Marcin Abram

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PROFESSIONAL EXPERIENCE

University of Southern California, Los Angeles, CA, USA

Postdoctoral Scholar – Teaching Fellow (Department of Physics and Astronomy) *July 2020 – Present*

⋄ Research on machine learning applications for science. Areas of focus: physics-informed machine learning, knowledge distillation, model generalization and zero-shot learning, uncertainty estimation in deep learning, interpretable machine learning.

⋄ Group leader for the project: *Emulating Quantum Dynamics via Neural Networks.*

⋄ Teaching physics and computer science classes on both undergraduate and graduate levels. Duties include: offering lectures, meetings with students (student/office hours), designing homework assignments, organizing exams, managing work of graders and teaching assistants.

In addition to my regular duties, I led a 12-week summer internship project on neural network interpretability for two master's degree students (May-August 2021), I served in a Physics Ph.D. qualifying exam committee (December 2020), and I supervised two senior projects for the physics/computer science majors (Spring and Fall 2021).

Visiting Researcher (Information Sciences Institute, ISI) *July 2020 – Present*

At ISI I am a research member of the *Machine Intelligence and Data Science* (MINDS) group. I am a team member in two research groups, one led by Prof. Greg Ver Steeg (Project 1), and the second led by Prof. José-Luis Ambite (Project 2).

⋄ *Project 1:* Research on machine learning techniques for scientific concept discovery. Focus on applications for material science research. A lead researcher in an inter-university collaboration (USC–Sandia National Laboratories) in a project: *Learning Control Parameters for the Synthesis of Novel Materials.*

⋄ *Project 2:* Research on protocols for federated learning. Working on a novel elastic-weight consolidation schema for training models in the regime of non-IID data distributions.

Fetch.ai, Cambridge, UK

Lead Research Scientist *January 2019 – May 2020*

⋄ Research on novel consensus protocols and machine learning applications in decentralized systems. Results of work presented at several international conferences and workshops (*Genesis 2019* in Toronto, *Tekonomics 2019* in Paris, *Astro Hack Week 2019* in Cambridge).

In a addition to my technical role, I led a group of 4 researchers, I conducted about 20 technical interviews, and I represented the company in bi-weekly contacts with our investor, Outlier Ventures.

Machine Learning Scientist *July 2018 – January 2019*

⋄ Research on consensus protocols in decentralized systems. Focus on scalability and protocol security.

⋄ Work on incentive mechanisms in multi-agent systems. Assessing various adversarial attack scenarios.

TypeScore, London, UK

Machine Learning Engineer *August 2016 – June 2018*

⋄ One of the two main developers at TypeScore, a financial risk assessment startup in London.

I was responsible for collection of raw data, testing different machine learning algorithms, software development and deployment. In addition to the technical aspects of my role, I was responsible for monitoring the newest developments in machine learning and proposing new research directions for the company.

Jagiellonian University, Kraków, Poland

Research Assistant *October 2011 – August 2016*

⋄ Member in two EU-funded projects: *Correlations and coherence in quantum materials and structures (CCQM) – unique properties on macro and nano scale* (2011-2015) and *Fundamental Properties of Strongly Correlated Systems: Unconventional Superconductivity, Quantum Critical Behavior, and Complex Electronic Structure* (2015-2016).

During that time, I published 7 peer-reviewed articles in leading international journals and I presented results of my work at several international conferences. In addition to my research, I led practical sessions for: *Physics with Biophysics Elements*, *Statistical Physics* and *Physics Laboratory*. For several years I was the main organizer of the *Physics Classes for Gifted High-School Students*.

EDUCATION

Jagiellonian University, Kraków, Poland

Ph.D. in Physics *2011 – 2016*

Research on approximation methods for modeling strongly-correlated quantum systems. Areas of focus: high-fidelity scientific simulations and high-performance computing techniques.

⋄ Dissertation title: *Nonstandard Representation of Correlated-Fermion Models and its Application to Description of Magnetism and Unconventional Superconductivity.*
⋄ Supervisors: Prof. J. Spałek and Dr. M. Zegrodnik.
⋄ Degree with Distinction.

Interdisciplinary Studies: Society–Environment–Technology (3-year program) *2012 – 2015*

This competitive, application-only program for top Ph.D. students, consisted of three years of coursework and independent research using social science, natural science and humanities research methods in English. Final mark: 4.4 (maximum 5.0)

B.Sc. in Computer Science (3-year program) *2009 – 2012*

Obtained independently from the Physics program as a second degree. Outcomes of my final project contributed to an on-going research in my department, and resulted in a publication in a prestigious *Physical Review E* journal in 2014 (see the list of publications below). Final mark: 4.5 (maximum 5.0)

M.Sc. in Theoretical Physics (5-year program) *2006 – 2011*

Interdisciplinary *Studies in Mathematics and Natural Sciences* with a *Theoretical Physics* as a major.

I finished a special, interdisciplinary 5-year Master's program that allows student to compose an individual programs of study from the offer of the mathematics and computer science department and all the natural science departments (physics, chemistry, biotechnology, geography, etc.).
⋄ Dissertation title: *Selected methods of correlated particles applied to atomic systems in optical lattices.*
⋄ Supervisor: Prof. J. Spałek.
⋄ Final mark: 5.0 (maximum 5.0)

PUBLICATIONS

1. <u>M. Abram</u>, J. Kaczmarczyk, J. Jędrak, and J. Spałek, *d-wave superconductivity and its coexistence with antiferromagnetism in t–J–U model: Statistically consistent Gutzwiller approach*, Phys. Rev. B **88**, 094502 (2013).

2. <u>M. Abram</u>, *t–t'–J–U Model in mean-field approximation: Coexistence of superconductivity and antiferromagnetism*, Acta. Phys. Pol. A **126**, 25 (2014).

3. A. Kapanowski and <u>M. Abram</u>, *Model of hard spheroplatelets near a hard wall*, Phys. Rev. E **89**, 062503 (2014).

4. M. M. Wysokiński, <u>M. Abram</u>, and J. Spałek, *Ferromagnetism in UGe_2: A microscopic model*, Phys. Rev. B **90**, 081114(R) (2014).

5. M. M. Wysokiński, <u>M. Abram</u>, and J. Spałek, *Criticalities in the itinerant ferromagnet UGe_2*, Phys. Rev. B **91**, 081108(R) (2015).

6. <u>M. Abram</u>, M. M. Wysokiński, and J. Spałek, *Tricritical wings in UGe_2: A microscopic interpretation*, J. Magn. Magn. Mater. **400**, 27–30 (2016).

7. <u>M. Abram</u>, M. Zegrodnik, and J. Spałek, *Antiferromagnetism, charge density wave, and d-wave superconductivity in the extended t–J–U model*, J. Phys.: Condens. Matter **29**, 365602 (2017).

8. <u>M. Abram</u>, D. Galindo, D. Honerkamp, J. Ward, and J.-M. Wong, *Democratising blockchain: A minimal agency consensus model* (a working paper presented at Tokenomics 2019, Paris), arXiv:2006.05390 (2020).

9. Y. Ye, D. Qiu, J. Ward, and <u>M. Abram</u>, *Model-free real-time autonomous energy management for a residential multi-carrier energy system: A deep reinforcement learning qpproach*, Proceedings of the Twenty-Ninth International Joint Conference on Artificial Intelligence (IJCAI) (2020).

10. Y. Yao, C. Cao, D. Khanna, M. Agarwal, S. Haas, and <u>M. Abram</u>, *Emulating quantum dynamics with neural networks via knowledge distillation* (in preparation).

11. <u>M. Abram</u>, K. Burghardt, R. Dingreville, J. A. Stewart, G. Ver Steeg, and A. Galstyan, *Learning concentration modulation in thin-films via neural modeling of transitional states* (in preparation).

12. D. Stripelis, <u>M. Abram</u>, and J.-L. Ambite, *Performance Weighting for Robust Federated Learning Against Corrupted Sources* (in preparation).

TEACHING EXPERIENCE

University of Southern California, Los Angeles, USC

DSCI 552: Machine Learning for Data Science (4 units) *Spring 2021*
◇ *Classes:* 60 hours per semester, 56 students.
◇ *Student's Evaluation:* Course Design 3.89, Instructional Practices 3.83, Inclusion Practices 3.84, Assessment Practices 3.75, Course Impact 3.81 (the max score in each category is 4).

PHYS 495: Senior Project (2 units) *Spring 2021 and Fall 2021*
◇ A senior project mentor. Project title: *Chaotic behavior emerging in simple mechanical systems.*
◇ A senior project mentor. Project title: *Finding optimal paths for spacecraft probes.*

PHYS 304: Mechanics (4 units) *Fall 2020 and Fall 2021*
◇ *Classes:* 60 hours per semester, 38 and 36 students respectively.
◇ *Student's Evaluation in Fall 2020:* Course Design 3.69, Instructional Practices 3.69, Inclusion Practices 3.60, Assessment Practices 3.67, Course Impact 3.74 (the max score in each category is 4).

Jagiellonian University, Kraków, Poland

Physics Laboratory *Spring 2015*
Leading laboratory sessions for a non-Physics major.
◇ *Classes:* 15 hours per semester, 4-6 students in a group.

Statistical Physics *Spring 2013 and Spring 2014*
Leading practical sessions for senior students of physics specialization.
◇ *Classes:* 30 hours per semester, 15 students in one class.
◇ *Student's Evaluation:* 4.88/5.0 (2013) and at 4.97/5.0 (2014).

Physics Classes for Gifted High-School Students *2012 – 2014*
Leading a program for gifted high-school students with the goal to prepare them for the Physics Olympiad and the Astronomy Olympiad.
◇ *Classes:* 90 hours of theory and 90 hours of laboratory sessions per year, up to 30 students in one class.
◇ *Student's achievement:* A silver medal on 7th International Olympiad on Astronomy and Astrophysics (IAOO 2013) and several finalist titles in the Polish National Physics Olympiads in years 2012-2014.

Physics with Biophysics Elements *Fall 2013*
Leading practical sessions for the environmental science majors.
◇ *Classes:* 15 hours per semester, 2 classes, 20 students in one class.

Additional Teaching Experience

Math tutor, Kraków, Poland *2012 – 2014*
Math tutor in the Center for the Blind and Visually Impaired.

RESEARCH AWARDS AND GRANTS

Using Machine Learning to Understand Material Science ($20,000) *Jan 1, 2021 – April 30, 2021*
PI: Dr. Keith Burghardt.

A sponsored research award by the Department of Energy, via Sandia National Laboratories.

Emulating Quantum Dynamics via Neural Networks ($150,000 per year, a PI role) *(pending)*
PI: Dr. Marcin Abram.

An application for the *Characteristic Science Applications* program for the Leadership-Class Computing Facility (LCCF). Funded through the NSF's Major Research and Equipment Facility Construction process.

We were selected to the second round as one of the 25 teams. We passed the initial technical evaluation conducted by a member of the Texas Advanced Computing Center (TACC). The funding will be awarded to 10-15 teams and can last up to 30 months.

A Digital Twin for Quantum Dynamics Emulation ($150,000) *(pending)*
PI: Prof. Stephan Haas.

A funding opportunity via the Sony Research Award Program as a part of the effort to develop *physically-motivated ML descriptors of molecular structures that are universally applicable across systems of different scales (from small molecules to materials).*

Learning the Controlled Synthesis of Functional Thin Films During Physical Vapor Deposition ($150,000) *(pending)*
PI: Prof. Greg Ver Steeg.

A funding opportunity via the Sony Research Award Program as a part of the effort to develop *AI-based methods for adroit prediction of material properties.*

FELLOWSHIPS, SCHOLARSHIPS AND MERIT AWARDS (SELECTION)

The *Outstanding Reviewer* title by the IOP Journal of Physics: Condensed Matter *2020*

A fellowship in a Research Grant *2015 – 2016*
Fundamental Properties of Strongly Correlated Systems: Unconventional Superconductivity, Quantum Critical Behavior, and Complex Electronic Structure, funded by the National Science Centre (NSC).

The Exceptional Doctoral Performance Award *2013 – 2015*
Awarded to the top 15% of PhD students departmentally at Jagiellonian University in Kraków, Poland.

A fellowship in a Research Grant *2011 – 2015*
A Ph.D, Student Member in *Correlations and coherence in quantum materials and structures (CCQM) – unique properties on macro and nano scale*, funded by the Foundation for Polish Science (FNP).

Scholarship: Interdisciplinary Ph.D. studies in English Program *2012 – 2015*
Awarded to the top PhD students at Jagiellonian University in Kraków, Poland.

Scholarship: Study Abroad *January – June 2010*
Erasmus Scholarship in Niels Bohr Institute in Copenhagen, Denmark.

Academic Achievement Scholarship *2008 – 2009*
Awarded to the top students departmentally at Jagiellonian University in Kraków, Poland.

Scholarship of Silesia Region for talented students *2006*

Scholarship of The President of Gliwice for talented students *2016*

Finalist (top 60 in the country) in the LV Polish Physics Olympiad *April 2006*

Finalist (the 9th place in the country) in the XLIX Polish Astronomy Olympiad *March 2006*

CONFERENCES AND INVITED TALKS (SELECTION)

⋄ *Astro Hack Week 2019*, Cambridge, UK (invited talk) *August 2019*
⋄ *Consensus 2019*, New York, NY, USA (participation) *May 2019*
⋄ *Tokenomics 2019*, Paris, France (talk & peer-reviewed working paper) *May 2019*
⋄ *PyData Cambridge Meetup*, Cambridge, UK (invited talk) *May 2019*
⋄ *Genesis 2019 – Rebuild Conference*, Toronto, Canada (invited talk) *April 2019*
⋄ *Machine learning in Physics, Physics in Machine Learning*,
Jagiellonian University, Kraków, Poland (seminar) *January 2019*
⋄ *CESC 2018: Cryptoeconomics and Security Conference*, San Francisco, USA (participation) *September 2018*
⋄ *PyData London 2018*, London, UK (volunteering) *April 2018*
⋄ *20th International Conference on Magnetism*, Barcelona, Spain (poster) *March 2015*
⋄ *From Spins to Cooper Pairs: New Physics of Spins*, Zakopane, Poland (talk) *September 2014*

ADDITIONAL TRAINING (SELECTION)

Certificates
⋄ *Certificate in Advanced English (CAE)*, No.: *163PL0015030*, *March 2016 – No Expiration Date*
University of Cambridge English Language Assessment

Other (non-credit)
⋄ *STAQ Quantum Ideas Summer School*, Duke University, Durham, CT, USA *June 17-21, 2019*
⋄ *Geometry of Data* (AMAH 797 / MATH 797), Yale University, New Haven, CT, USA *January – April 2020*
⋄ *Theory of Deep Learning* (S&DS 670), Yale University, New Haven, CT, USA *January – April 2020*
⋄ *Topics in Cryptography & Security* (CPSC 767), Yale University, New Haven, CT, USA *January – April 2020*
⋄ *Topics in Foundations of ML* (CPSC 464/564), Yale University, New Haven, CT, USA *January – April 2020*
⋄ *Economics and Computation* (CPSC 455/555), Yale University, New Haven, CT, USA *August – December 2019*
⋄ *The Analytic Edge*, MITx (an online learning initiative of MIT) *June – August 2015*

SERVICE

Reviews for: *New Journal of Physics* (3), *Journal of Physics: Material* (3), *Journal of Physics: Condensed Matter* (6), *Physica Scripta* (1), *Machine Learning: Science and Technology* (3), *IOP SciNotes* (2) and, *Superconductor Science and Technology* (2).

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