Elias Roland Most

Princeton University
Princeton Center
for Theoretical Science
405 Jadwin Hall
Princeton, NJ 08544, USA
emost@princeton.edu

Institute for
Advanced Study
School of Natural Sciences
250 Bloomberg Hall
1 Einstein Drive
Princeton, NJ 08540, USA
ermost@ias.edu

Professional Experience

Postdoctoral Fellow (Associate Research Scholar), 2020–
Princeton Center for Theoretical Science, Princeton University, NJ, USA.
Three year fellowship jointly with the Princeton Gravity Initiative.

Postdoctoral Fellow (Associate Research Scholar), 2020–
Princeton Gravity Initiative, Princeton University, NJ, USA.
Five year fellowship jointly with the Princeton Center for Theoretical Science.

Postdoctoral Fellow (Long-term Member), 2020–
School of Natural Sciences, Institute for Advanced Study, Princeton, NJ, USA.
Five year membership in the Astrophysics group.

Predoctoral Fellow (Research Analyst), 2019–2020
Center for Computational Astrophysics, Flatiron Institute,
Simons Foundation, New York, NY, USA.
Five month fellowship. Mentor: Dr. Alexander Philippov

Education

Doctorate (Physics), *Goethe University Frankfurt*, Germany. 2017–2020
Thesis title: *Probing dense matter with binary neutron star mergers.*
Advisor: Prof. Luciano Rezzolla Grade: summa cum laude

Master of Science (Physics), *Goethe University Frankfurt*, Germany. 2014–2017
Thesis title: *Collapse to black holes of rotating magnetised neutron stars.*
Advisor: Prof. Luciano Rezzolla Overall Grade: with distinction (1.0)

Natural Sciences Tripos, Part III (Physics), *University of Cambridge*, UK. 2013–2014
Erasmus Student Exchange
Research project: *Investigating the effects of ray-theoretic approximations in seismic tomography.*
Advisor: Dr. David Al-Attar Overall Grade: 73% (equivalent to Class I)

Bachelor of Science (Physics), *University of Göttingen*, Germany. 2010–2013
Thesis title: *On models of cosmological inflation using the Higgs field.*
Advisor: Prof. Laura Covi Overall Grade: very good (1.3)

Awards

Giersch Excellence Award, *Giersch Foundation & HGS-HIRe Graduate School*, 2020
Frankfurt am Main, Germany.
Awarded for an excellent doctoral thesis.

Joint Postdoctoral Prize Fellowship, 2020
Center for Theoretical Science & Gravity Initiative, Princeton University.

Postdoctoral Fellowship, *Institute for Advanced Study*, Princeton. 2020

NASA Hubble Fellowship Program: Einstein Fellowship (declined). 2020

Postdoctoral Fellowship (declined), *Perimeter Institute*, Waterloo, Canada. 2020

Flatiron Predoctoral Fellowship, *Simons Foundation*, New York, NY, USA. 2019

James B. Hartle Award, *International Society on General Relativity and Gravitation.* 2019
Best student talk (session B2) at GR22/Amaldi13 conference.

Giersch Excellence Grant, *Giersch Foundation*, Frankfurt am Main, Germany. 2018
Awarded for outstanding progress in the doctoral thesis.

Travel Grant, *Willkomm Foundation*, Frankfurt am Main, Germany. 2018
Support for a conference trip to Shanghai.

PhD Scholarship, *HGS-HIRe Graduate School*, Frankfurt am Main, Germany. **2017–2020**
Three year PhD scholarship.

Scholarship, *German Academic Scholarship Foundation*, Bonn, Germany. **2010–2016**
Highly competitive scholarship for academic excellence.

Grants

Compute Time Grant, *NSF Frontera*, Co-I (PI: A. Philippov), **798,336 SUs**. 2021-2022
AST21006: *Simulations of reconnection-powered flares in magnetospheres of magnetars, binary neutron stars and black holes*

Compute Time Grant, *NSF Frontera*, Co-I (PI: A. Philippov), **300,000 SUs**. 2020-2021
AST20008: *Investigating electormagnetic precursors to neutron star merger gravitational wave events*

Compute Time Grant, *NSF Frontera*, Co-I (PI: A. Philippov), **6,000 SUs**. 2020-2021
AST20001: *Investigating electormagnetic precursors to neutron star merger gravitational wave events (Startup)*

AstroLab Code Optimisation Grant, *LRZ* , Garching, Germany. 2019-2020
12-month high level high-performance computing support for code optimization.

Publications

I have published **19 refereed papers**, with 1 additional paper being currently under review. As of April 2021, my works have gained **>1200 citations** with an **h-index 13** (according to Google Scholar).

1. L. J. Papenfort, S. D. Tootle, P. Grandclement, **E. R. Most**, and L. Rezzolla. *A new public code for initial data of unequal-mass, spinning compact-object binaries* . arXiv:2103.09911, *(submitted to Phys. Rev. D)*
2. **E. R. Most**, L. J. Papenfort, S. Tootle, L. Rezzolla. *Fast ejecta as a potential way to distinguish black holes from neutron stars in high-mass gravitational-wave events*. arXiv:2012.03896, *Astrophys. J. (in press)*.
3. A. Nathanail, **E. R. Most**, and L. Rezzolla. *GW170817 and GW190814: tension on the maximum mass* . Astrophys. J. Lett, 908 L28, 2021, *Featured as research highlight in AAS Nova.*
4. **E. R. Most**, L. J. Papenfort, L. R. Weih, L. Rezzolla. *A lower bound on the maximum mass if the secondary in GW190814 was once a rapidly spinning neutron star*. Mon. Not. R. Astron. Soc. Lett., 499 (1), L82-L86, 2020.
5. **E. R. Most**, L. R. Weih, L. Rezzolla. *The heavier the better: how to constrain mass ratios and spins of high-mass neutron-star mergers*. Mon. Not. R. Astron. Soc. Lett., 496, L16-L21, 2020.
6. **E. R. Most** and A. A. Philippov. *Electromagnetic precursors to gravitational wave events: Numerical simulations of flaring in pre-merger binary neutron star magnetospheres*. Astrophys. J. Lett., 893, L6, 2020. *Featured as research highlight in AAS Nova.*
7. **E. R. Most**, L. J. Papenfort, V. Dexheimer, M. Hanauske, H. Stöcker, and L. Rezzolla. *On the deconfinement phase transition in neutron-star mergers*. Eur. Phys. J. A , 56:59, 2020.
8. **E. R. Most**, L. J. Papenfort, and L. Rezzolla. *Beyond second-order convergence in simulations of magnetised binary neutron stars with realistic microphysics*.
Mon. Not. R. Astron. Soc., 490:3588–3600, 2019.
9. **E. R. Most**, L. J. Papenfort, A. Tsokaros, and L. Rezzolla. *Impact of High Spins on the Ejection of Mass in GW170817*. Astrophys. J. 884:40, 2019.
10. **E. R. Most**, L. J. Papenfort, V. Dexheimer, M. Hanauske, S. Schramm, H. Stöcker, and L. Rezzolla. *Signatures of Quark-Hadron Phase Transitions in General-Relativistic Neutron-Star Mergers*. Phys. Rev. Lett., 122:061101, 2019, **Citations: 113.** *Featured as Editors' suggestion.*
11. H. Olivares, O. Porth, J. Davelaar, **E. R. Most**, C.M. Fromm, Y. Mizuno, Z. Younsi, L. Rezzolla.

Constrained transport and adaptive mesh refinement in the Black Hole Accretion Code. Astron. & Astrophys. 629, A61, 2019.
12. B. Ripperda, F. Bacchini, O. Porth, **E. R. Most**, H. Olivares, A. Nathanail, L. Rezzolla, J. Teunissen, R. Keppens. *General relativistic resistive magnetohydrodynamics with robust primitive variable recovery for accretion disk simulations*. Astrophys. J. Supp. 244:1, 2019.
13. M. Hanauske, J. Steinheimer, A. Motornenko, V. Vovchenko, L. Bovard, **E. R. Most**, L.J. Papenfort S. Schramm,H. Stöcker. *Neutron Star Mergers: Probing the EoS of Hot, Dense Matter by Gravitational Waves*. Particles 2:1,44-56, 2019.
14. V. Dexheimer, C. Constantinou, **E. R. Most**, L. J. Papenfort, M. Hanauske, S. Schramm, H. Stöcker, and L. Rezzolla. *Neutron-Star-Merger Equation of State*. Universe, 5:5, 129, 2019.
15. L. R. Weih, **E. R. Most**, and L. Rezzolla. *Optimal neutron-star mass ranges to constrain the equation of state of nuclear matter with electromagnetic and gravitational-wave observations*. Astrophys. J., 881:73, 2019.
16. **E. R. Most**, L. R. Weih, L. Rezzolla, and J. Schaffner-Bielich. *New Constraints on Radii and Tidal Deformabilities of Neutron Stars from GW170817*.
Phys. Rev. Lett., 120(26):261103, 2018, **Citations: 339**.
17. **E. R. Most**, A. Nathanail, and L. Rezzolla. *Electromagnetic Emission from Blitzars and Its Impact on Non-repeating Fast Radio Bursts*. Astrophys. J., 864:117, 2018.
18. L. Rezzolla, **E. R. Most**, and L. R. Weih. *Using Gravitational-wave Observations and Quasi-universal Relations to Constrain the Maximum Mass of Neutron Stars*.
Astrophys. J. Lett., 852:L25, 2018, **Citations: 361**.
19. L. R. Weih, **E. R. Most**, and L. Rezzolla. *On the stability and maximum mass of differentially rotating relativistic stars*. Mon. Not. R. Astron. Soc., 473:L126–L130, 2018.
20. A. Nathanail, **E. R. Most**, and L. Rezzolla. *Gravitational collapse to a Kerr-Newman black hole*. Mon. Not. R. Astron. Soc., 469:L31–L35, 2017.

Talks and Conferences

Talks and seminars

Informal Seminar Series, *Institute for Advanced Study*, Princeton, NJ, USA. **03/2021**
Invited seminar *On the maximum mass of neutron stars and electromagnetic precursor emission from inspiralling neutron star binaries.*

Astrophysics seminar, *Cornell University*, Ithaca, NY, USA, (virtual). **03/2021**
Invited seminar on *Binary neutron star mergers: Fast ejecta and prospects for electromagnetic precursor signals.*

Houston/UIUC/Kent Nuclear Physics Journal Club, (virtual meeting). **01/2021**
Invited seminar on *Fast ejecta as a potential way to distinguish black holes from neutron stars in high-mass gravitational-wave events.*

Princeton Gravity Initiative Lunch Talk, *Princeton University*, Princeton, NJ, USA. **09/2020**
Invited seminar on *Neutron star mergers: On the impact of high spins in multi-messenger gravitational wave events.*

Princeton Center for Theoretical Science Lunch Talk, *Princeton University*, Princeton, NJ, USA. **09/2020**
Invited seminar on *Probing dense matter with neutron star mergers.*

Stavanger Virtual Seminar, *University of Stavanger*, Stavanger, Norway. **09/2020**
Invited seminar on *Neutron star mergers: What recent gravitational wave events have taught us about the equation of state.*

Computational Relativity Seminar, *Max-Planck-Institute for Gravitational Physics*, Potsdam, Germany. **02/2020**
Invited seminar on *Constraints on nuclear physics and electromagnetic precursors from neutron star mergers.*

Astrophysics, Gravitation and Cosmology Seminar, *University of Illinois at Urbana/Champaign*, Urbana, IL, USA. 02/2020
Invited seminar on *Constraints on nuclear physics and electromagnetic precursors from neutron star mergers.*

Nuclear Physics Seminar, *Kent State University*, Kent, OH, USA. 02/2020
Invited seminar on *Constraints on nuclear physics from neutron star mergers.*

HEP Seminar, *Columbia University*, New York, NY, USA. 12/2019
Invited seminar on *Constraints on nuclear physics and electromagnetic precursors from neutron star mergers.*

Bahcall Lunch Talk, *Institute for Advanced Study*, Princeton, NJ, USA. 12/2019
Invited talk on *Electromagnetic precursors from neutron star mergers.*

Princeton Gravity Initiative Lunch Talk, *Princeton University*, Princeton, NJ, USA. 12/2019
Invited seminar on *Constraints on nuclear physics and electromagnetic precursors from neutron star mergers.*

Strong Gravity Seminar, *Perimeter Institute*, Waterloo, Canada. 11/2019
Invited seminar on *How neutron star mergers can be used to study hadron-quark phase transitions.*

HEP Seminar, *Penn State University*, State College, PA, USA. 11/2019
Invited seminar on *How neutron star mergers can be used to study hadron-quark phase transitions.*

String Theory Seminar, *Institute for Theoretical Physics*, Utrecht, The Netherlands. 03/2019
Invited seminar on *First-order phase transitions in neutron star mergers.*

Conferences and workshops

APS April Meeting 2021. 04/2021
Contributed talk on *Fast ejecta as a potential way to distinguish neutron stars from black holes.*

Workshop of the APS Topical Group on Hadron Physics. 04/2021
Invited talk on *the role of exotic hadronic degrees of freedom in neutron-star mergers.*

CompOSE (PHAROS WG1+WG2) Workshop, Barcelona (virtual meeting). 02/2021
Invited panelist on *WHAT WE NEED for an improvement of our CompOSE data base for the equation of state and transport properties of neutrons stars.*

AAS237, virtual meeting. 01/2021
Contributed talk on *Electromagnetic precursors to neutron star mergers.*

Athena Developer Workshop, *Center for Computational Astrophysics, Flatiron Institute*, New York, NY, USA. 10/2020
Invited talk on *Update on resistive GRMHD and force-free strategies* (jointly with J. Mahlmann & B. Ripperda).

Midwest Relativity Meeting, *Notre Dame University*, virtual meeting. 10/2020
Contributed talk on *Electromagnetic precursors to neutron star mergers.*

From heavy-ion collisions to neutron stars, *Illinois Center for Advanced Studies of the Universe*, virtual meeting. 08/2020
Invited panelist on *Dynamical phenomena in ultradense matter.*

GR22/Amaldi13 International Conference, *Valencia*, Spain. 07/2019
Contributed talk on *Signatures From First-Order Phase Transitions In Neutron Star Mergers.*

The Radiating Universe Workshop, *Tsung-Dao Lee Institute*, Shanghai, China. 05/2019
Invited talk on *Multi-messenger aspects of gravitational wave sources.*

First EPS Conference on Gravitation, *La Sapienza University*, Rome, Italy. 02/2019
Contributed talk on *What neutron star mergers and their gravitational wave signal can teach us about matter under extreme conditions.*

Pharos WG1+WG2 meeting, *University of Coimbra*, Portugal. 09/2018
Contributed talk on *Constraining the equation of state with GW170817.*

The Exploding Universe Workshop, *Tsung-Dao Lee Institute*, Shanghai, China. **05/2018**
Invited talk on *Binary neutron star mergers: A status report from Frankfurt.*

Fire and Ice Workshop, *Saariselkä*, Finnland. **04/2018**
Invited talk on *Constraints on neutron star properties from GW170817.*

MICRA Meeting 2017, *Michigan State University*, East Lansing, USA. **07/2017**
Contributed talk on *Neutrino and magnetic effects on neutron star mergers.*

NewCompStar Conference 2017, *Polish Academy of Sciences*, Warsaw, Poland. **03/2017**
Contributed talk on *Fast radio bursts from collapsing neutron stars.*

Teaching Experience

Tutor(TA), *Institute for Theoretical Physics*, Frankfurt am Main, Germany. **2018**
Supervisions for the course *Advanced Introduction to C++, Scientific Computing and Machine Learning.*

Tutor(TA), *Institute for Theoretical Physics*, Frankfurt am Main, Germany. **2016**
Supervisions for the course *Theoretical Physics I.*

Tutor(TA), *Institute for Theoretical Physics*, Göttingen, Germany. **2013**
Supervisions for the course *Mathematics for Physicists I.*

Tutor(TA), *Institute for Theoretical Physics*, Göttingen, Germany. **2012**
One-week revision course for *Mathematics for Physicists I*, included preparation of course materials.

Leadership and Service

Co-organizer, *Princeton Gravity Initiative Lunch Talks*, Princeton University. **2021–**

Co-organizer, *Plasma Physics Learning Seminar*, Institute for Advanced Study. **2021–**

Co-organizer, *Gravitational Waves Learning Seminar*, Institute for Advanced Study. **2020-2021**

Student tour guide, *Einstein Inside Exhibition*, Goethe University Frankfurt. **2016**
Giving guided tours to local high school students.

Community service (Zivildienst), *Dieburg*. **2009-2010**
Nine month assistant position at a local high school for children with special needs.

Referee: The Astrophysical Journal Letters, The Astrophysical Journal, Monthly Notices of the Royal Astronomical Society, Monthly Notices of the Royal Astronomical Society: Letters, Classical and Quantum Gravity

Research Interests

- **Theoretical Astrophysics.** General Relativity, Neutron Stars, Black Holes, Compact Binaries, Gravitational Waves, Kilonova Afterglow, EM Counterparts, Multi-messenger Astronomy, Neutron Star Magnetospheres, Relativistic Magnetohydrodynamics, Equation of State, First-order Phase Transitions, Quark-Gluon-Plasma.
- **Computational Physics.** Numerical Relativity, Computational Fluid Dynamics and Magnetohydrodynamics, Adaptive Mesh Refinement.

Professional Skills

Computational Frameworks:
AMReX, Einstein Toolkit, MPI-AMRVAC

Codes: Lead developer: *GReX*, *FIL*
Co-developer: *BHAC*

Visualisation: Matplotlib, Visit, Paraview, Amira

Programming languages:
C++17, C, Python,
Fortran2008, Matlab, Java, SQL

Programming paradigms:
MPI, OpenMP, x86 intrinsics, OpenACC, CUDA(basics)

Tools:
Gitlab, Github, Subversion

High-performance computing:
Use of several Tier-0 supercomputing facilities in Germany including Hazel Hen (HLRS, Stuttgart) and SuperMUC(-NG) (LRZ, Munich) utilising up to 10,000 cores per simulation. Helped writing several applications for compute time proposals, out of which I have used around **25 million core-hours** for my research over the past years.

Schools (attended)

PRACE Winter School, *KU Leuven*, Belgium. 03/2019
One week school on machine learning for scientists.

GWverse School, *University College Dublin*, Ireland. 06/2018
Two week school on gravitational waves.

NewCompStar School, *University of Sofia*, Bulgaria. 09/2017
One week school on neutron stars and gravitational physics.

NewCompStar School, *University of Coimbra*, Portugal. 09/2016
One week school on neutron stars and gravitational physics.

International Summer Academy, *Rot an der Rot, Germany*. 08/2014
Workshop on monstrous moonshine theory for master students in physics and mathematics.

Jürgen Ehlers Spring School, *Max Planck Institute for Gravitational Physics*, Golm, Germany. 03/2013
Two week school on general relativity and cosmology.

Training Courses (attended)

Advanced C++ Programming Course, *HLRS*, Stuttgart, Germany. 11/2018
Four day training course on modern C++ features and code design related to software engineering.

Cray XC40 Workshop on Optimisation at Scale, *HLRS*, Stuttgart, Germany. 11/2018
Five day workshop on code optimisation for Cray supercomputers.

HiPerCH10, *HKHLR*, Darmstadt, Germany. 09/2018
One day training course on SIMD vectorisation with C++.

SuperMUC Status and Results Workshop, *LRZ*, Garching, Germany. 07/2018
Two day workshop on recent developments of SuperMUC.

HGS-HIRe Soft-Skill Course I, *Castle Buchenau*, Germany. 11/2017
Four day training course on *Making an Impact as an Effective Researcher*.

Advanced Parallel Programming Course, *JSC*, Jülich, Germany. 11/2017
Three day training course on advanced parallel programming with MPI and OpenMP.

PRACE PATC Course, *LRZ*, Garching, Germany. 12/2016
Two day training course on node-level performance engineering on modern supercomputers.

HiPerCH6, *HKHLR*, Darmstadt, Germany. 11/2016
One day course on parallel debugging using TotalView.

Cray XC40 Workshop on Optimisation at Scale, *HLRS*, Stuttgart, Germany. 10/2016
Three day workshop on code optimisation for Cray supercomputers.

HLRS Parallel Programming Workshop, *University of Mainz*, Germany. 03/2016
Three day workshop on MPI and OpenMP parallelisation.