Mateusz Kapusta

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Summary

I am a physicist and machine learning researcher involved in disciplinary research across physics/astronomy and computer science. I am mostly interested in advanced inference techniques and their potential application in the field of natural sciences.

Work Experience

Machine Learning Research Intern — ASML, Veldhoven, NL Oct 2025 – June 2026

- Developed advanced Bayesian models for diagnostics of ASML's EUV lithography systems.
- Integrated differentiable physical simulators with machine learning models to enhance state-of-the-art physical modeling through learned corrections.
- Investigated diverse inference techniques for fast and reliable model inference, ranging from traditional Bayesian methods to modern deep learning approaches.
- Research on efficient multi-GPU solutions for large-scale inference on HPC clusters.

Quantitative Developer Intern - UBS AG Jul 2025 - September 2025

- Working with the C++ high-performant Monte Carlo code used to value Lombard loans.
- Performance benchmarking, memory and speed optimizations.
- Reduced processing time 3 times and reduced required memory 2 times.

Research Assistant - University of Warsaw June 2022 - July 2025

Performing basic research in Astrophysical sciences (exoplanetary research, statistical methods in astronomy), written two first-pearson papers and one co-author paper. Research included:

- applied research in astronomy, utilizing Bayesian methods, performing statistical analysis [3, 2, 4],
- imaging techniques on astronomical detectors [3].

Projects

Neural Posterior Estimation for Spectral Energy Distribution fitting Github

Reaserching applications of Neural Posterior Estimation in Astronomy. Spectral Energy Distribution fitting is powerfull yet computationally expensive technique widelly used in Astronomy. I demonstrated that with the help of normalizing flows one can speed up the inference of parameters by several orders of magnitudes. To do so, I designed my own complex preprocessing model that was paried with Masked Autoregressive Flow. Model was then fined-tuned so it can operate on real-life astronomical data. **Model was accepted as poster at the ICML 2025 co-located workshop: Machine Learning for Astrophysics** [1].

Computational Fluid Dynamics on GPU-s Github

Astrophysical research heavilly rellies on the simulations. In the project, a Riemann solver was used to solve the equations of relativistic fluids, which are very common in astrophysical research. It is written in CUDA-enabled Julia code paralellized with MPI to utilize massive GPU clusters. It relies on manually written computational kernels that are optimized for A100 NVIDIA GPU-s (compute - memory bandwidth - communication). Project is being developed with the help of EuroHPC development access computing grant EHPC-DEV-2025D02-085 on the Leonardo BOOSTER, where I am a Co-PI.

Education

2020 - 2025 Masters's Degree at **University of Warsaw** (GPA: 4.90/5.00)
Master's in Astrophysics with minor in Computer Science at the University of Warsaw as part of Interdysciplinary Collage of Interdysciplinary studies.
Specialization: Machine Learning, High Performance Computing

References

[1] Kapusta, M. 2025, in ICML2025: Machine Learning for Astrophysics, Vancouver. https://ml4astro.github.io/icml2025/assets/camera_ready/17_IrisML_Neural_Posterior_Est.pdf

[2] Kapusta, M., & Mróz, P. 2023, Acta Astronomica, 73, 197, doi: 10.32023/0001-5237/73.3.1

[3] Kapusta, M., Mroz, P., Ryu, Y.-H., et al. 2025, arXiv e-prints, arXiv:2507.01109, doi: 10.48550/arXiv.2507.01109

[4] Mróz, P., Udalski, A., Szymański, M. K., et al. 2024, ApJS, 273, 4, doi: 10.3847/1538-4365/ad452e

Awards & Scholarships

- Gold medal at 2021 University Physics Competition (as part of the team representing Faculty of Physics)
- Silver medal at the 1st Global e-Competition on Astronomy and Astrophysics (in place of 14th International Olympiad on Astronomy and Astrophysics), 2020
- Bronze medal at 13th International Olympiad on Astronomy and Astrophysics, 2019 Hungary
- Winner of 62th and 63th Polish Astronomy Olympiad for high school students
- Finalist of 67th and 69th (11th place) Polish Physics Olympiad for high school students
- Finalist of 70th Polish Mathematical Olympiad for high school students
- Minister of Education's scholarship in the year 2018/2019, 2019/2020
- Rector's scholarship in the academic year 2020/2021, 2021/2022, 2022/2023, 2023/2024, 2024/2025

OUTREACH

- Jury at the international math competition Naboj (March, 2025)
- Jury at the international math competition Naboj (March, 2024)
- Judge at the 16th International Olympiad on Astronomy and Astrophysics (August, 2023)
- Jury at the international math competition Naboj (March, 2023)

Skills

ML related libraries	PyTorch, Jax, Pyro, NumPyro, DVC, CUDA & MPI
Programing Languages	Python, C++, Julia, Go