

# Ziming Liu

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## EXPERIENCE

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### Massachusetts Institute of Technology, USA

Feb 2021 – Present

PhD student in physics, Research Assistant, IAIFI junior investigator

Cambridge, MA, USA

- Research in the intersection of artificial intelligence (AI) and physics (science), advised by Prof. Max Tegmark
- Physics of AI: Studied deep neural networks through the lens of physics. These works are published in top machine learning conferences (NeurIPS 2 orals, 1 poster; ICLR 1 spotlight) and covered by the Quanta magazine.
- Physics for AI: Designed Poisson Flow Generative Models and variants. These works are covered by MIT News and the Quanta Magazine, and are published in top machine learning conferences (NeurIPS 2, ICML 1).
- AI for physics: Built AI scientists that automate the discovery of physical laws. These works are covered by the New Scientist Magazine, and published in top physics journals: Physical Review Letters twice (both editors' suggestion), Physical Review E twice, and Entropy.
- Neuroscience for AI: Proposed Brain-inspired modular training for neural network interpretability, covered by Cognitive Revolution Podcast.
- Math for AI: Proposed **Kolmogorov-Arnold Network**, which has attracted enormous attention in the AI community since the preprint was released on April 30th, 2024.

### Microsoft Research Asia, China

Sep 2020 – Feb 2021

Research Assistant in machine learning theory group

Beijing, China

- Augmenting Lagrangian neural networks for new physics detection, published in Physical Review E

### Peking University, Beijing, China

Sep 2016 – June 2020

Undergraduate student in physics, Research Assistant

Beijing, China

- Applying machine learning tools to analyze data from high-energy experiments, published in European physical Journal C and Physical Review C.

## MEDIA COVERAGE

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- Quanta Magazine, "[The Physical Process That Powers a New Type of Generative AI](#)"
- MIT News, "[From physics to generative AI: An AI model for advanced pattern generation](#)"
- Quanta Magazine, "[How Do Machines 'Grok' Data?](#)"
- New Scientist, "[AI solves complex physics problems by looking for signs of symmetry](#)"
- Nature Review Physics, "[How machines could teach physicists new scientific concepts](#)".
- Cognitive evolution Podcast, "[Seeing is Believing with MIT's Ziming Liu](#)"
- MarketTechPost, "[Kolmogorov-Arnold Networks \(KANs\): A New Era of Interpretability and Accuracy in Deep Learning](#)"
- Levelup Coding, "[Kolmogorov-Arnold Networks \(KANs\) Might Change AI As We Know It, Forever](#)"

## SERVICE

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### Reviewing

- Journals: Physical Review Research, IEEE Transactions on Neural Networks and Learning Systems

- Conferences: NeurIPS, ICLR, ICML
- Workshops: ML4Physics workshop, UniReps workshop, AI4Science workshop

### Community Building

- Serve as an organizer for the AI4Science workshop at NeurIPS 2021, ICML 2022 and NeurIPS 2023.

### REPRESENTATIVE PAPERS

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- **[KAN: Kolmogorov-Arnold Networks](#)**. [arXiv:2404.19756](#)  
[Ziming Liu](#), Yixuan Wang, Sachin Vaidya, Fabian Ruchle, James Halverson, Marin Soljačić, Thomas Y. Hou, Max Tegmark
- **The Clock and the Pizza: Two Stories in Mechanistic Explanation of Neural Networks, NeurIPS (Oral), 2023**  
Ziqian Zhong\*, [Ziming Liu\\*](#), Max Tegmark, Jacob Andreas
- **Seeing is Believing: Brain-Inspired Modular Training for Mechanistic Interpretability, Entropy, 2023**  
[Ziming Liu](#), Eric Gan, Max Tegmark
- **Growing Brains: Co-emergence of Anatomical and Functional Modularity in Recurrent Neural Networks, NeurIPS 2023 UniReps workshop**  
[Ziming Liu](#), Mikail Khona, Ila R. Fiete, Max Tegmark
- **Scientific discovery in the age of artificial intelligence, Nature, 2023**  
Hanchen Wang, Tianfan Fu, Yuanqi Du, Wenhao Gao, Kexin Huang, [Ziming Liu](#), et al.
- **Poisson flow generative models, NeurIPS, 2022**  
Yilun Xu\*, [Ziming Liu\\*](#), Max Tegmark, Tommi Jaakkola
- **Towards understanding grokking: An effective theory of representation learning, NeurIPS (Oral), 2022**  
[Ziming Liu](#), Ouail Kitouni, Niklas S Nolte, Eric Michaud, Max Tegmark, Mike Williams
- **Machine learning hidden symmetries, Physical Review Letter (Editor's suggestion), 2022**  
[Ziming Liu](#), Max Tegmark
- **Machine learning conservation laws from trajectories, Physical Review Letter (Editor's Suggestion), 2021**  
[Ziming Liu](#), Max Tegmark

### FULL PUBLICATION LIST

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- **[KAN: Kolmogorov-Arnold Networks](#)**. [arXiv:2404.19756](#)  
[Ziming Liu](#), Yixuan Wang, Sachin Vaidya, Fabian Ruchle, James Halverson, Marin Soljačić, Thomas Y. Hou, Max Tegmark
- **A Resource Model For Neural Scaling Law, ICLR 2024 BGPT workshop**  
Jinyeop Song\*, [Ziming Liu\\*](#), Max Tegmark, Jeff Gore
- **Do Diffusion Models Learn Semantically Meaningful and Efficient Representations?, ICLR 2024 BGPT workshop**  
Catherine Liang, [Ziming Liu](#), Ila R. Fiete
- **GenEFT: Understanding Statics and Dynamics of Model Generalization via Effective Theory, ICLR 2024 BGPT workshop**  
David Baek, [Ziming Liu](#), Max Tegmark
- **Growing Brains: Co-emergence of Anatomical and Functional Modularity in Recurrent Neural Networks, NeurIPS 2023 UniReps workshop**  
[Ziming Liu](#), Mikail Khona, Ila R. Fiete, Max Tegmark
- **Grokking as Compression: A Nonlinear Complexity Perspective, NeurIPS 2023 UniReps workshop**  
[Ziming Liu](#), Ziqian Zhong, Max Tegmark

- **A Neural Scaling Law from Lottery Ticket Ensembling**, arXiv: 2310.02258, 2023  
Ziming Liu, Max Tegmark
- **Scientific discovery in the age of artificial intelligence**, Nature, 2023  
Hanchen Wang, Tianfan Fu, Yuanqi Du, Wenhao Gao, Kexin Huang, [Ziming Liu](#), ...
- **The Clock and the Pizza: Two Stories in Mechanistic Explanation of Neural Networks**, NeurIPS (Oral), 2023  
Ziqian Zhong\*, [Ziming Liu\\*](#), Max Tegmark, Jacob Andreas
- **Restart Sampling for Improving Generative Processes**, NeurIPS, 2023  
Yilun Xu, Mingyang Deng, Xiang Cheng, Yonglong Tian, [Ziming Liu](#), Tommi Jaakkola
- **Discovering New Interpretable Conservation Laws as Sparse Invariants**, Physical Review E  
[Ziming Liu](#), Patrick Obin Sturm, Saketh Bharadwaj, Sam Silva, Max Tegmark
- **Seeing is Believing: Brain-Inspired Modular Training for Mechanistic Interpretability**, Entropy  
[Ziming Liu](#), Eric Gan, Max Tegmark
- **GenPhys: From Physical Processes to Generative Models**, arXiv: 2304.02637, 2023  
[Ziming Liu](#), Di Luo, Yilun Xu, Tommi Jaakkola, Max Tegmark
- **The quantization model of neural scaling**, NeurIPS, 2023  
Eric J Michaud, [Ziming Liu](#), Uzay Girit, Max Tegmark
- **Pfgm++: Unlocking the potential of physics-inspired generative models**, ICML, 2023  
Yilun Xu, [Ziming Liu](#), Yonglong Tian, Shangyuan Tong, Max Tegmark, Tommi Jaakkola
- **Precision machine learning**, Entropy, 2023  
Eric J Michaud, [Ziming Liu](#), Max Tegmark
- **Poisson flow generative models**, NeurIPS, 2022  
Yilun Xu\*, [Ziming Liu\\*](#), Max Tegmark, Tommi Jaakkola
- **Towards understanding grokking: An effective theory of representation learning**, NeurIPS (Oral), 2022  
[Ziming Liu](#), Ouail Kitouni, Niklas S Nolte, Eric Michaud, Max Tegmark, Mike Williams
- **Machine learning conservation laws from differential equations**, Physical Review E, 2022  
[Ziming Liu](#), Varun Madhavan, Max Tegmark
- **Omnigrok: Grokking beyond algorithmic data**, ICLR (Spotlight), 2022  
[Ziming Liu](#), Eric J Michaud, Max Tegmark
- **Second order ensemble Langevin method for sampling and inverse problems**, arXiv: 2208.04506, 2022  
[Ziming Liu](#), Andrew M Stuart, Yixuan Wang
- **Machine learning hidden symmetries**, Physical Review Letter (Editor's suggestion), 2022  
[Ziming Liu](#), Max Tegmark
- **Machine-learning nonconservative dynamics for new-physics detection**, Physical Review E, 2021  
[Ziming Liu](#), Bohan Wang, Qi Meng, Wei Chen, Max Tegmark, Tie-Yan Liu
- **Physics-augmented learning: A new paradigm beyond physics-informed learning**, NeurIPS 2021 AI4Science workshop, 2021  
[Ziming Liu](#), Yunyue Chen, Yuanqi Du, Max Tegmark
- **Schrödinger principal-component analysis: On the duality between principal-component analysis and the Schrödinger equation**, Physical Review E, 2021  
[Ziming Liu](#), Sitian Qian, Yixuan Wang, Yuxuan Yan, Tianyi Yang
- **Applications of deep learning to relativistic hydrodynamics**, Physical Review Research, 2021  
Hengfeng Huang, Bowen Xiao, [Ziming Liu](#), Zeming Wu, Yadong Mu, Huichao Song
- **Machine learning conservation laws from trajectories**, Physical Review Letter (Editor's Suggestion), 2021  
[Ziming Liu](#), Max Tegmark
- **Robustness of principal component analysis of harmonic flow in heavy ion collisions**, Physical Review C, 2020

Ziming Liu, Arabinda Behera, Huichao Song, Jiangyong Jia

- **Quantum-inspired hamiltonian monte carlo for bayesian sampling**, arXiv: 1912.01937, 2019

Ziming Liu, Zheng Zhang

- **Principal component analysis of collective flow in relativistic heavy-ion collisions**, *European Physical Journal C*, 2019

Ziming Liu, Wenbin Zhao, Huichao Song

## **SKILL**

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- **Technical Skills:** Python (PyTorch), Mathematica, C++
- **Languages:** Chinese (native), English (fluent)