EKATERINA IVSHINA

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EDUCATION

Harvard University May 28
Ph.D. Student in Applied Mathematics

Princeton University May 23
Bachelor of Arts in Mathematics with honors

PUBLICATIONS

Ivshina ES, Anikeeva G, Zhou L. *Detecting Toroidal Structure in Data: Implementation and Applications of Persistent Cup-Length.* ArXiv preprint to be released (mid-April 25).
Ivshina ES *Patterns in Knot Floer Homology.* ArXiv preprint (Jul 23).
Ivshina ES *On Slice Knots and Patterns in Knot Floer Homology.* Senior thesis. (Sept 22 - May 23).
Ivshina ES, Winn JN. *TESS Transit Timing of Hundreds of Hot Jupiters.* Astrophysical Journal Supplement Series (Feb 20 - Feb 22).

RESEARCH & TEACHING EXPERIENCE

`PhD Student, advised by Marinka Zitnik, Harvard University` Jan 25 - present
I develop knowledge graph-powered AI agents to enhance pharmacovigilance by accurately detecting adverse drug reactions, in collaboration with GSK.

`PhD Researcher, advised by Ling Zhou, Harvard University` Jun 24 - present
I implemented and provided theoretical guarantees for persistent cup-length algorithm, a cohomology-based method that extends persistent homology to capture interactions between topological features in data. This work decisively demonstrated toroidal structure in grid cell population activity—providing robust evidence for continuous attractor network (CAN) models underlying spatial navigation.

`PhD Researcher, advised by Eghbal Hosseini, MIT` Jul 24 - present
I investigated representational alignment by analyzing the internal representations of language and vision models using curvature as a geometric metric. Findings revealed consistent straightening in the language model with limited evidence in the vision model, highlighting the critical role of metric selection in alignment studies.

`Seminar Instructor, Yale Young Global Scholars` Jun 23 - Jul 23
I designed and taught four seminars in knot theory, topological data analysis, ethics & machine learning, and astrophysics to high school students from around the world. I led group discussions, mentored capstone projects, and facilitated bonding activities among the students.

`Senior Thesis Researcher, advised by Zoltan Szabo, Princeton Math Department` Sept 22 - May 23
I conducted computational experiments and established three new conjectures relating the hyperbolic volume of knot's complement, the knot determinant, and the total rank of knot Floer homology.

`ML Intern, Advanced Computation Group, Camera & Photos, Apple Inc.` Jun 22 - Aug 22
I was responsible for writing a research proposal of a new music source separation model. I have experience in designing system architectures and implementing ML models with sliced score matching and Langevin dynamics. I am also skilled in collaborating with team members on evaluating state-of-the-art source separation models on internal datasets. I presented my work to Apple's VP of Camera & Photos.

`Researcher, advised by Herman Verlinde & Zoltan Szabo, Princeton Physics Dept` Jan 22 - May 22
I implemented ML models for predicting solar wind min B_z value from in situ observations of coronal mass ejections. My contribution was creating a new dataset by extracting statistical features from solar wind time-series, training the models and improving on the state-of-the-art performance. This work is a step towards forecasting intense geoeffective events on Earth.

`Researcher, advised by Ev Fedorenko. MIT Dept of Brain and Cognitive Sciences` Jul 21 - Feb 22
I designed a self-paced reading study to test the effects of repeated sentence presentation on language processing. I collected & processed the data, and performed a statistical correlation analysis of the survey results. This work has implications both for theories of language comprehension and for experimental methodology.

`Researcher, advised by Joshua Winn, Princeton Astrophysics Department` Feb 20 - Jan 22

I searched for evidence of orbital period changes in 382 planets. My contribution was developing a parallelized code to fit transit models to TESS light curves and scrape timing data from ArXiv, which helped us discover transit timing variations and detect a new planet, NGTS-11c. The project's website is transit-timing.github.io

LEADERSHIP

`Content Creator` June 21 - present

My blog's mission is to inspire and empower young individuals, particularly international students, immigrants, and underrepresented minorities in the world of higher education, with the dream of making research and education accessible to all. I currently have 90,000+ followers and 30+ million views across social media platforms.

`Co-founder & President, "02.24.2022" Student Organization, Princeton` Feb 22 - Feb 23

In response to the war in Ukraine, I lead a team of ten students to write a letter of solidarity with Ukraine signed by 550+ Princeton affiliates; co-organize a series of talks with prominent anti-war public figures; partner with the Music Department on four charitable concerts to raise funds for Ukrainian refugees. Our team wrote a weekly newsletter and have organized a 5-week "Momentum 4 Ukraine" educational program pairing 50 Ukrainian war refugee students with mentors from Princeton/Harvard/MIT.

ACCOMPLISHMENTS

- Invited to give a research talk at the Young Topologists Meeting (Stockholm, 2025).
- Invited to give a research talk at the Computational Geometry Week, the premier international forum for advances in computational geometry and its many applications (Japan, 2025).
- Analytic Connectionism Summer School participant (Flatiron Institute, 2024)
- NSF Graduate Research Fellowship (2023).
- Harvard Graduate School of Arts and Sciences Prize fellowship, which "recognizes a select group of prospective PhD students who show exceptional promise to expand the diversity of experience and thought on our campus" (2023).
- Inducted into Sigma Xi honor society by Princeton's Mathematics Department (2023).
- Women and Math program participant (Institute for Advanced Study, Princeton, 2022).
- Alberto Santos-Dumont Prize for Innovation (Princeton Office of the Dean of Undergraduate Students, 2022). The award recognized "02.24.2022" student organization as a "unique and creative initiative from the past academic year which have had wide-reaching impact and visibility."
- Manfred Pyka Memorial Prize in Physics (Princeton Department of Physics, 2021). The award is given to "outstanding physics undergraduates who have shown excellence in course work and promise in independent research."
- All-Russian National Astronomy Olympiad (ranked top 3 in state, top 50 nationally, 2018, 2019).
- D.E. Shaw Zenith Fellowship (2021).
- "PhysTech" All-Russian National Physics Olympiad bronze medalist (2019).
- 20+ national and state awards for achievements in playing the Domra, a Russian folk string instrument.

OUTREACH

- Keynote speaker, Girls in Engineering and Robotics Symposium, Andover Robotics Club (March 2025).
- Invited speaker, BB&N High School HacKnight (June 2024).
- Invited speaker, "Alternative pathways in Mathematics", ENYGMMa (Empowering New York Gender Minority Mathematicians), CUNY (May 2024).
- Invited speaker, Northeastern Graduate Women in Science and Engineering workshop (February 2024).