

# Stephen McCormick

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## Education

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### PhD in Mathematics

THE PHASE SPACE FOR THE EINSTEIN–YANG–MILLS EQUATIONS, BLACK HOLE MECHANICS,  
AND A CONDITION FOR STATIONARITY

*Monash University, Australia*

2014

### Bachelor of Science (Honours)

SPECIALISATION: MATHEMATICS

*Monash University, Australia*

2008

### Bachelor of Science

SPECIALISATIONS: MATHEMATICS & PHYSICS

*Monash University, Australia*

2007

## Employment

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### Luleå University of Technology

SENIOR LECTURER/ASSOCIATE PROFESSOR †

*Luleå, Sweden*

*Since January 2023*

### University of Regensburg

RESEARCHER

*Regensburg, Germany*

*March 2022 – December 2022*

### Uppsala University

RESEARCHER

POSTDOCTORAL RESEARCH FELLOW

*Uppsala, Sweden*

*December 2019 – December 2021*

*December 2017 – December 2019*

### KTH Royal Institute of Technology

POSTDOCTORAL RESEARCH FELLOW

*Stockholm, Sweden*

*August 2016 – December 2017\**

### University of New England

POSTDOCTORAL FELLOW

*Armidale, Australia*

*June 2014 – June 2017\**

† *Current position (Universitetslektor).*

\* *Concurrent appointments at 50% for a period.*

## Research funding

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### Kempestiftelserna Postdoc Stipend

• PROJECT: ON THE ENERGY OF SPACE-TIME

*Kempestiftelserna*

*2024–2027*

### Stiftelsen GS Magnusons fond

• PROJECT: ADVANCING A NEW MASS FOR ASYMPTOTICALLY HYPERBOLIC MANIFOLDS

*Royal Swedish Academy of Sciences*

*2024*

### Australia–Germany Joint Research Cooperation Scheme

• PROJECT: ON BARTNIK'S QUASI-LOCAL MASS FUNCTIONAL

JOINTLY FUNDED WITH PROF. DR. CARLA CEDERBAUM (TÜBINGEN)

*Universities Australia/DAAD*

*2016–2017*

### UNE Research Seed Grant

• PROJECT: THE YAMABE PROBLEM OUTSIDE A BALL AND THE BARTNIK MASS

*University of New England, Australia*

*2015*

## Languages

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**English:** First language

**Swedish:** Good working knowledge

**German:** Elementary communication

## Publication List

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Authors are listed alphabetically with contributions considered equal, following standard practice in mathematics research.

- 20XX **McCormick, S.**, V-static metrics and the volume-renormalised mass, preprint arXiv:2406.09101
- 20XX **Dahl, M.; Kröncke, K.; McCormick, S.**, A volume-renormalized mass for asymptotically hyperbolic manifolds, preprint arXiv:2307.06196
- 2024 **McCormick, S.**, An Overview of Bartnik's Quasi-Local Mass, *Beijing J. Pure Appl. Math.*, **1**(2)
- 2024 **McCormick, S.**, Fill-ins with scalar curvature lower bounds and applications to positive mass theorems, *Ann. Glob. Anal. Geom.*, **65**(26)
- 2022 **Chen, P.-N.; McCormick, S.**, Quasi-local Penrose inequalities with electric charge, *Int. Math. Res. Not.*, **2022**(22)
- 2021 **Alaee, A.; Cabrera Pacheco, A. J.; McCormick, S.**, Stability of a quasi-local positive mass theorem for graphical hypersurfaces of Euclidean space, *Trans. Amer. Math. Soc.*, **374**
- 2021 **McCormick, S.**, The Hilbert manifold of asymptotically flat metric extensions, *Gen. Relativ. Gravit.* **53**(14).
- 2020 **McCormick, S.**, Gluing Bartnik extensions, continuity of the Bartnik mass, and the equivalence of definitions, *Pacific J. Math.*, **304**(2).
- 2019 **McCormick, S.**, On the charged Riemannian Penrose inequality with charged matter, *Class. Quantum Gravity*, **37**(1).
- 2019 **McCormick, S.; Miao, P.**, On the evolution of the spacetime Bartnik mass, *Pure Appl. Math. Q.* **15**(3).
- 2019 **McCormick, S.; Miao, P.**, On a Penrose-like inequality in dimensions less than eight, *Int. Math. Res. Not.*, **2019**(7).
- 2018 **Cabrera Pacheco, A. J.; Cederbaum, C.; McCormick, S.**, Asymptotically hyperbolic extensions and an analogue of the Bartnik mass, *J. Geom. Phys.*, **132**.
- 2018 **McCormick, S.**, On a Minkowski-like inequality for asymptotically flat static manifolds, *Proc. Am. Math. Soc.*, **146**(9).
- 2017 **Cabrera Pacheco, A. J.; Cederbaum, C.; McCormick, S.; Miao, P.**, Asymptotically flat extensions of CMC Bartnik data, *Class. Quant. Grav.* **34**(10).
- 2017 **McCormick, S.**, The asymptotically flat scalar-flat Yamabe problem with boundary, *J. Geom. Anal.*, **27**(3).
- 2015 **McCormick, S.**, A note on mass-minimising extensions, *Gen. Rel. Grav.* **47**(12).
- 2014 **McCormick S.**, First Law of Black Hole Mechanics as a Condition for Stationarity, *Phys. Rev. D* **90**, 104034.
- 2014 **McCormick S.**, The Phase Space for the Einstein-Yang-Mills Equations and the First Law of Black Hole Thermodynamics, *Adv. Theor. Math. Phys.* **18**(4).

## Extended research programmes

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### Institut Mittag-Leffler

GENERAL RELATIVITY, GEOMETRY, AND ANALYSIS: BEYOND THE FIRST 100 YEARS AFTER EINSTEIN

*Djursholm, Sweden*

*September – December 2019*

### Erwin Schrödinger Institute

GEOMETRY AND RELATIVITY PROGRAM

*Vienna, Austria*

*July – August 2017*

### Institut Henri Poincaré

MATHEMATICAL GENERAL RELATIVITY PROGRAM

*Paris, France*

*September – November 2015*

### Mathematical Sciences Research Institute (MSRI)

MATHEMATICAL GENERAL RELATIVITY PROGRAM

*Berkeley, USA*

*November – December 2013*

## Talks

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### On bounded scalar curvature fill-ins and positive mass theorems

INVITED SEMINAR

*KTH, Sweden*

*October 2024*

### A new mass-like invariant for asymptotically hyperbolic manifolds

LEFSCHETZ GEOMETRY & GEOMETRIC ANALYSIS SEMINAR (INVITED)

*Clark University, USA (online)*

*April 2024*

### Variational properties of the volume-renormalised mass

INVITED SEMINAR

*KTH, Sweden*

*March 2024*

### A volume-renormalised mass for asymptotically hyperbolic manifolds

EINSTEIN SPACES AND SPECIAL GEOMETRY

*Institut Mittag-Leffler, Sweden*

*July 2023*

### The Riemannian Penrose inequality with electric charge with a quasi-local perspective

INVITED SEMINAR

*KTH, Sweden*

*October 2022*

### Gluing collars to manifolds; how and why

FHST MEETING ON GEOMETRY AND ANALYSIS

*Universität Freiburg, Germany*

*January 2020*

### Gluing collars to manifolds; how and why

GENERAL RELATIVITY, GEOMETRY, AND ANALYSIS: BEYOND THE FIRST 100 YEARS AFTER EINSTEIN

*Institut Mittag-Leffler, Sweden*

*November 2019*

### Bartnik's quasi-local mass

MATHEMATICAL RELATIVITY: A RIEMANNIAN APPROACH

*CIMAT (Guanajuato), Mexico*

*May 2019*

### Some recent developments on Bartnik's quasi-local mass

INVITED SEMINAR

*Queen Mary University of London, UK*

*March 2019*

### Some recent results pertaining to Bartnik's quasi-local mass

INVITED SEMINAR

*University of Miami, USA*

*October 2018*

### Asymptotically hyperbolic extensions and estimates for an analogue of the Bartnik mass

WORDSHOP ON ASYMPTOTICALLY HYPERBOLIC MANIFOLDS

*Banff International Research Station, Canada*

*May 2018*

### A Penrose-like inequality in dimensions less than eight

INTERNATIONAL CONFERENCE ON PDES, GEOMETRIC ANALYSIS AND FUNCTIONAL INEQUALITIES

*University of Sydney, Australia*

*March 2017*

### The first law of black hole mechanics as a condition for stationarity and staticity

STATIC METRICS AND BARTNIK'S QUASI-LOCAL MASS CONJECTURE

*Universität Tübingen, Germany*

*May 2016*

### **Killing vectors as Lagrange multipliers**

WORKSHOP ON ANALYSIS, GEOMETRY AND MATHEMATICAL RELATIVITY:  
A CELEBRATION OF ROBERT BARTNIK'S 60TH BIRTHDAY

*Monash University, Australia*

*February 2016*

### **The Phase Space for the Einstein-Yang-Mills Equations,**

INVITED SEMINAR

*Universität Regensburg, Germany*

*October 2015*

### **The First Law of Black Hole Mechanics as a Condition for Stationarity**

INVITED SEMINAR

*ICMAT, Spain*

*October 2015*

### **The Phase Space for the Einstein-Yang-Mills Equations and the First Law of Black Hole Thermodynamics**

MINI-WORKSHOP ON NONLINEAR PDES

*University of New England, Australia*

*October 2014*

### **The Phase Space for the Einstein-Yang-Mills Equations and the First Law of Black Hole Thermodynamics**

INVITED SEMINAR

*University of Wollongong, Australia*

*September 2014*

### **The Einstein-Yang-Mills Phase Space and the First Law of Black Hole Mechanics**

INVITED SEMINAR

*MSRI, Berkeley, USA*

*November 2013*

### **The First Law of Black Hole Mechanics as a Condition for Stationarity**

57TH ANNUAL MEETING OF THE AUSTRALIAN MATHEMATICAL SOCIETY

*University of Sydney, Australia*

*October 2013*

### **The Phase Space for the Einstein-Yang-Mills Equations and the First Law of Black Hole Thermodynamics**

AUSTRALIAN MATHEMATICAL SCIENCES STUDENTS' CONFERENCE

*Australian National University,*

*Australia*

*July 2013*

### **Linearisation Stability of the Einstein-Maxwell and Einstein-Yang-Mills Constraints on an Asymptotically Flat Manifold**

56TH ANNUAL MEETING OF THE AUSTRALIAN MATHEMATICAL SOCIETY

*University of Ballarat, Australia*

*September 2012*

### **Dain's Variational Principle and its Relation to an Angular Momentum-Mass Inequality in General Relativity**

55TH ANNUAL MEETING OF THE AUSTRALIAN MATHEMATICAL SOCIETY

*University of Wollongong*

*September 2011*

## **Miscellaneous**

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### **Supervision**

- Cosupervision of one PhD student, KTH Royal Institute of Technology (ongoing).
- Supervision of one Bachelor's thesis, Uppsala University (2020).
- Supervision of two Bachelor's projects, University of New England (2014 – 2016).

### **Teacher Training**

I have completed 16 credits (ECTS) of pedagogical education at LTU:

- Qualifying course in higher education pedagogy, parts 1 and 2 (7.5 credits), 2023.
- Course Design (2 credits), 2024.
- Programme Design (2 credits), 2024.
- Research Supervision Course (4.5 credits), 2024.

### **Conference organisation**

Oct. 2014 **Mini-Workshop on Nonlinear PDEs,**

Jul. 2013 **2nd Annual Australian Mathematical Sciences Students' Conference,**

Jul. 2011 **Inaugural Australian Mathematical Sciences Students' Conference\*,**

I was the primary organiser of this conference

*\*The Australian Mathematical Sciences Students' Conference has now become a regular event.*

## Outreach

### Interview for Cosmos Magazine and associated video

PROMOTIONAL PIECE FOR UNE (LINK: [HTTPS://BIT.LY/3G3RE1P](https://bit.ly/3G3RE1P))

2016

### Talk – Complicated ideas in less than 140 characters

PART OF A SERIES TO GET STAFF AT UNE INVOLVED IN SCIENCE COMMUNICATION (LINK: [HTTPS://GOO.GL/8WKWHU](https://goo.gl/8wkWHU))

2016

### Presenter for Far Out Science at UNE

A PROGRAMME FOR SCHOOL STUDENTS TO BE INTRODUCED TO FUN SCIENCE

2015 – 2016

### Multiple radio interviews

I WAS INTERVIEWED ON ABC RN TAMWORTH (NEW ENGLAND RADIO) ON A FEW OCCASIONS TO SPEAK ABOUT MATHEMATICS, PHYSICS AND SCIENCE COMMUNICATION

2015 – 2016

### Presenter for the Science Experience at Monash University

A PROGRAMME FOR SCHOOL STUDENTS TO BE INTRODUCED TO FUN SCIENCE (LINK: [HTTPS://GOO.GL/KNRJNH](https://goo.gl/kNRJNH))

2012 – 2014

## Reviewing

I recent years I have reviewed for the following journals:

Annals of Global Analysis and Geometry  
Classical and Quantum Gravity  
Communications in Mathematical Physics  
International Mathematics Research Notices  
Journal of Mathematical Physics  
SIGMA

Beijing Journal of Pure and Applied Mathematics  
Communications in Contemporary Mathematics  
General Relativity and Gravitation  
Journal of Geometric Analysis  
Mathematische Nachrichten  
Transactions of the American Mathematical Society

## Elected positions

### National Committee for Mathematics

ROLE: MEMBER

*Sweden*

*February 2024 – Present*

### Faculty of Science Postgraduate Committee

ROLE: REPRESENTATIVE FOR THE SCHOOL OF MATHEMATICAL SCIENCES

*Monash University, Australia*

*July 2010 – March 2014*

### Council of the Australian Mathematical Society

ROLE: STUDENT OBSERVER

*Australia*

*2011 – 2012*

## Expert roles

- Mentor for British Isles Graduate Workshop V (2024).
- Special reviewer (opponent) for one licentiate thesis defence (KTH, Stockholm 2023).

## Conferences & workshops

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July 2024 **British Isles Graduate Workshop V: Mathematical General Relativity (mentor)**, Coalport, England

July 2023 **Einstein Spaces and Special Geometry**, Djursholm, Sweden

May 2023 **13th Central European Relativity Seminar**, Stockholm, Sweden

Jan. 2020 **2nd FHST Meeting on Geometry and Analysis**, Freiburg, Germany

Jun. 2019 **Geometric Analysis and General Relativity: A conference in honour of Gerhard Huisken's 60th birthday**, ETH Zürich, Switzerland

May 2019 **Mathematical Relativity: A Riemannian Approach**, CIMAT (Guanajuato), Mexico

Aug. 2018 **Mathematical General Relativity**, Mathematisches Forschungsinstitut Oberwolfach, Germany

May. 2018 **Asymptotically Hyperbolic Manifolds**, Banff International Research Station, Canada

Apr. 2018 **Mass in General Relativity**, Simons Center for Geometry and Physics, NY, USA

Jul. 2017 **Between Geometry and Relativity**, Erwin Schrödinger Institute, Vienna, Austria

Mar. 2017 **International Conference on PDEs, Geometric Analysis and Functional Inequalities**, University of Sydney, Australia

May 2016 **Static metrics and Bartnik's quasi-local mass conjecture**, Universität Tübingen, Germany

Feb. 2016 **Workshop on Analysis, Geometry and Mathematical Relativity: a celebration of Robert Bartnik's 60th birthday**, Monash University, Australia

Nov. 2015 **General Relativity: A Celebration of the 100th Anniversary**, Institute Henri Poincaré, France

Oct. 2015 **Dynamics of Self-Gravitating Matter**, Institute Henri Poincaré, France

Sep. 2015 **Geometric Aspects of Mathematical Relativity**, Université de Montpellier, France

Sep. 2015 **Recent Advances in General Relativity**, Institute Henri Poincaré, France

Mar. 2015 **Andrejewski Days: 100 years of General Relativity**, Brandenburg an der Havel, Germany

Oct. 2014 **Mini-Workshop on Nonlinear PDEs**, University of New England, Australia

Sep. 2014 **Mini-Workshop on Geometric Analysis**, University of Wollongong, Australia

Jul. 2014 **AMSI/AustMS Conference on Geometric Analysis and Stochastic Methods in Geometry**, University of Queensland, Australia

Nov. 2013 **Initial Data and Evolution Problems in General Relativity**, MSRI, Berkeley, CA, USA

Dec. 2012 **Trilateral Meeting on PDE and Related Topics**, University of Wollongong, Australia

Sep. 2012 **56th Annual Meeting of the Australian Mathematical Society**, University of Ballarat, Australia

Sep. 2012 **Early Career Researcher Workshop of the Australian Mathematical Society**, University of Ballarat, Australia

Sep. 2011 **55th Annual Meeting of the Australian Mathematical Society**, University of Wollongong, Australia

Sep. 2011 **Early Career Researcher Workshop of the Australian Mathematical Society**, University of Wollongong, Australia

Sep. 2011 **Geometry of Differential Equations Workshop**, Australian National University, Australia

Jun. 2011 **Australian Mathematical Sciences Students' Conference**, Monash University, Australia

Dec. 2010 **Riemannian and Differential Geometry Workshop**, Latrobe University, Australia

Sep. 2010 **54th Annual Meeting of the Australian Mathematical Society**, University of Queensland, Australia

Sep. 2010 **International Conference on "Geometric and Nonlinear Partial Differential Equations"**, Mission Beach, QLD, Australia, Hosted by the Australian National University

Jul. 2010 **Victorian Mathematical Sciences Students' Conference**, University of Melbourne, Australia

Apr. 2010 **Workshop on nonlinear PDEs**, University of Wollongong, Australia

Jan. 2010 **Workshop on General Relativity and Geometric Analysis**, Monash University, Australia