

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	Expected Dec 2026
B.S. in Physics & Computer Science (Double Major); Minor in Mathematics	Berea, KY
Lyceum of Belarusian State University (STEM magnet high school)	2022–2024
Physics track; admission by national exam; selective national program	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) MIT Kavli Institute
Undergraduate Researcher (mentor: Xuejian “Jacob” Shen) 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. Liang*, **A. Melnichenka***, A. Bukhtatyi, 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	Long Beach, CA
“3D Magnetic Turbulence Recovery from Polarization Maps” (12 min)	Nov 2025
American Astronomical Society (AAS) 247	Phoenix, AZ
Oral: “Single-frequency Faraday-screen tomography: turbulence from one map”	Jan 2026
The Magnetized Turbulent Universe (Honoring A. Lazarian)	Playa del Carmen, MX
Invited talk: polarization-angle statistics & crossover scaling	Nov 2025

Slides: PDF — Video: YouTube

HONORS & AWARDS

- 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

SavchenkoSolutions

Founder

Open, community-maintained archive of worked physics problems

2023 – present

- 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

- **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

CONFERENCES & VISITS

- 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

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

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

SKILLS

Programming: Python (NumPy, SciPy, Astropy, JAX), C/C++, Bash; Git; \LaTeX .

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

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