Mohammed Khalil

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PROFESSIONAL EXPERIENCE

Perimeter Institute for Theoretical Physics　　　　　　　　　　　　　Waterloo, Canada
Postdoctoral Researcher　　　　　　　　　　　　　　　　　　　　　　*Sep 2022 – Present*

Max Planck Institute for Gravitational Physics　　　　　　　　　　　Potsdam, Germany
PhD Researcher　　　　　　　　　　　　　　　　　　　　　　　　　　*Jan 2018 – Aug 2022*

University of Maryland　　　　　　　　　　　　　　　　　　College Park, MD, USA
Graduate Teaching Assistant　　　　　　　　　　　　　　　　　　　　*Sep 2016 – Dec 2017*

EDUCATION

University of Maryland　　　　　　　　　　　　　　　　　　College Park, MD, USA
PhD in Physics　　　　　　　　　　　　　　　　　　　　　　　　　　*Aug 2016 – Aug 2022*
　Dissertation Title: Analytical modeling of compact binaries in general relativity and modified gravity theories
　Supervisor: Prof. Alessandra Buonanno

Alexandria University　　　　　　　　　　　　　　　　　　　　　Alexandria, Egypt
BSc in Electrical Engineering: Communications and Electronics　　　　　*Sep 2011 – Jul 2016*

TECHNICAL SKILLS

Programming	Python (NumPy, Pandas, . . .), SQL, Mathematica, TeX/LaTeX
Machine Learning	Scikit-learn, Keras, TensorFlow, PyTorch
Data Visualization	Matplotlib, Seaborn, Plotly, Dash, Tableau
Model Deployment	Streamlit, FastAPI, Docker, AWS
Developer Tools	Git, Bash, VS Code, Jupyter Notebooks
Statistics	Frequentist and Bayesian inference, Monte Carlo simulations, hypothesis testing

AWARDS AND FELLOWSHIPS

Marie Skłodowska-Curie Postdoctoral Fellowship (declined)　　　　　　　　　2025 – 2027
The European Commission
　For the proposal: "Accurate analytical modeling of compact binaries in general relativity and beyond"

Otto Hahn Medal　　　　　　　　　　　　　　　　　　　　　　　　　　Jun 2024
The Max Planck Society
　Dissertation award for "work enabling precision improvements of theoretical predictions for gravitational-wave astronomy, in Einstein's theory of General Relativity and beyond"

Charles W. Misner Award　　　　　　　　　　　　　　　　　　　　　　　May 2021
University of Maryland
　Award for "outstanding dissertation research in gravitation and cosmology"

International Graduate Research Fellowship　　　　　　　　　　　　　　　Spring 2018
University of Maryland and Max Planck Institute for Gravitational Physics
　Fellowship to do part of my Ph.D. research in Germany at the Max Planck Institute

Ralph Myers & Friends of Physics Award　　　　　　　　　　　　　　　　May 2017
Department of Physics, University of Maryland
　Award for "outstanding performance as a teaching assistant"

Dean's Fellowship　　　　　　　　　　　　　　　　　　　　　Fall 2016 – Spring 2018
Graduate School, University of Maryland
　Additional funding to recruit outstanding prospective graduate students to the University

FQxI Essay Contest (Third Prize)　　　　　　　　　　　　　　　　　　　Aug 2014
Foundational Questions Institute (FQxI)

Certificates

Data Science Professional Certificate (12 courses) from IBM on Coursera   May 2025
Machine Learning Specialization (3 courses) from DeepLearning.AI on Coursera   Jun 2025
Machine Learning Professional Certificate (6 courses) from IBM on Coursera   Jul 2025

Professional Activities

Former member of the LIGO Scientific Collaboration, LISA Consortium, and American Physical Society.
Refereed 16 papers for the Physical Review D journal and 2 papers for the MDPI journals.

Teaching Experience

Graduate Teaching Assistant, University of Maryland
Taught students in recitation sections, led laboratory experiments, and graded assignments and exams.
Received excellent evaluations from students and a teaching award from the department.

PHYS 131: Fundamentals of Physics for Life Sciences I	Fall 2017
PHYS 132: Fundamentals of Physics for Life Sciences II	Summer 2017
PHYS 260: Vibrations, Waves, Heat, Electricity and Magnetism	Spring 2017
PHYS 103: Physics of Music Laboratory	Fall 2016
PHYS 270: Electrodynamics, Light, Relativity and Modern Physics	Fall 2016

Publications

According to Google Scholar (in August, 2025): 33 publications, over 2,000 citations, h-index 24
ORCID: 0000-0002-6398-4428 | Inspire | arXiv

Papers on gravitational-wave physics (PhD and postdoc research)

1. A. Gamboa, **M. Khalil** and A. Buonanno, "Third post-Newtonian dynamics for eccentric orbits and aligned spins in the effective-one-body waveform model SEOBNRv5EHM," Phys. Rev. D **112**, 044037 (2025), arXiv:2412.12831.

2. A. Gamboa, A. Buonanno, R. Enficiaud, **M. Khalil**, A. Ramos-Buades, L. Pompili, H. Estellés, *et al.* "Accurate waveforms for eccentric, aligned-spin binary black holes: The multipolar effective-one-body model SEOBNRv5EHM," Phys. Rev. D **112**, 044038 (2025), arXiv:2412.12823.

3. Y. F. Bautista, **M. Khalil**, M. Sergola, C. Kavanagh and J. Vines,, "Post-Newtonian observables for aligned-spin binaries to sixth order in spin from gravitational self-force and Compton amplitudes," accepted in Phys. Rev. D (2024), arXiv:2408.01871.

4. G. Faggioli, M. van de Meent, A. Buonanno, A. Gamboa, **M. Khalil** and G. Khanna, "Testing eccentric corrections to the radiation-reaction force in the test-mass limit of effective-one-body models," Phys. Rev. D **111**, 044036 (2025), arXiv:2405.19006.

5. Q. Henry and **M. Khalil**, "Spin effects in gravitational waveforms and fluxes for binaries on eccentric orbits to the third post-Newtonian order," Phys. Rev. D **108**, 104016 (2023), arXiv:2308.13606.

6. **M. Khalil**, A. Buonanno, H. Estelles, D. P. Mihaylov, S. Ossokine, L. Pompili and A. Ramos-Buades, "Theoretical groundwork supporting the precessing-spin two-body dynamics of the effective-one-body waveform models SEOBNRv5," Phys. Rev. D **108**, 124036 (2023), arXiv:2303.18143.

7. L. Pompili, A. Buonanno, H. Estellés, **M. Khalil**, M. van de Meent, D. P. Mihaylov, S. Ossokine, M. Pürrer and A. Ramos-Buades, *et al.* "Laying the foundation of the effective-one-body waveform models SEOBNRv5: improved accuracy and efficiency for spinning non-precessing binary black holes," Phys. Rev. D **108**, 124035 (2023), arXiv:2303.18039.

8. A. Ramos-Buades, A. Buonanno, H. Estellés, **M. Khalil**, D. P. Mihaylov, S. Ossokine, L. Pompili and M. Shiferaw, "SEOBNRv5PHM: Next generation of accurate and efficient multipolar precessing-spin effective-one-body waveforms for binary black holes," Phys. Rev. D **108**, 124037 (2023), arXiv:2303.18046.

9. Q. Henry, S. Marsat and **M. Khalil**, "Spin contributions to the gravitational-waveform modes for spin-aligned binaries at the 3.5PN order," Phys. Rev. D **106**, 124018 (2022), arXiv:2209.00374.

10. **M. Khalil**, R. F. P. Mendes, N. Ortiz and J. Steinhoff, "Effective-action model for dynamical scalarization beyond the adiabatic approximation," Phys. Rev. D **106**, 104016 (2022), arXiv:2206.13233.

11. **M. Khalil**, A. Buonanno, J. Steinhoff and J. Vines, "Energetics and scattering of gravitational two-body systems at fourth post-Minkowskian order," Phys. Rev. D **106**, 024042 (2022), arXiv:2204.05047.

12. A. Ramos-Buades, A. Buonanno, **M. Khalil** and S. Ossokine, "Effective-one-body multipolar waveforms for eccentric binary black holes with nonprecessing spins," Phys. Rev. D **105**, 044035 (2022), arXiv:2112.06952.

13. **M. Khalil**, "Gravitational spin-orbit dynamics at the fifth-and-a-half post-Newtonian order," Phys. Rev. D **104**, 124015 (2021), arXiv:2110.12813.

14. **M. Khalil**, A. Buonanno, J. Steinhoff and J. Vines, "Radiation-reaction force and multipolar waveforms for eccentric, spin-aligned binaries in the effective-one-body formalism," Phys. Rev. D **104**, 024046 (2021), arXiv:2104.11705.

15. A. Antonelli, C. Kavanagh, **M. Khalil**, J. Steinhoff and J. Vines, "Gravitational spin-orbit and aligned spin_1-spin_2 couplings through third-subleading post-Newtonian orders," Phys. Rev. D **102**, 124024 (2020), arXiv:2010.02018.

16. A. Antonelli, C. Kavanagh, **M. Khalil**, J. Steinhoff and J. Vines, "Gravitational spin-orbit coupling through third-subleading post-Newtonian order: from first-order self-force to arbitrary mass ratios," Phys. Rev. Lett. **125**, 011103 (2020), arXiv:2003.11391.

17. **M. Khalil**, J. Steinhoff, J. Vines and A. Buonanno, "Fourth post-Newtonian effective-one-body Hamiltonians with generic spins," Phys. Rev. D **101**, 104034 (2020), arXiv:2003.04469.

18. **M. Khalil**, N. Sennett, J. Steinhoff and A. Buonanno, "Theory-agnostic framework for dynamical scalarization of compact binaries," Phys. Rev. D **100**, 124013 (2019), arXiv:1906.08161.

19. **M. Khalil**, N. Sennett, J. Steinhoff, J. Vines and A. Buonanno, "Hairy binary black holes in Einstein-Maxwell-dilaton theory and their effective-one-body description," Phys. Rev. D **98**, 104010 (2018), arXiv:1809.03109.

Reviews

20. LISA Consortium Waveform Working Group, "Waveform Modelling for the Laser Interferometer Space Antenna," arXiv:2311.01300.

21. A. Buonanno, **M. Khalil**, D. O'Connell, R. Roiban, M. P. Solon and M. Zeng, "Snowmass White Paper: Gravitational Waves and Scattering Amplitudes," arXiv:2204.05194.

PhD Dissertation

22. **M. Khalil**, "Analytical modeling of compact binaries in general relativity and modified gravity theories," PhD dissertation, University of Maryland, College Park, 2022. DOI:10.13016/nj5r-bfj5

Papers on quantum gravity phenomenology (undergraduate research)

23. A. F. Ali, **M. M. Khalil**, and E. C. Vagenas, "Minimal Length in quantum gravity and gravitational measurements," EPL 112 (2015) 20005, arXiv:1510.06365.

24. A. F. Ali, and **M. M. Khalil**, "Black Hole with Quantum Potential," Nucl.Phys. B909 (2016), arXiv:1509.02495.

25. A. F. Ali, M. Faizal, and **M. M. Khalil**, "Short Distance Physics of the Inflationary de Sitter Universe," JCAP 09(2015)025, arXiv:1505.06963.

26. M. Faizal, **M. M. Khalil**, and S. Das, "Time Crystals from Minimum Time Uncertainty," Eur.Phys.J. C76(2016)1, arXiv:1501.03111.

27. M. Faizal, **M. M. Khalil**, "GUP-Corrected Thermodynamics for all Black Objects and the Existence of Remnants," Int.J.Mod.Phys. A30 (2015) 1550144, arXiv:1411.4042.

28. A. F. Ali, M. Faizal, and **M. M. Khalil**, "Remnant for all black objects due to gravity's rainbow," Nucl.Phys. B894 (2015), arXiv:1410.5706.

29. A. F. Ali, M. Faizal, and **M. M. Khalil**, "Absence of black holes at LHC due to gravity's rainbow," Phys.Lett. B743 (2015) 295, arXiv:1410.4765.

30. A. F. Ali, M. Faizal, and **M. M. Khalil**, "Remnants of Black Rings from Gravity's Rainbow." JHEP 12(2014)159, arXiv:1409.5745.

31. A. F. Ali, and **M. M. Khalil**, "A proposal for testing gravity's rainbow," EPL 110 (2015) 20009, arXiv:1408.5843.

32. **M. M. Khalil**, "Some Implications of Two Forms of the Generalized Uncertainty Principle," AHEP 619498 (2014), arXiv:1309.6682.

Book Chapter

33. **M. M. Khalil**, "Improving Science for a Better Future," *How Should Humanity Steer the Future?* Eds. Anthony Aguirre et al. Springer International Publishing, 2015. 113-126

CONFERENCES AND SEMINARS

Invited Conference Talks

1. *Modeling gravitational waves from compact binaries*, Annual Meeting of the Max Planck Society, Berlin, Germany, June 2024.
2. *Analytical modeling of dynamical scalarization in an effective-action approach*, Connecting the dots workshop, Max Planck Institute for Gravitational Physics, Potsdam, Germany, June 2023.

Invited Seminars

3. *Analytical modeling of spinning compact binaries*, Universidad Nacional Autónoma de México (online), November 2022
4. *Synergies between post-Newtonian and self-force approaches to the dynamics of spinning binaries*, University of Southampton (online), June 2022.
5. *Energetics and scattering at fourth post-Minkowskian order*, DESY, Zeuthen, Germany, May 2022.
6. *Dynamics of spinning compact binaries: synergies between post-Newtonian and self-force approaches*, Strong Gravity Seminar, Perimeter Institute (online, https://pirsa.org/21110046), November 2021.
7. *Hairy binary black holes in Einstein-Maxwell-dilaton theory*, Gravity Theory Seminar, University of Maryland, MD, USA, November 2018.

Contributed Conference Talks

8. *Accurate modeling of compact binaries in eccentric orbits*, 34th Midwest Relativity Meeting, University of Michigan in Ann Arbor, USA, November 2024.
9. *Energetics and scattering of compact objects at fourth post-Minkowskian order*, 23rd International Conference on General Relativity and Gravitation (online), July 2022.
10. *Gravitational spin-orbit dynamics at the fifth-and-a-half post-Newtonian order*, Midwest Relativity Meeting, University of Illinois at Urbana-Champaign (online), November 2021.
11. *New spin-orbit and spin-squared post-Newtonian results from first-order self-force*, 24th Capra Meeting on Radiation Reaction in General Relativity, Perimeter Institute (online, https://pirsa.org/21060025), June 2021.
12. *Multipolar effective-one-body waveforms for eccentric, spin-aligned binaries*, APS Meeting (online), April 2021.
13. *Theory-agnostic framework for dynamical scalarization of compact binaries*, APS Meeting (online), April 2020.
14. *Theory-agnostic modeling of dynamical scalarization in binary systems*, 22nd International Conference on General Relativity and Gravitation, and 13th Amaldi Conference on Gravitational Waves, Valencia, Spain, July 2019.
15. *Hairy binary black holes in Einstein-Maxwell-dilaton theory*, workshop on parametrized tests of general relativity, Johns Hopkins University, MD, USA, November 2018.

Other Attended Conferences and Workshops

16. 5th Testing Gravity conference, Simon Fraser University, Vancouver, Canada, Feb 2025.
17. 26th Capra Meeting on Radiation Reaction in General Relativity, Niels Bohr Institute, Copenhagen, July 2023.
18. 1st Trieste meeting on the physics of gravitational waves, Trieste, Italy, June 2023.
19. Gravity Workshop, Kolleg Mathematik Physik Berlin, Berlin, Germany, November 2019.
20. LISA Waveform Working Group Meeting, AEI Potsdam, Germany, May 2019.
21. Gravitational Wave Physics and Astronomy Workshop, College Park, Maryland, December 2018.
22. Gravitational Wave Physics and Astronomy Workshop, Annapolis, Maryland, November 2016.

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