

Conor Dyson

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I am pursuing a PhD at the Niels Bohr Institute, University of Copenhagen where I am supervised by Maarten van de Meent and Vitor Cardoso. My primary interests are in post-adiabatic gravitational self-force for modeling intermediary and extreme mass ratio inspirals. Beyond modeling binary black holes in the purely gravitational case, my interest in these systems also extends to modeling these systems in the presence of environments.

EDUCATION

Københavns Universitet (Niels Bohr Institute) , København, Danmark Doctor of Philosophy	Enrolled: Sep 2022 — Sep 2026
Københavns Universitet (Niels Bohr Institute) , København, Danmark Master of Science, Physics	Enrolled: Oct 2022 — Oct 2023
University of Cambridge (DAMTP) , Cambridge, United Kingdom Master of Advanced Study, Applied Mathematics	Enrolled: Sep 2021 — Jun 2022
University College Dublin , Dublin, Ireland BSc Applied and Computational Mathematics	Enrolled: Sep 2017 — Jun 2021

EXPERIENCE

Niels Bohr Institute <i>PhD student</i>	København, Danmark Sep 2022 - present
<ul style="list-style-type: none">I am three-quarters of the way through my four-year PhD program at the Niels Bohr Institute. Within my PhD I am primarily focused on the gravitational self-force approach to modeling the asymmetric two-body problem both in vacuum and in the presence of environments surrounding the central supermassive black hole.	
IBM Research <i>Summer Research Intern</i>	Dublin, Ireland May 2021 - Sep 2021
<ul style="list-style-type: none">Here I was responsible for developing and implementing a novel method for non-parametric estimation of non-linear dynamical systems using a functional analysis approach to convex optimization.	

Conferences

Organiser: 26th Capra conference on radiation reaction in GR , Copenhagen, Denmark	June 2023
<ul style="list-style-type: none">I played a significant role in organizing the 2023 Capra conference as a member of the local organizing committee. My responsibilities included liaising with attendees prior to the event and managing the conference website. During the conference, I also handled various logistical tasks to ensure smooth operations. Additionally, I presented my work on analytic solutions to plunging geodesics in Kerr.	
15th International LISA Symposium , Dublin, Ireland	July 2024
<ul style="list-style-type: none">I attended a week-long conference on the ongoing LISA mission, where I presented a poster on the black hole Magnus effect. The conference featured plenary talks as well as parallel sessions broadly focused on instrumentation, astrophysics, and waveform modeling.	
YITP long term workshop: GRavity and Cosmology , Kyoto, Japan	Feb 2024
<ul style="list-style-type: none">I attended a 5-week workshop in Kyoto, covering topics in early universe inflation, large-scale structure, gravitational wave astronomy, and modified theories of gravity.	
Kavli Summer School on Gravitational Waves , Corfu, Greece	Sep 2023
<ul style="list-style-type: none">I attended a six-day PhD school in Corfu, covering topics in dynamical friction, covering all aspects of gravitational wave physics, from black hole perturbation theory to statistical inference and Numerical relativity.	
Nordic Winter School in Gravitational Wave Astrophysics , Skeikampen, Norway	Jan 2023
<ul style="list-style-type: none">I attended a five-day PhD school in Norway, covering topics in dynamical friction, gravitational wave detection and modeling active galactic nuclei. Here I also presented my work on analytic solutions to plunging geodesics in Kerr.	

Teaching

Københavns Universitet (Niels Bohr Institute), København, Danmark

Course: Scientific Computing

Sep 2023 - Nov 2023

- Here I was responsible for over 20 students as part of the masters level scientific computing course at the University of Copenhagen. My responsibilities involved teaching tutorial and grading homework assignments.

Course: Stochastic Approach to Inverse Problems

Nov 2023 - Jan 2024 & Nov 2024 - Jan 2025

- Here I was responsible for over 40 students as part of the masters level Inverse Problems course at the University of Copenhagen. My responsibilities involved teaching tutorial and grading homework assignments.

Ongoing Projects

Disk EMRI interactions in the Kerr Geometry.

Ongoing

Collaborators: C. Dyson, Daniel D’Orazio

- In this project, we are actively developing solutions for perturbations to cold, thin disks in the fully relativistic Kerr geometry. This calculation resembles those from analytic Newtonian disk migration models, but is formulated covariantly in curved spacetime before solving on top of the Kerr background.

Two-Timescale analysis for extreme mass ratio inspirals coupled to matter

Ongoing

Collaborators: C. Dyson, M.v.d.Meent.

- In this project, we are developing a multi-scale analysis of the field equations coupled to matter for analyzing extreme mass ratio systems. By completing such an analysis, one can concretely distinguish between dissipative and conservative effects on the EMRI dynamics in strong gravity, as well as identify novel mechanisms such as energy transfer between the matter and gravitational fields.

M-mode scheme for second-order self-force calculations in Kerr spacetime: construction of the second-order source

Ongoing

Collaborators: Patrick Bourg, S. Dolan, C. Dyson, Benjamin Leather, , Zachary Nasipak, A. Pound, et al

- In this project, we are developing the source term for the second-order self-force problem in a two-dimensional m-mode scheme, which hopes to circumvent some of the issues associated with the spheroidal harmonic decomposition. We hope to have this project completed later this summer.

Black Hole Perturbation Toolkit: KerrGeodesics

Ongoing

Collaborators: Black Hole Perturbation Toolkit Collaboration.

- As a contributor to the Black Hole perturbation toolkit (a freely accessible software) I am involved in writing the back-end code and helping develop the user-facing functionality. I have also contributed to the upcoming "black hole perturbation toolkit white paper" which should be soon released.

Publications Section

Selected Publications

Environmental effects in extreme mass ratio inspirals: perturbations to the environment in Kerr

Journal: Physics Review Letters

April 2025

Authors: C.Dyson, T.Spiekma, R.Brito, M.v.d.Meent and S.Dolan.

- Working in Lorenz gauge and considering equatorial circular orbits, we present the first self-consistent, fully relativistic calculation of a perturbation to a black hole environment due to an inspiraling secondary in the Kerr geometry. As an example case, we consider the environment to be that of a superradiantly grown scalar cloud, though our framework is generalizable to other scenarios. We demonstrate that the scalar field develops a rich wake structure induced by the secondary and compute scalar fluxes emitted to infinity and through the horizon. Relative differences in the fluxes compared to Schwarzschild are tens of percent on large intervals of parameter space, underscoring the importance of modeling in Kerr.

Relativistic Aerodynamics of Spinning Black Holes

Journal: Physical Review D

Feb 2024

Authors: C.Dyson, J.Redondo-Yuste, M.v.d.Meent, V.Cardoso

- The motion of black holes through a galaxy is modified due to the galactic medium. The effect of dynamical friction – the drag force suffered by the black hole due to the gravitational pull of the stars and dark matter that lags behind its motion – has significant consequences ranging from the formation of supermassive black hole binaries to modifications in the phase of binary mergers. Here we show from a first principle calculation that when spinning black holes move on a medium they also suffer two additional effects: a rotational force, which in the context of fluid dynamics is dubbed Magnus effect, and a lift, orthogonal to the direction of motion.

Analytic solutions to plunging geodesics in Kerr

Paper: Classical and Quantum Gravity

Jun 2023

Authors: C.Dyson, M.v.d.Meent

- Here we developed novel analytic solutions to plunging geodesics in Kerr in terms of Jacobi Elliptic Integrals. Forms of these solutions have been found previously but in form not practical for efficient computation, the solutions we have provided have been implemented in the Black Hole perturbation toolkit and are already being used by members of the community.

Awards and Achievements

Poster winner, Black Holes Inside and Out conference, Copenhagen, Denmark

Aug 2024

Awarding Institute: Strong group

- Awarded for placing in the top three poster presentations at the conference.

Ad Astra Scholarship, Dublin, Ireland

Sep 2018 - May 2021

Awarding Institute: University College Dublin

Value: €12,0000

- Awarded for placing at the top of the University College Dublin school of Science.

University College Dublin - Stage 4 scholarship, Dublin, Ireland

May 2020

Awarding Institute: University College Dublin

Value: €1,000

- Highest overall GPA in the Applied Maths degree.

University College Dublin - Stage 4 scholarship, Dublin, Ireland

May 2020

Awarding Institute: University College Dublin

Value: €250

- Highest average grade in five core applied Maths courses.