Mariia Efremova

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Objective

4th-year physics student developing a pipeline for optical counterpart searches of gravitational-wave events (currently applied to GW190425) at IKI RAS, seeking to broaden experience in neutrino physics.

Education

- **B.Sc. in Physics** *Ongoing: Sep 2023 - Jun 2027*
  National Research University Higher School of Economics [🌐] Moscow, Russia
  - Major: Space Physics
  - Minor: Applied Programming
  - GPA: 7.75/10.00 cumulative; 9.00/10.00 in 3rd year (HSE 10-pt scale: 10=Excellent, 9 & 8=Very Good, 7=Good)

Research Experience

- **B.Sc. Thesis: Search for the Optical Counterpart of GW190425 in ZTF Data, [Code]** *Sep 2025 - Ongoing*
  Research Supervisor: Alexei Pozanenko, IKI RAS [🌐] Moscow, Russia
  - Compiled a catalog of ∼27,000 potential host galaxies within the region of the GW190425 localization area motivated by the radio source reported by Rodin et al. (2026), and retrieved ZTF difference-image cutouts within 2 days of the trigger
  - Built a 4-stage vetting pipeline: (1) SNR-based photometric filtering (SNR $\geq$ 3); (2) triplet extraction and real/bogus classification via BRAAI (Duev et al. 2019); (3) temporal vetting to exclude candidates with pre-trigger detections; (4) FWHM consistency checks against ZTF image metadata
  - Pipeline has narrowed the ∼27,000-galaxy sample to 9 surviving candidates so far, with vetting ongoing
- **Summer Internship** *Aug 2024*
  Research Supervisor: Alexander Meshcheryakov [🌐] Space Research Institute
  - Classified HMXBs into supergiant/Be systems using a Decision Tree (Scikit-Learn), achieving 87% accuracy; produced a Corbet diagram

Research Training

- **Neutrino Physics & Astroparticle Physics Program [🌐]** *Sep 2026 – Ongoing*
  Lomonosov Moscow State University Moscow, Russia
  - Two-year advanced program with scholarship; theory and experimental tracks covering neutrino physics, particle astrophysics, general relativity theory, and methods of high-energy physics
- **SJTU Physics International Summer School 2026 "The Largest and the Smallest" [🌐]** *5-18 Jul 2026*
  Zhiyuan College & Tsung-Dao Lee Institute, Shanghai Jiao Tong University Shanghai, China
  - Awarded merit-based travel grant
  - Courses: Astrophysics of Compact Objects, Transients & Exoplanets (Dong Lai); Mysteries of the Particle World (Xiangdong Ji); Superfluidity and Superconductivity (Nanlin Wang)
  - Seminars covering astroparticle physics (JUNO, TRIDENT), gravitational waves, dark matter detection, and etc.
  - Group project "Neutrino flavour measurements and the KM3-230213A event"
- **Personal Research Training** *Oct 2025 - Dec 2025*
  Taught by Alina Volnova Space Research Institute
  - Covered observational fundamentals: stellar classification, evolution, supernovae, kilonovae, and compact remnants
  - Performed aperture and PSF photometry in IRAF, including primary reduction (bias, dark, flat) and catalog-based magnitude calibration using USNO-B and SDSS
- **GW Open Data Workshop [🌐]** *12-14 May 2025*
  Crash-course in gravitational-wave (GW) data analysis Online course
  - Analyzed LIGO/Virgo strain data using gwpy and gwosc; worked through FFT-based signal processing problems

Conferences

[1] **Efremova M. A.**, Pozanenko A. S., Pankov N. S., Volnova A. A. (2026, April 22-24). "Search for the Optical Counterpart of GW190425 in ZTF Data," presented at XXIII Conference of Young Scientists on Space Research (KMU 2026), Space Research Institute (IKI RAS), Moscow, Russia

Slides [Eng] | Abstract [Rus]

[2] **Efremova M. A.**, Pozanenko A. S., Pankov N. S., Volnova A. A., Moskvitin A. S. (2026, October 20-23). "ZTF Optical Counterpart Search Method for GW190425," accepted for presentation at the XXVIII "Data Analytics and Management in Data Intensive Domains" (DAMDID) conference, Lobachevsky State University of Nizhny Novgorod, Russia

Publications

[1] **Efremova M. A.**, Pozanenko A. S., Pankov N. S., Volnova A. A., Moskvitin A. S. **ZTF Optical Counterpart Search Method for GW190425**. Manuscript in preparation, to be submitted to *Lobachevskii Journal of Mathematics*.

Selected Projects

- **Practical Workshop in Optics on the Michelson interferometer** *May 2025*
  Tools: two mirrors, various lasers and LEDs, beam splitter, Python
  - Aligned the mirrors and measured the number of light-dark transitions while changing the optical path length
  - Determined the laser wavelength and spectrum, the coherence lengths of two LEDs, the refractive index of a plexiglass sample, and the coefficient of thermal expansion of an aluminum rod
  - Used Python to produce plots and perform approximations for the refractive index and rod length versus temperature
  - Gave a 30-minute presentation on the work, supplemented by information on the working principles of LIGO/VIRGO/KAGRA/GEO600
- **Mixture models/EM/Gaia cluster finding** *Apr 2025*
  Tools: Python (NumPy, SciPy, Matplotlib, Astropy), MLE and EM algorithms
  - Implemented MLE and Expectation–Maximization (EM) for 1D and 2D Gaussian mixtures (diagonal covariances), including convergence/regularization options
  - Applied EM to Gaia DR3 proper-motion data (astroquery): computed membership probabilities, cluster centroids, and relative population fractions for h and χ Persei
  - Visualized sky-position and proper-motion scatter plots colored by membership probability; annotated cluster centers and 1-sigma circles.
- **Computational Cosmology Project: Optimization methods, Hubble constant, Dark Matter** *Mar 2025*
  Tools: Python (numpy, scipy, matplotlib), optimization methods (Gauss-Newton, Levenberg-Marquardt)
  - Implemented Gauss–Newton and Levenberg–Marquardt optimization algorithms from scratch in Python
  - Applied nonlinear least-squares fitting to Type Ia supernova data to infer cosmological parameters H_0 and Ω_Λ
  - Performed numerical integration of cosmological distance relations using SciPy
  - Estimated parameter uncertainties via Jacobian-based error propagation and bootstrap resampling
  - Produced plots of distance modulus vs. redshift and optimization convergence

Skills

- **Programming & Data Analysis:** Python (NumPy, SciPy, Pandas, Scikit-learn, Astropy, Matplotlib); Jupyter
- **Astronomical Data:** ZTF, SDSS, DESI Legacy Surveys, GLADE+, NED-LVS, CatWISE, Gaia DR3; photometry and image processing; IRAF
- **Gravitational-Wave Data:** GWpy, GWOSC; signal processing and Fourier analysis
- **Statistical Methods:** MLE, Expectation–Maximization, regression, optimization, hypothesis testing, bootstrap resampling
- **Computing & Tools:** Linux, Git, LaTeX

Volunteering & Outreach

- **Educational Video Localization & Narration** *Oct 2026 - Ongoing*
  2swap (YouTube) [🌐]
  - Translated, adapted, and narrated 8 educational mathematics videos for a channel with 300k+ subscribers, handling full localization end-to-end, from script adaptation for a Russian-speaking audience to final voiceover.

Additional Information

Languages: Russian (Native), English (C2 – TOEFL iBT 6.0/6.0)