

# Aliaksandr (Alex) Melnichenka

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## RESEARCH INTERESTS

Magnetized turbulence and plasma diagnostics; radio polarimetry methods; self-interacting dark matter near SMBHs; collective modes and instabilities in electron fluids; reproducible scientific software.

## EDUCATION

### Berea College

B.S. in Physics & Computer Science (Double Major); Minor in Mathematics

**Expected Dec 2026**

Berea, KY

### Lyceum of Belarusian State University (STEM magnet high school)

Physics track; admission by national exam; selective national program

**2022–2024**

Minsk, Belarus

## RESEARCH EXPERIENCE

### Faraday Screen Method for Turbulence Recovery (w/ A. Lazarian & D. Pogosyan) UW-Madison *Undergraduate Researcher*

*2025 – present*

- Showed that inertial-range magnetic turbulence can be recovered from a single polarization map at one frequency; validated on synthetic Faraday screens and ATHENA MHD snapshots (sub- and super-Alfvénic).
- Released an observer-ready pipeline robust to interferometric filtering; practical for LOFAR/MeerKAT/VLA archives. [talk slides]

### Self-Interacting Dark Matter near SMBHs (w/ M. Vogelsberger)

*Undergraduate Researcher (mentor: Xuejian “Jacob” Shen)*

MIT Kavli Institute

*2025 – present*

- Computed velocity-dependent drift and diffusion from local Monte Carlo and Langevin formalisms; clarified limits of fluid analogies and when higher moments matter.
- Current focus: orbit-averaged evolution, stochastic loss-cone capture, and collapse/seed timescale scalings. [notes]

### Electron-Fluid Instabilities in Dirac Materials (w/ L. Levitov) MIT Condensed Matter Theory

*Undergraduate Researcher (co-first author)*

*2025 – present*

- Predicted a current-driven, Kapitza-type electron-hydrodynamic instability in graphene; identified threshold behavior and narrow-band emission as experimental signatures.
- Outlined a minimal device geometry and measurement checklist for near-term tests.

## PUBLICATIONS & PREPRINTS

- [1] **A. Melnichenka**, A. Lazarian, D. Pogosyan, et al. “Recovering 3D Magnetic Turbulence from a Single Polarization Map.” *in preparation*, target: ApJ (2026).
- [2] **A. Melnichenka**, X. Shen, V. Tran, M. Vogelsberger. “Drift-Diffusion Coefficients for Self-Interacting Dark Matter.” *in preparation* (2026).
- [3] P. Lioung\*, **A. Melnichenka\***, A. Bukhtayi, A. Bilous, L. Levitov. “Turing instability and current-driven self-sustained waves in Dirac fluids.” *submitted* (2025). (\*equal contribution)

## SELECTED TALKS

### American Physical Society DPP 2025, *Oral contributed*

“3D Magnetic Turbulence Recovery from Polarization Maps” (12 min)

Long Beach, CA

*Nov 2025*

### American Astronomical Society (AAS) 247

*Oral:* “Single-frequency Faraday-screen tomography: turbulence from one map”

Phoenix, AZ

*Jan 2026*

### The Magnetized Turbulent Universe (Honoring A. Lazarian)

*Invited talk:* polarization-angle statistics & crossover scaling

Playa del Carmen, MX

*Nov 2025*

Slides: PDF — Video: YouTube

## HONORS & AWARDS

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- Belarus National Physics Olympiad — **Gold** (2022), **Silver** (2024), **Bronze** (2023); Top-6 nationally (IPhO reserve training camp, 2022).
- Presidential Award for Gifted Youth (Belarus).
- Invited 30-minute talk, *The Magnetized Turbulent Universe: A Conference Honoring Alex Lazarian*, Mexico (Nov 2025).
- Oral presentation, APS Division of Plasma Physics (DPP), Long Beach, CA (Nov 2025).
- Oral presentation, American Astronomical Society 247th Meeting, Phoenix, AZ (Jan 2026).

## LEADERSHIP & OUTREACH

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### SavchenkoSolutions

Founder

2023 – present

*Open, community-maintained archive of worked physics problems*

- Built contributor workflow (review, QA, versioning) with bilingual content (RU/EN).
- My account (*astrosander*): **12,820** total contributions, **847** unique solutions, **362** translations — <https://savchenkosolutions.com/user/astrosander>.
- Created rubrics and style guide to standardize proof/derivation write-ups.

### BelPhO.org

Creator

*Belarusian Physics Olympiad portal (multi-decade archive, training resources, alumni tracker)* 2023 – present

- Consolidated past problems/solutions into a searchable archive; added topic tags and difficulty.
- Published preparation roadmaps and a lightweight submission/review flow for new material.

## SELECTED SOFTWARE & DATA ARTIFACTS

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- **AstroTurbulence**: polarization-angle directional correlations; crossover finder; figure regeneration.
- **SIDM\_Transport\_Theory\_vs\_MC**: local MC/Langevin derivation of SIDM drift/diffusion; tests and example notebooks.
- **electronic-kapitsa-waves**: FFT spectrum synthesis; azimuthal averaging; structure functions.
- GitHub: [github.com/astrosander](https://github.com/astrosander)

## CONFERENCES & VISITS

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- SPS Congress (PhysCon) — Denver, CO (discussions with S. Chu, E. Cornell, J. Bell Burnell).
- The Magnetized Turbulent Universe — Playa del Carmen, MX.
- APS DPP — Long Beach, CA.
- AAS 247 — Phoenix, AZ.

## TEACHING & MENTORING

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### Teaching Assistant, Physics & Astronomy

Berea College

*Courses served:* PHY 111 *Introduction to Astronomy* (non-majors), PHY 127 *General Physics I*, PHY 221-222 *Intro Physics I-II with Calculus* (majors), GSTR 332 *Scientific Origins* (gen ed).

*Teaching contributions:* weekly office hours and targeted review sessions; lab and demo support; grading of written work with transparent rubrics; feedback on problem-solving writeups emphasizing clarity of assumptions and units.

## SELECTED COURSEWORK

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- Real Analysis, Differential Equations, Numerical Analysis, Topology, Combinatorics, Classical Mechanics, Quantum Physics, Thermal Physics.

## SKILLS

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**Programming:** Python (NumPy, SciPy, Astropy, JAX), C/C++, Bash; Git; L<sup>A</sup>T<sub>E</sub>X.

**Methods:** MHD turbulence statistics; structure/angle correlations; Monte Carlo/Langevin; numerical ODE/PDE; spectral methods.

**Reproducibility:** Commit-pinned figures; environment specs; minimal run scripts.

**Languages:** English (fluent); Belarusian (native); Russian (native).

## REFERENCES

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Available upon request (have worked with: Alex Lazarian, Mark Vogelsberger, Leonid Levitov; collaborators include Dmitri Pogosyan).