Cian Roche

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Education

Massachusetts Institute of Technology 2021 – Present
PhD candidate - Physics
Thesis: *"Dark Matter on Small and Large Scales"*
Advisors: Prof. Michael McDonald, Prof. Mark Vogelsberger

Universität Tübingen 2019 – 2021
MSc Mathematical Physics 1.1 GPA[†]
Thesis: *"Exact parallel waves in general relativity"*
Advisor: Prof. Carla Cederbaum

University College Cork 2015 – 2019
Bachelor of Science: Physics, 1st class honours

Research Experience

Massachusetts Institute of Technology 2022 – Present
Advisors: Michael McDonald, Mark Vogelsberger
Topics: Dynamical and strong lensing probes of dark matter in galaxy clusters, the observation-simulation connection

Massachusetts Institute of Technology 2021
Advisors: Lina Necib, Tongyan Lin
Topics: Milky Way stellar kinematics, galactic escape velocity profiles, dark matter

Universität Tübingen 2020
Advisors: Carla Cederbaum, Amir Babak Aazami
Topics: Wavelike spacetimes, exact solutions in general relativity, the Ehlers-Kundt Conjecture

University College Cork 2019
Advisor: Anthony Kiely
Topics: Exotic quantum state preparation in optical lattices

Max Planck Institute for Plasma Physics 2018
Advisor: Mike Dunne
Topics: Magnetic field structure in a fusion-grade tokamak, high order nulls and complex field structure

University of Notre Dame 2017
Advisor: Peter Garnavich
Topics: Type 1a supernova progentitors, late-time light curves modelling

Publications

7. Tran, V., et al. 2024; *"A Novel Density Profile for Isothermal Cores of Dark Matter Halos"*, arXiv:2411.11945, submitted to PRD

6. Nguyen, T., et al. 2024; *"How DREAMS are made: Emulating Satellite Galaxy and Subhalo Populations with Diffusion Models and Point Clouds"*, arXiv:2409.02980

5. Rose J. C., et al. 2024; *"Introducing the DREAMS Project: DaRk mattEr and Astrophysics with Machine learning and Simulations"*, arXiv:2405.00766

4. **Roche, C.**, McDonald M., Vogelsberger, M., et al. 2024; *"Brightest Cluster Galaxy Offsets in Cold Dark Matter"*, arXiv:2402.00928, OJA, astro-ph.GA 7

[†]on a scale of 1-5, where 1 is the highest grade. Approximately equivalent to a 4.0 US grade.

3. **Roche, C.**, Necib, L., Lin, T., et al. 2024; *"The Escape Velocity Profile of the Milky Way from Gaia DR3"*, arXiv:2402.00108, ApJ, 972, 70

2. **Roche, C.**, Aazami, A.B. & Cederbaum, C. 2023; *"Exact parallel waves in general relativity"* Gen Relativ Gravit 55, 40, https://doi.org/10.1007/s10714-023-03083-x

1. **Roche, C.** & Garnavich, P. 2020; "*Testing Progenitor Models Using the Late-Time Light Curve of Supernova 1992A*" Res. Notes AAS 4 207, https://doi.org/10.3847/2515-5172/abcb05

Awards

DAAD Graduate Program Full Scholarship	2019
College Scholar - University College Cork	2019
Naughton Research Fellowship (one of 8 in Ireland)	2018
Naughton Foundation Scholarship (one of 29 in Ireland)	2015
All-Ireland Scholarship (one of 125 in Ireland; declined)	2015

TEACHING

Teaching Assistant - MIT 8.13 Fall 2022, Fall 2023, Spring 2024, Fall 2024
Designed and presented lectures on programming, statistics, data analysis, plotting, simulations and uncertainty to be presented as part of the junior lab (8.13) curriculum. Also held office hours, $\sim$ 200 oral exams, assisted in grading, and provided regular in-lab assistance.

Instructor - Gaia DR3 Hackathon 06/22
Created and presented tutorial documentation and code for the downloading of and interaction with Gaia DR3 data to a mixed audience of undergraduate students to faculty at MIT.

Teaching Assistant - Introductory Physics II 2017 – 2018
Lead tutorials for 1st year physics undergraduate students at University College Cork on the topics of electromagnetism, optics, special relativity and quantum mechanics.

Leader - Peer Assisted Learning Scheme 2016 – 2018
Lead weekly mathematics/physics learning sessions for undergraduate students in scientific degrees other than math or physics.

TALKS

7. "*Testing CDM with the First End-to-End Cluster Strong Lensing Simulations*" 26/06/25
European Astronomical Society Conference 2025

6. "*Dark Matter Self-Interaction via Galaxy Cluster Dynamics*" 14/02/24
Harvard University

5. "*Galaxies Lacking Dark Matter Produced in a Cosmological Simulation*" 08/04/22
MIT Kavli Institute for Astrophysics and Space Research

4. "*Waves in General Relativity*" 01/07/21
Guest Lecture - Mathematical Relativity at the University of Tübingen

3. "*Exact parallel waves in general relativity*" 16/06/21
University of Tübingen Mathematical Physics Colloquium

2. "*How to Stop a Hurricane: Complexity in Physics*" 29/10/20
University College Cork "Blow Your Mind Week" 2020

1. "*Hermiticity of Young Operators*" 30/06/20
Young Tableaux Seminar Series - Universität Tübingen

COMMUNITY

MIT Physics Graduate Admissions Committee 2022/2023 Cycle, 2023/2024 Cycle
Served for two admissions cycles on the admissions committee to the graduate program in physics as part of SAMC (student admissions committee members) initiative.

AstroWiki 2023 – Present
Created and co-maintain a set of living notes covering most of graduate level astrophysics, specifically designed to aid students when studying for the MIT astrophysics oral qualification exam. (link)

MIT Summer Research Program Admissions Committee 2022/2023 Cycle
Served on the admissions committee for the MIT Summer research program (MSRP), which aims in particular to provide high-quality research experiences to promising undergraduate students from underrepresented backgrounds.

MKI Graduate Student Lunch | Organiser 2022 – 2023
Organised a weekly lunch and talk series for the physics graduate students of the MIT Kavli Institute for Astrophysics and Space Research.

MIT GAGA Initiative | Co-Lead 2022 – 2023
The Graduates Advising Graduate Admissions (GAGA) program provides the graduate student perspective to the Chair of Graduate Admissions, offers information and mentorship to underrepresented groups in physics and advises on improvements to the admissions process.

MIT GAGA Initiative | Organising Committee 2021 – 2024

MIT Physics Graduate Student Council 2021 – 2023

MIT GAGA Initiative | Organising Committee 2021 – 2024

MIT Graduate Student Union | Organising Committee 2021 – 2023

MIT PhysGAAP program - Mentor and Co-Organiser 2021 – 2023
The Physics Graduate Application Assistance Program (PhysGAAP) provides guidance to prospective applicants on navigating the application process, and liases with the physics department leadership on issues of accessibility and equity in the graduate application. I have served as a co-organizer and have mentored 5 students through the program.

UCC Physics and Astronomy Society | Astronomy Officer 2017 – 2019