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. Liong*, **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 / Virtual
"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).