

# Mahir Hadžić

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**Born** August 1982

## Employment

- Professor, University College London, Oct 2021 –
- Associate Professor, University College London, Sep 2019 – Sep 2021
- Senior Lecturer in Analysis, King's College London, Sep 2017 – Aug 2019
- Lecturer in Analysis, King's College London, Sep 2013 – Aug 2017
- C.L.E. Moore Instructor, MIT, 2010 – 2013, (on leave 2010 – 2011)
- Postdoc, University of Zurich, 2010 – 2011, Postdoc supervisor: Camillo DeLellis

## Education

Brown University, Ph.D, 2010 (thesis advisor: Prof. Yan Guo)

University of Vienna, Mag. rer. nat, 2005 (with Distinction)

## Awards and External Funding

Adams Prize, 2021

EPSRC Fellowship, Sep 2019 - Aug 2024 (total value: 957,306 GBP)

EPSRC First Grant, Mar 2016 - Feb 2018 (total value 93,937 GBP)

NSF Grant: DMS-1211517, 2012 - 2015 (total value 132,672 USD, given up in 2013)

J. T. Oden Visitor Fellowship - UT Austin, 2016

Silver medal at the International Mathematics Olympiad (IMO) 2001, bronze medals at the IMO 2000 and IMO 1999.

## Research Interests

*Partial Differential Equations, Mathematical Analysis, Mathematical Physics*

My research draws on mathematical fluid dynamics, kinetic theory, and general relativity.

## Supervision

### PhD students

Shrish Parmeshwar, King's College London, January 2017- November 2020 (accepted a post-doctoral position at the University of Bath, to start in Autumn Term 2020)

King Ming Lam, University College London, 2019 -

Christopher Straub, University of Bayreuth, Germany (External supervisor), 2020 -

### Postdocs

Matthew Schrecker (PDRA), funded through EPSRC Fellowship, 2020 - 2023

Fatima-Ezzahra Jabiri (PDRA), funded through EPSRC Fellowship, 2021 - 2024

1. (with Yan Guo and Juhi Jang) Naked singularities in the Einstein-Euler system. *Preprint, arXiv:2112.10826*, 150 pages
2. (with Yan Guo, Juhi Jang, and Matthew Schrecker) Gravitational Collapse for Polytopic Gaseous Stars: Self-similar Solutions. *Preprint, arXiv:2107.12056*, 92 pages
3. (with Gerhard Rein and Christopher Straub) On the existence of linearly oscillating galaxies. *Arch. Rat. Mech. Anal.* **243**, 611–696 (2022)
4. (with Yan Guo and Juhi Jang) Larson-Penston Self-similar Gravitational Collapse. *Commun. Math. Phys.*, **386**, 1551–1601 (2021)
5. (with Zhiwu Lin) Turning point principle for relativistic stars. *Commun. Math. Phys.* **387** (2), 729–759 (2021),
6. (with Calum Rickard and Juhi Jang) Global existence of the nonisentropic compressible Euler equations with vacuum boundary surrounding a variable entropy state. *Nonlinearity*, **34**(1), 33–91 (2021)
7. (with Shrish Parmeshwar and Juhi Jang) Global expanding solutions of compressible Euler equations with small initial densities. *Quart. Appl. Math.*, **79**, 273–334 (2021)
8. (with Yan Guo and Juhi Jang) Continued gravitational collapse for Newtonian stars. *Arch. Rat. Mech. Anal.* **239**, 431–552 (2021)
9. (with Zhiwu Lin and Gerhard Rein) Stability and instability of self-gravitating relativistic matter distributions. *Arch. Rat. Mech. Anal.*, **241**, 1–89 (2021)
10. (with Juhi Jang) A class of global solutions to the Euler-Poisson system. *Comm. Math. Phys.*, **370**, no 2, 475–505 (2019)
11. (with Juhi Jang) Expanding large global solutions of the equations of compressible fluid mechanics. *Invent. Math.*, **214** (3), 1205–1266 (2018).
12. (with Andreas Seeger, Charles Smart and Brian Street) Singular integrals and a problem on mixing flows. *Annales Inst. Henri Poincaré - Analyse Nonlinéaire*, **35**, 4, 921–943 (2018)
13. (with Steve Shkoller and Gustavo Navarro) Local well-posedness and Global stability of the Two-Phase Stefan problem. *SIAM J. Math. Anal.*, **49**, Issue 6, 4942–5006 (2017)
14. (with Juhi Jang) Nonlinear stability of expanding star solutions in the radially-symmetric mass-critical Euler-Poisson system. *Comm. Pure Appl. Math.*, **71**, no. 5, 827–891 (2018)
15. (with Steve Shkoller and Jared Speck) A priori estimates for solutions to the relativistic Euler equations with a moving vacuum boundary. *Comm. PDE*, **44**, 85–906 (2019)
16. (with Pierre Raphaël) On melting and freezing for the 2d radial Stefan problem, *Jour. Eur. Math. Soc.*, **21**, Issue 11, 3259–3341 (2019)
17. (with Steve Shkoller) Global stability and decay for the classical Stefan problem for general boundary shapes, *Phil. Trans. Royal Soc. A*, **373**, 2050 (2015)
18. (with Gerhard Rein) On the small redshift limit of steady states of the spherically symmetric Einstein-Vlasov system and their stability, *Math. Proc. Camb. Phil. Soc.*, **159**, 529–546 (2015).
19. (with Jared Speck) The non-linear future stability for the dust-Einstein system, *Jour. Hyp. Diff. Eqns.*, **12**, no. 1, 87–188 (2015)

20. (with Steve Shkoller) Global stability and decay for the classical Stefan problem, *Comm. Pure Appl. Math.*, **68**, 689–757 (2015).
21. (with Steve Shkoller) Well-posedness for the classical Stefan problem and the zero surface tension limit, *Arch. Rational Mech. Anal.* **223** (1), 213–264 (2016)
22. (with Gerhard Rein) Stability for the spherically symmetric Einstein-Vlasov system – a coercivity estimate, *Math. Proc. Camb. Phil. Soc.*, **155**, 529–556 (2013)
23. Orthogonality conditions and asymptotic stability in the Stefan problem with surface tension, *Arch. Rational Mech. Anal.*, **203**, 3, 719–745 (2012)
24. (with Govind Menon) Gradient flow structure for domain relaxation in Langmuir films, *Quart. Appl. Math.*, **70**, 659–664 (2012)
25. (with Yan Guo) Stability in the Stefan problem with surface tension (I), *Commun. Partial Differential Eqns.*, **35** (2), 201–244 (2010).
26. (with Gerhard Rein) Global existence and nonlinear stability for the relativistic Vlasov-Poisson system in the gravitational case, *Indiana Univ. Math. J.* **56**, (2007).
27. A constraint variational problem arising in stellar dynamics, *Quart. Appl. Math.*, **65**, 145–153 (2007)

Conference Proceedings

28. (with Juhi Jang) Gravitational Collapse for Newtonian Stars. Research Institute for Mathematical Science, Kyoto (2021)
29. (with Juhi Jang) Dynamics of expanding gases, Research Institute for Mathematical Science, Kyoto, Kokyuroku, No. 2038 (2017)

**Selected  
invitations**

Frontiers in kinetic theory: connecting microscopic to macroscopic scales - KineCon 2022, Isaac Newton Institute, Spring Term 2022

Erwin Schrödinger Institute, Mathematical Perspectives of Gravitation beyond the Vacuum Regime, Spring Term 2021

70th Birthday Conference in honour of John Toland, May 2020 - Invited Speaker - cancelled due to COVID

Oberwolfach Workshop - Mathematical Relativity - August 2018

Conference at Institut Henri Poincaré - Fluids, dispersion and blow-up, July 2017

Oberwolfach Workshop - Dispersive PDEs - June 2017

Erwin Schrödinger Institute, February 2017, Workshop on Geometric Transport Equations in General Relativity

Conference on Nonlinear Wave Equations, May 2016, IHES, Paris

Workshop on Dynamics & Kinetic theory of self-gravitating systems, Institut Henri Poincaré, Paris, November 2013

Oberwolfach Workshop - Nonlinear Evolution Problems - May 2012

**Institutional  
Citizenship****University College London**

Member of the REF Assessment team, 2020 -

Member of the Hiring Panel for Lectureships in Pure Mathematics 2020

**King's College London**

Programme Director and Admissions Tutor, Graduate Diploma in Mathematics, from 2013

Third year programme director, 2014–2017

Athena Swan Self-assessment Team, 2016–2017

Member of the department marketing team, 2017

Library Officer 2014–2015

**Service to the  
Community**

Member of the EPSRC Associate College

Referee for research proposals in UK and internationally

Peer reviewer for top journals (in mathematics generally as well as in field-specific ones)

**Teaching****University College London**

Differential Geometry, MATH 0020, Instructor, Spring 2021, 2022

LTCC course on “Free Surface Euler Flows”, Spring 2021

Tutorials for MATH0010, Winter 2020 (online)

Analysis Stream Leader - Year 3 Projects - Winter 2020 (face to face)

Tutorial for MATH0040 - Winter 2019

**King's College London**

Linear Algebra and Geometry (1st year module), 2019

Fourier Analysis (3rd and 4th year module), 2015 - 2018

Nonlinear Analysis (4th year module), 2014 - 2019

**MIT**

MIT Project Lab in Mathematics, Instructor 2012

Seminar in Dynamical Systems for undergraduates, Instructor, 2013

Teaching Assistant for Calculus courses, 2011-2012

**University of Zurich**

Selected Topics in Analysis, Advanced undergraduate course, 2011

**Master theses supervision**

Supervised 13 MSc theses since 2014 (at KCL and UCL)

**Teaching  
Qualifications**

Fellow of the HEA

**Outreach**

*Scaling, PDEs and Iceberg Melting*, popular article on my research, De Morgan Newsletter, 2020

King's Factor Lecture: The Invariance Principle (popular maths lecture aimed at high-school students), Feb 2019

Popular lectures about my research to undergraduate maths and science students at the University of Tuzla and University of Sarajevo (Bosnia and Herzegovina), Sep 2017

King's College London Taster Days (twice), popular research-themed lectures aimed at high school students.

King's College London Christmas lectures (introducing mathematical research to school students). <https://www.youtube.com/watch?v=tCGzKAZ7Lm8>, 2015

King's College London Teachers' Conference (popularisation of research among secondary school teachers)

**Conference and  
Seminar  
Organisation**

"When Kinetic Theory meets Fluid Dynamics", International Conference at ETH Zurich, July 2022 (co-organised with Mikaela Iacobelli (ETH) and Alexis Vasseur (UT Austin))

International Conference "Recent Trends in PDE", King's College London, January 2018 (co-organised with Gustav Holzegel (Imperial College London) and Alexander Pushnitski (King's College London))

International Conference: "The Cauchy Problem in Kinetic Theory - Recent Progress in Collisionless Models", Imperial College London, September 2015 (co-organised with Jonathan Ben-Artzi (Cardiff) and Steve Pankavich (Colorado))

Organiser of the Paris-London Analysis Seminar 2015-2017

Organiser of the UCL-ICL Analysis and PDE seminar

Organiser of the London PDE seminar

**Talks and  
conference  
invitations,  
complete list**

- PDE Seminar, University of Science and Technology of China, May 2022
- Relativity Seminar, University of Vienna, March 2022
- Princeton Analysis seminar, Feb 2022
- Erwin Schrödinger Institute, Mathematical Perspectives of Gravitation beyond the Vacuum Regime, Feb 2022, Invited speaker and programme participant
- Frontiers in kinetic theory: connecting microscopic to macroscopic scales, Isaac Newton Institute, Cambridge, Invited Speaker, Jan 2022
- Warwick PDE seminar, October 2021
- Erwin Schrödinger Institute, Mathematical Perspectives of Gravitation beyond the Vacuum Regime, Spring Term 2021, Invited speaker and programme participant
- Virtual Analysis and PDE seminar, Invited Speaker, February 2021
- Center for Nonlinear Analysis, CMU, Online Seminar Talk, October 2020
- Invited Speaker, Conference on Mathematical General Relativity, June 2020, Paris 6 (postponed due to COVID)

- Invited Speaker at the International Conference, Long Time Behavior and Singularity Formation in PDEs, NYU Abu Dhabi, May 2020
- KTH Online Seminar in Analysis, Seminar Talk, May 2020
- 70th Birthday Conference in honour of John Toland, May 2020 - Invited Speaker - cancelled due to COVID
- Invited Speaker at Shanks Workshop on Mathematical Aspects of Fluid Dynamics, March 2020 (postponed due to COVID)
- Invited Speaker at OxPDE Conference, February 2020 (postponed due to COVID)
- PDE Seminar, Brown University, January 2020
- PDE and Analysis Seminar, GeorgiaTech, January 2020
- Analysis Seminar, University of Sussex, October 2019
- Workshop on Shocks and Interfaces, Oxford University, July 2019
- Analysis Seminar, University of Cardiff, Spring term 2019
- Workshop on PDEs, Invited Speaker, Université Cergy-Pontoise, May 2019
- PDE Seminar, Imperial College London, January 2019
- PDE Seminar, Brown University, December 2018
- Analysis Seminar, University of Warwick, November 2018
- MAFRAN days, University of Cambridge, Invited Speaker, September 2018
- Oberwolfach Workshop - Mathematical Relativity - August 2018
- Analysis Seminar, University of Durham, March 2018
- Analysis Seminar, King's College London Spring term 2018
- Analysis Seminar, University of Birmingham, January 2018
- Analysis and PDE Seminar, Georgia Tech, December 2017
- MAFRAN days, University of Cambridge, Invited Speaker, September 2017
- Conference at Institut Henri Poincaré, Conference "Fluids, dispersion and blow-up" , July 2017, Invited Speaker
- Oberwolfach Workshop - Dispersive PDEs - June 2017
- Geometry and Analysis Seminar, Queen Mary University London, March 2017
- Erwin Schrödinger Institute, February 2017, Workshop on "Geometric Transport Equations in General Relativity"
- Analysis Seminar, KCL, February 2017
- Analysis Seminar, University of Edinburgh, February 2017
- Colloquium, NYU Abu Dhabi, December 2016
- Basel-Zurich Seminar
- Colloquium USC
- Differential Equations Seminar, U Michigan Ann Arbor
- Analysis Seminar UT Austin
- Conference on Nonlinear Wave Equations, May 2016, IHES, Paris, Invited Speaker
- Analysis Seminar, KCL, April 2016
- Loughborough University, Analysis Seminar, December 2015
- University of Chicago, PDE Seminar, November 2015
- University of Texas Austin, Analysis Seminar, November 2015
- New York University Abu Dhabi, Seminar, October 2015
- University of Sussex, October 2015, Analysis and PDE seminar
- PDE Seminar, University of Bayreuth, July 2015
- PDE Seminar, University of Cambridge, March 2015

- PDE Seminar, Oxford University, February 2015
- Colloquium, University of Tuzla, December 2014
- Analysis Seminar, University of Zagreb, December 2014
- PDE and Analysis Seminar, University of Zurich, November 2014
- Analysis Seminar, EPFL Lausanne, November 2014
- PDE Seminar, Imperial College, October 2014
- PDE Seminar, University of Warwick, October 2014
- ESI, Vienna, Workshop on Kinetic theory, September 2014
- Summer School in Applied Mathematics, Beijing University, July 2014
- AIMS conference on Dynamical Systems, Differential Equations and Applications, Madrid, Spain, July, 2014.
- Seminar on Mathematical General Relativity, Paris 6, May 28 2014
- ICMAT, Madrid, PDE Seminar, May 2014
- Analysis Seminar, NYU, April 2014
- Oxbridge PDE days, Cambridge, March 20–21 2014
- Free Boundaries and Moving Interfaces Workshop, Oxford, February 20–22 2014
- Geometry and Analysis Seminar, Imperial College London, December 2013
- GRAVASCO, Workshop on Dynamics & Kinetic theory of self-gravitating systems, IHP, Paris, November 2013
- Two day meeting on hyperbolic PDEs, Trieste, October 2013
- PDE Seminar, University of Zurich, October 2013
- Analysis Seminar, University of Bath, October 2013
- London Analysis and Probability Seminar, October 2013
- Workshop on Kinetic Description of Multiscale Phenomena, June 17–28, Heraklion, Crete, June 2013.
- Conference on Mathematical Topics in Kinetic Theory, University of Cambridge, June 2013
- PDE Seminar, Georgia Tech, April 2013
- PDE seminar, IMATI-CNR Institute, Pavia, Italy, June 2012
- Contributed talk, HYP2012, Padova, Italy, June 2012
- Talk at the Oberwolfach workshop on Nonlinear Evolution Problems, Oberwolfach, Germany, May 2012
- PDE/Analysis seminar, UCLA, April 2012
- PDE seminar, UC Davis, April 2012
- Invited talk, AMS-Sectional Meeting on PDE-s, Hawaii, March 2012
- Colloquium, US Naval Academy, March 2012
- PDE/Analysis seminar, MIT, March 2012
- Analysis/PDE seminar, New York University, February 2012
- PDE seminar, Brown, February 2012
- Analysis seminar, ETH, June 2011
- Analysis seminar, University of Cambridge, March 2011
- Mathematical Physics seminar, University of Rome- Tor Vergata, December 15, 2010
- Geometry an analysis seminar, University of Copenhagen, November 19, 2010
- Colloquium, University of Bayreuth, November 2010
- Invited talk at the Workshop on Kinetic and Fluids, Beijing International Center for Mathematical Research, Beijing, July 26 -30, 2010

- PDE/Analysis Seminar, MIT, April 2010
- Brown/Paris 6 PDE Seminar, April 2010
- Participating Analysis Seminar, UCLA, January 2010.
- Stability and Instability in the Stefan problem with surface tension  $\sigma$ , SIAM Conference on Analysis of PDEs, Miami, December 2009.
- PDE Seminar, University of Connecticut, November 16, 2009.
- Mathematical Physics Seminar, University of Bonn, June 25, 2009.
- Mathematical Physics Seminar, University of Bayreuth, June 17, 2009.
- PDE Seminar, Brown University, May 2009.
- PDE Seminar, Brown University, October 2008.
- Contributed talk, Conference on Nonlinear Dispersive Equations, Istanbul, August 25-29, 2008.
- Joint Dynamical Systems Seminar, Brown Univ. - Free Univ. Berlin, October 2006.
- Mathematical Physics Seminar, University of Bayreuth, June 2006.
- Wissenschaftskolleg Seminar, University of Vienna, April 2005.
- Contributed talk, Workshop on Stability in Kinetic and Fluid models, Thurnau, Germany, September 6-10, 2004.