Chris Choi

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Research Interests

Theoretical cosmology, gravitational waves (GWs), massive gravity (MG), pulsar timing arrays (PTAs), inflation

Education

Carnegie Mellon University (CMU) Pittsburgh, PA

PhD in Physics *Aug 2024 – May 2029*

- Cumulative GPA: 3.83 / 4.00

BS in Physics *Aug 2020 – May 2024*

- Astrophysics Track
- Minor in Mathematical Sciences
- Cumulative GPA: 3.92 / 4.00
- Major GPA: 3.95 / 4.00

Research Experience

MG Signatures in PTAs Through Additional Polarization (CMU) Sept 2024 – Present

- Derived frequency-dependent overlap reduction functions (ORF) for ghost-free MG and linked them to a modified GW dispersion relation.
- Implemented a Monte-Carlo ORF integrator and χ^2 pipeline that improves fits for NANOGrav and CPTA.
- Demonstrated model-independent evidence that extra GW polarizations better match observations than the Hellings–Downs curve.
- Presented results at PHENO 2025; manuscript under journal review [1], and accompanied by open-access data & code repository.
- **Advisor**: Tina Kahniashvili (CMU)

NANOGrav 15-yr Stochastic GW Background & Time-Dependent MG (CMU) Jun 2023 – Sept 2024

- Formulated a step-function–mass (SFM) version of minimal MG, deriving an analytic amplification factor for the primordial tensor power spectrum.
- Implemented a Python pipeline that evolves mode equations through inflation, reheating, radiation- and matter-dominated eras, and confronts the model with NANOGrav 15-yr data.
- Presented results at AAS 243, published a paper in PRD [2], and released open-access code & data.
- **Advisors**: Tina Kahniashvili (CMU)

Free Streaming Neutrino Damping of Primordial Gravitational Waves (CMU) Jan 2023 – Jun 2023

- Applied the results of Weinberg (2003) to GWs produced during different cosmological eras
- Numerically solved an integro-differential equation for the metric perturbation damped by neutrinos
- Verified that the damping constant is in agreement with Weinberg and Maggiore (2018)
- Presented results at the Physics Research Symposium in 2023 and published an open-source repository for the code.
- **Advisors**: Tina Kahniashvili (CMU)

Belle II Experiment: Calibration of the Drift Chamber (CMU) Feb 2022 – Aug 2022

- Designed and ran tests for the calibration of the drift chamber in the SuperKEK particle accelerator
- Developed pipelines and programs in C++ for efficiently performing sets of truncation on the raw data
- Provided a correction to the software for the filtering of the data from the drift chamber
- Presented results at Meeting of the Minds 2023 and published an open-source repository for the software

developed during the project.
- **Advisors**: Roy A. Briere (CMU)

Characterizing Electronic Structure of $Cd_2Re_2O_7$ and $ZrTe_5$ With ARPES (NYU) Mar 2019 – Aug 2019

- Built a Java/Processing pipeline that converts proprietary Angle-Resolved Photoemission Spectroscopy (ARPES) `.bin` files to text and reproduces energy–momentum maps, adding second-derivative and minimum-gradient algorithms to highlight electronic band structure.
- Implemented momentum-slice navigation and Fermi–Dirac convolution routines, enabling examination of states near and below the Fermi level in $Cd_2Re_2O_7$ and $ZrTe_5$.
- Compared experimental dispersions with density functional theory predictions, evaluating symmetry and resolution limits that informed subsequent measurement strategy.
- Collaborated with an international team, presented weekly progress, and synthesized literature on pyrochlores and Hund-coupled systems to guide analysis.
- Published an open-source repository for the software used to analyze ARPES data and perform convolution.
- **Advisor**: L. Andrew Wray (NYU)

Teaching Experience

Graduate Teaching Assistant —Modern Physics Laboratory (CMU) Jan 2025 – May 2025

- Helped students with experiments in classical, quantum, nuclear, and condensed matter physics.

Graduate Teaching Assistant —Physics I for Engineers (CMU) Aug 2024 – Dec 2024

- Taught concept reviews during recitation and led students through practice problems
- Led course centers to help students prepare for quizzes, exams, and with homework

Undergraduate Teaching Assistant Assistant — Physics I for Engineers (CMU) Aug 2021 – Dec 2021

- Provided assistance to students with homework and lectures during the class's Course Center

Undergraduate Teaching Assistant Assistant — Basic Experimental Physics (CMU) Jan 2022 – May 2022

- Helped set up the laboratory and prepared radioactive samples and low-temperature gases for experiments

Tutor — Physics Assignment Tutoring Help (CMU) Aug 2023 – May 2024

- Helped students with homework from every undergraduate physics course in the department

Workshops and Events

2025 Phenomenology Symposium — Speaker May 2025

- Gave a 15-min talk about the ongoing project regarding MG and the feasibility of detecting the graviton mass with additional polarizations

Non-Standard Cosmological Epochs and Expansion Histories — Workshop Participant Sept 2024

- Attended workshop on non-standard cosmological expansion histories, exploring impacts on string theories, GWs, and CMB observables.
- Collaborated on new observational approaches for probing early-universe histories

American Astronomical Society 243 Meeting — Presenter (New Orleans) Jan 2024

- Abstract from MG paper [1] accepted
- Awarded funds for travel to present poster at conference

Unravelling the Universe with Pulsar Timing Arrays — Workshop Participant Nov 2023 – Dec 2023

- Learned from experts about PTAs and GW physics.
- Corresponded with graduate students, postdoctoral researchers, and faculty from around the country

CMU McWilliams Jamboree — Presenter (CMU) Nov 2023, Oct 2024

- Presented slide on research interests and current projects
- Networked with graduate students and faculty from CMU and University of Pittsburgh (UPitt)

Meeting of the Minds — Presenter (CMU) May 2023

- Presented poster on summer research project with Prof. Briere.

Physics Undergraduate Research Symposium — Presenter (CMU) Apr 2022, 2023

- Presented posters on my dE/dx research with Prof. Briere (2022, 2023) and research on neutrino damping with Prof. Kahniashvili (2023).

PUBLICATIONS

[1] **Chris Choi**, Tina Kahniashvili. "Do Pulsar Timing Array Datasets Favor Massive Gravity?", arXiv:2505.15084 (2025) [astro ph.CO].

[2] **Chris Choi**, Jacob Magallanes, Murman Gurgenidze, Tina Kahniashvili. "Stochastic Gravitational Wave Background Detection Using NANOGrav 15-year Data Set in the Context of Massive Gravity", Phys. Rev. D 110, 063525 (2024).

HONORS AND AWARDS

Sigma Pi Sigma Membership 2024

- National Physics Honor Society, endorsed by CMU faculty member

ARCS Foundation Scholarship 2024

- $5000 for first three years of PhD at CMU, $15,000 in total

Dean's List with High Honors (CMU) 2020, 2021, 2022, 2023, 2024

Summer Undergraduate Research Fellowship (CMU) 2022

The William Lowell Putnam Mathematical Competition (CMU) 2021

- Competed in the 83rd Putnam Exam, representing CMU, placed in the top 500

TECHNICAL SKILLS

Languages: Python, HTML, Java, C, C++, Matlab, SQL, Rust

Frameworks & Software: Mathematica, ROOT, Git, Linux (Ubuntu, Archlinux), LaTeX