Minkowski background are achieved in 2020 internship.
- LaTeX: The only text editting tool since 2019. Experience with tikz for making visually appealing figures.

Languages: English (fluent, highest TOEFL score: 116/120), Chinese (mother tongue), French (intermediate).

Amateur interest: History of Science & Mathematics, football, swimming, badmiton.