CURRICULUM VITAE

PERSONAL INFORMATION

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Center for Computational Astrophysics
Flatiron Institute
162 5th Avenue, New York, NY-10010

EDUCATION

2014–2017	PhD (with honors; ranked in the top 10% of dissertations internationally) Faculty of Mathematics and Natural Sciences, University of Turku, Finland
2012–2013	MSc, Degree Program in Physics Faculty of Science, University of Oulu, Finland

CURRENT POSITIONS

2024–	Associate Professor of Astrophysics University of Helsinki, Helsinki, Finland
2024–	Associate Research Scientist Columbia Astrophysics Laboratory, Columbia University, New York, USA

PREVIOUS POSITIONS

2019–2023	Postdoctoral Researcher (Joint Columbia/Flatiron Institute Research Fellow) Department of Physics, Columbia University, New York, USA Center for Computational Astrophysics, Flatiron Institute, New York, USA
2018–2019	Postdoctoral Researcher (Nordita Fellow) Nordic Institute for Theoretical Physics (Nordita), Stockholm, Sweden
2014–2017	PhD Student Faculty of Mathematics and Natural Sciences, University of Turku, Finland
2011–2013	Research Assistant Astronomy Department, University of Oulu, Finland

FELLOWSHIPS, AWARDS, AND RECOGNITION

2024	European Research Council (ERC) Starting Grant Awardee (2.2M EUR)
2023	Ref. [34] on cover of *PRL* (vol. 131, issue 23), *Editor's Suggestion*, and APS *Viewpoint*
2022	Ref. [30] on cover of *PRL* (vol. 128, issue 7) and APS *Viewpoint*
2021	Mikael Björnberg Prize for Young Theoretical Physicist; 10 000 EUR, Finland
2018	Väisälä Prize 2018: Outstanding Thesis in Astronomy, Finland
2018	Turku Finnish University Society Prize for Best Doctoral Dissertation, Finland
2018	PCS Best Doctoral Thesis of 2017 Prize, Finland
2016	Nordita Visiting PhD Fellow, Nordita, Sweden
2015–2017	University of Turku Chemical and Physical Sciences Program PhD Scholar Awardee
2014–2015	Väisälä Foundation PhD Scholar Awardee

RESEARCH INTERESTS

I am a computational astrophysicist studying the dynamics of astrophysical fluids and plasmas. I have a broad range of research interests, including:

High-energy astrophysics: accretion flows around black holes; thermonuclear X-ray bursts; magnetar flares, fast radio bursts; neutron star mergers; pulsar radio emission
Plasma physics: turbulence; collisionless shocks; magnetic reconnection
Fluid dynamics: storm dynamics in hot-exoplanet atmospheres
Nuclear physics: equation of state of ultra-dense matter inside neutron stars
Computer sciences: high-performance computing; machine learning; Monte Carlo methods
Mathematics: cellular automata models

MENTORING AND SUPERVISION

In total, advised/co-advised 1 PhD, 2 PreDocs, 3 MSc, and 2 BSc thesis.

2023	PreDoc advisor, Flatiron Pre-Doctoral Program (PhD student T. Ha), USA
2023	PreDoc advisor, Flatiron Pre-Doctoral Program (PhD student V. Loktev), USA
2017–2020	PhD co-advisor (T. Salmi), University of Turku, Finland
2019–2020	MSc advisor (J. Hope), Nordita/University of Bath, Sweden/UK
2014–	Co-advisor of 1 BSc and 2 MSc students (J. Kuuttila, T. Salmi), Finland

In addition, supervised various shorter student projects: E. van Woerkom (undergrad, 2023), R. Serrano (undergrad, 2023), M. Bussov (PhD, 2019), K. Smedt (PhD, 2019), T. Salmi (PhD, 2019).

TEACHING

2021	Topical Lecturer, Nordita Winter School: *Waves in Astrophysics*, Nordita, Sweden
2019	Visiting Lecturer, *Computational fluid dynamics*, Columbia University, USA
2015–2019	Lecturer, (5×) *High Performance Computing Summer School*, CSC, Finland
2018–2019	Lecturer, (2×) *Introduction to Julia*, CSC, Finland (course developed from scratch)
2015–2017	Lecturer, (3×) *Software tools in Physics*, University of Turku, Finland
2011–2016	Teaching Assistant in 10 courses (e.g., *Thermophysics*, *Electricity and Magnetism*)

TALKS, SEMINARS, AND COLLOQUIUMS

In total, 3 colloquiums, 30 invited talks/seminars, and 31 contributed talks. Most recent ones include:

2024	Arizona Theoretical Astrophysics Colloquium, University of Arizona, USA
2023	Invited talk and participation in Aspen Workshop on *"Astro-bio-geo fluids"*, USA
2023	CTC seminar, University of Maryland, USA
2023	Invited talk at Hamilton Institute Workshop on *Relativistic Plasmas*, Ireland
2022	Seminar at CITA (Canadian Institute for Theoretical Astrophysics), Canada
2022	Brandeis Physics Colloquium, Brandeis University, USA
2022	Invited talk at ECT Workshop on "*Neutron stars as multimessenger laboratories*", Italy
2022	Nordita Astrophysics Seminar, Nordita, Sweden
2021	Invited talk and participation in Aspen Workshop on *"Exploring Extreme Matter"*, USA
2020	Kumpula Physics Colloquium, University of Helsinki, Finland

FUNDING

2024	500k USD, NASA ATP, PI, Columbia University, USA "*Fast Radio Bursts and X-ray Flares from Magnetars* "
2024	2.2M EUR, ERC StG, PI, University of Helsinki, Finland "*Illuminating Neutron Stars with Radiative Plasma Physics*"
2023	80k USD, NASA Fermi grant, Co-PI (PI: A. Beloborodov), Columbia University, USA "*Gamma-ray precursors from neutron star mergers* "
2016	2k EUR, Magnus Ehrnrooth Foundation, travel grant, Finland
2015	82k EUR, UTUGS Physical and Chemical Sciences PhD scholarship, Finland
2015	23k EUR, Magnus Ehrnrooth Foundation PhD scholarship (declined), Finland
2014	23k EUR, Väisälä Foundation PhD scholarship, Finland

SUPERCOMPUTING TIME AWARDS

2022	1 MCPUhrs, Co-PI, CSC, *Bayesian parameter constraints for neutron stars*, Finland
2019–2023	$\sim$ 20 MCPUhrs/year, PI, internal Flatiron Institute supercomputers, USA
2018–2021	$\sim$ 20 MCPUhrs/year, Co-PI, SNIC, *Astrophysical turbulence and dynamo action*, Sweden
2018	$\sim$ 60 kCPUhrs, PI, SNIC/HPC2N, *Relativistic plasmas in silico*, Sweden

INSTITUTIONAL RESPONSIBILITIES

2021–	Main organizer, *Flatiron Observational Astrophysics Series*, USA
2021–	Member, Open Science Working Group (sub-group under Young Academy Finland)
2017	Student Member, Astronomy Faculty Search Committee, University of Turku, Finland
2017	Convenor, *Computational Coffee Break*, Tuorla Observatory, Finland
2016–	Member, eXTP Science Working Group, Dense Matter
2015–2018	Member, ESA XIPE Satellite Science Team (SWG2.2 Accreting Millisecond Pulsars)
2014–2019	Member, organizing committee, CSC HPC Summer Schools, CSC, Finland
2013–2019	Member, JuliaLang (open-source organization for Julia programming language)

CONFERENCE ORGANIZATION

2023	Lead organizer, workshop, *Black Hole Flares: Connecting Theory and Observations*, USA
2023	Lead organizer, conference, *Astrophysics of Fast Radio Bursts II*, USA
2022	Organizer, workshop, *Dynamics of Coherent Structures in Astro-Geo-Turbulence*, USA
2022	Co-organizer, symposium, *Flatiron Exoplanet Symposium*, USA
2022	Co-organizer, conference, *Physics of Exoplanet Atmospheres*, USA
2022	Co-organizer, PCTS workshop, *Weather and Climate on Neutron Stars*, USA
2021	Lead organizer, workshop, *Frontiers in Relativistic Turbulence*, USA
2017	Co-organizer, workshop, *Exascale thinking to Particle Energization Problems*, Sweden
2015	Local organizing committee, workshop, *Relativistic Astrophysics*, Finland

REVIEWING ACTIVITIES

Peer reviewer: Nature, Nature Astronomy, PRL, ApJL, ApJ, ApJS, MNRAS, A&A, PRD, PRE, EPJA, Universe

Grant reviewer: DOE (Fusion energy sciences), ORAU Ralph E Powe Junior Faculty Enhancement Award 2024

MEMBERSHIPS OF SCIENTIFIC SOCIETIES

2019–	Member, Young Academy Finland, under Academy of Science and Letters, Finland
2018–	IAU Junior Member
2012–	Member, Finnish Astronomical Society, Finland

PUBLIC OUTREACH

2020–	Responses/commentaries on newspapers and popular science magazines (Tähdet & Avaruus, 9/2020, 10/2020; Helsingin Sanomat 6/1/2021)
2020	Meet the Scientist, youtu.be/Ch38VpF341I Educational video about *Gravitation* for high-school students
2019	Public Science Talk, Academy Club for Young Scientists, youtu.be.com/W7ljVlSEAX4 *Astrophysical Turbulence: from stirring coffee to mixing galaxies*
2019–2020	Appearances on popular science articles on *Quark matter cores in neutron stars* Astrobites, Universe Today, Physics World, Wikipedia, Tähdet & Avaruus 4/2019
2018	Personal profile on Finnish astronomy Magazine Tähdet & Avaruus 2/2018
2017	Appearances on popular newspaper articles on *Groundbreaking neutron star measurement* Incl. Cosmos, Phys.org. Tähdet & Avaruus (25.11.2017)

MAJOR COLLABORATIONS

A. Beloborodov (radiative plasmas, Columbia, USA), **A. Brandenburg** (MHD turbulence, Nordita, Sweden), **J.Y-K Cho** (exoplanet fluid dynamics, Brandeis, USA), **A. Kurkela**, (neutron star quark matter, Stavanger, Norway), **C. Miller** (neutron star mass-radius measurements, Maryland, USA), **D. Mitra** (switchbacks in the solar wind, Nordita, Sweden), **A. Philippov** (pulsar magnetospheres, Maryland, USA), **L. Sironi** (turbulence, reconnection, and shocks, Columbia, USA), **A. Steiner** (neutron star EOS, Tennessee USA), **V. Suleimanov** (neutron star atmosphere models, Tubingen, Germany), **A. Vuorinen** (neutron star quark matter, Helsinki, Finland),

PUBLICATION RECORD

I have 36 original research articles published in international peer-reviewed journals, including *Nature Physics*, *Nature Communications*, *Physical Review Letters*, and *Physical Review X*. In addition, 1 invited book chapter, 3 conference proceedings, and 6 major open-source software repositories.

My total citation count is 1600 in ADS (1848 in Google Scholar); h-index is 19, i10-index 27, and i100-index 3.

Submitted:

[2] V. Loktev, A. Veledina, J. Poutanen, **J. Nättilä**, and V.F Suleimanov. artpol: Analytical ray-tracing method for spectro-polarimetric properties of accretion disks around Kerr black holes. *submitted*, [arXiv:2308.15159].

[1] **J. Nättilä**, J. Y-K. Cho, J.W. Skinner, E.R. Most, B. Ripperda. Neutron Star Atmosphere-Ocean Dynamics. *ApJ*, July 2023. [arXiv:2306.08186].

Published:

[36] Q. Changeat, J. Skinner, J. Cho, **J. Nättilä**, et al. Is the Atmosphere of the Ultra-hot Jupiter WASP-121 b Variable?. *ApJS*, Feb 2024. [arXiv:2201.01465].

[35] E. Annala, T. Gorda, A. Kurkela, **J. Nättilä**, and A. Vuorinen. Strongly interacting matter exhibits deconfined behavior in massive neutron stars. *Nature Communications*, December 2023. [arXiv:2303.11356].

[34] J. Skinner, **J. Nättilä**, and J. Y-K. Cho. Repeated Cyclogenesis on Hot-Exoplanet Atmospheres with Deep Heating. *Phys. Rev. Lett.*, December 2023. [arXiv:2212.05114].

[33] **J. Nättilä** and J. J. E. Kajava. Fundamental Physics with Neutron Stars. *Handbook of X-ray and Gamma-ray Astrophysics* (editors: Cosimo Bambi and Andrea Santangelo), December 2022, Springer. [arXiv:2211.15721].

[32] C. Demidem, **J. Nättilä**, and A. Veledina. Relativistic Collisionless Shocks in Inhomogeneous Magnetized Plasmas. *ApJL*, December 2022. [arXiv:2212.06053].

[31] K. Smedt, D. Ruprecht, J. Niesen, S. Tobias, and **J. Nättilä**. New applications for the Boris Spectral Deferred Correction algorithm for plasma simulations. *Applied Mathematics and Computation*, November 2022, [arXiv:2110.08024].

[30] **J. Nättilä** and A. M. Beloborodov. Heating of Magnetically Dominated Plasma by Alfvén-Wave Turbulence. *Phys. Rev. Lett.*, 128(7):075101, February 2022, [arXiv:2111.15578].

[29] M. Bussov and **J. Nättilä**. Segmentation of turbulent computational fluid dynamics simulations with unsupervised ensemble learning. *Signal Processing: Image Communication*, 99:116450, September 2021, [arXiv:2109.01381].

[28] L. Sironi, I. Plotnikov, **J. Nättilä**, and A. M. Beloborodov. Coherent Electromagnetic Emission from Relativistic Magnetized Shocks. *Phys. Rev. Lett.*, 127(3):035101, July 2021, [arXiv:2107.01211].

[27] E. Annala, T. Gorda, E. Katerini, A. Kurkela, **J. Nättilä**, V. Paschalidis, and A. Vuorinen. Multimessenger constraints for ultra-dense matter. *PRX*, May 2021, [arXiv:2105.05132].

[26] E. Sobacchi, **J. Nättilä**, and L. Sironi. A fully kinetic model for orphan gamma-ray flares in blazars. *MNRAS*, 503(1):688–693, May 2021, [arXiv:2102.11770].

[25] **J. Nättilä** and A. M. Beloborodov. Radiative Turbulent Flares in Magnetically Dominated Plasmas. *ApJ*, 921(1):87, November 2021, [arXiv:2012.03043].

[24] M. Al-Mamun, A. W. Steiner, **J. Nättilä**, J. Lange, R. O'Shaughnessy, I. Tews, S. Gandolfi, C. Heinke, and S. Han. Combining Electromagnetic and Gravitational-Wave Constraints on Neutron-Star Masses and Radii. *Phys. Rev. Lett.*, August 2020, [arXiv:2008.12817].

[23] V. Loktev, T. Salmi, **J. Nättilä**, and J. Poutanen. Oblate Schwarzschild approximation for polarized radiation from rapidly rotating neutron stars. *A&A*, 643:A84, November 2020, [arXiv:2009.08852].

[22] T. Salmi, V. F. Suleimanov, **J. Nättilä**, and J. Poutanen. Magnetospheric return-current-heated atmospheres of rotation-powered millisecond pulsars. *A&A*, 641:A15, September 2020, [arXiv:2002.11427].

[21] E. Annala, T. Gorda, A. Kurkela, **J. Nättilä**, and A. Vuorinen. Evidence for quark-matter cores in massive neutron stars. *Nature Physics*, 16(9):907–910, June 2020, [arXiv:1903.09121].

[20] P. Abolmasov, **J. Nättilä**, and J Poutanen. Kilohertz quasi-periodic oscillations from neutron star spreading layers. *A&A*, 638:A142, June 2020, [arXiv:1910.09906].

[19] A. Veledina, **J. Nättilä**, and A. M. Beloborodov. Pulsar Wind-heated Accretion Disk and the Origin of Modes in Transitional Millisecond Pulsar PSR J1023+0038. *ApJ*, 884(2):144, October 2019, [arXiv:1906.02519].

[18] F. Nauman and **J. Nättilä**. Exploring helical dynamos with machine learning: Regularized linear regression outperforms ensemble methods. *A&A*, 629:A89, September 2019, [1905.08193].

[17] **J. Nättilä**. Runko: Modern multiphysics toolbox for plasma simulations. *A&A*, 664:A68, August 2022 (submitted originally on June 2019), [1906.06306].

[16] J. J. M. in't Zand, E. Bozzo, J. Qu, X.-D. Li, L. Amati, Y. Chen, I. Donnarumma, V. Doroshenko, S. A. Drake, and et al. (incl. **J. Nättilä**). Observatory science with eXTP. *Science China Physics, Mechanics, and Astronomy*, 62:29506, February 2019.

[15] A. L. Watts, W. Yu, J. Poutanen, S. Zhang, S. Bhattacharyya, S. Bogdanov, L. Ji, A. Patruno, T. E. Riley, and et al. (incl. **J. Nättilä**). Dense matter with eXTP. *Science China Physics, Mechanics, and Astronomy*, 62:29503, February 2019.

[14] Z. Li, V. F. Suleimanov, J. Poutanen, T. Salmi, M. Falanga, **J. Nättilä**, and R. Xu. Evidence for the Photoionization Absorption Edge in a Photospheric Radius Expansion X-Ray Burst from GRS 1747−312 in Terzan 6. *ApJ*, 866:53, October 2018, [arXiv:1809.00098].

[13] T. Salmi, **J. Nättilä**, and J. Poutanen. Bayesian parameter constraints for neutron star masses and radii using X-ray timing observations of accretion-powered millisecond pulsars. *A&A*, 618:A161, October 2018, [arXiv:1805.01149].

[12] P. Pihajoki, M. Mannerkoski, **J. Nättilä**, and P. H. Johansson. General purpose ray-tracing and polarized radiative transfer in General Relativity. *ApJ*, 863:8, August 2018, [arXiv:1804.04670].

[11] **J. Nättilä** and P. Pihajoki. Radiation from rapidly rotating oblate neutron stars. *A&A*, 615:A50, July 2018, [arXiv:1709.07292].

[10] **J. Nättilä**, M. C. Miller, A. W. Steiner, J. J. E. Kajava, V. F. Suleimanov, and J. Poutanen. Neutron star mass and radius measurements from atmospheric model fits to X-ray burst cooling tail spectra. *A&A*, 608:A31, December 2017, [arXiv:1709.09120].

[9] V. F. Suleimanov, J. J. E. Kajava, S. V. Molkov, **J. Nättilä**, A. A. Lutovinov, K. Werner, and J. Poutanen. Basic parameters of the helium-accreting X-ray bursting neutron star in 4U 1820-30. *MNRAS*, 472:3905–3913, December 2017, [arXiv:1708.09168].

[8] J. J. E. Kajava, K. I. I. Koljonen, **J. Nättilä**, V. Suleimanov, and J. Poutanen. Variable spreading layer in 4U 1608-52 during thermonuclear X-ray bursts in the soft state. *MNRAS*, 472:78–89, November 2017, [arXiv:1707.09479].

[7] J. Kuuttila, J. J. E. Kajava, **J. Nättilä**, S. E. Motta, C. Sánchez-Fernández, E. Kuulkers, A. Cumming, and J. Poutanen. Flux decay during thermonuclear X-ray bursts analysed with the dynamic power-law index method. *A&A*, 604:A77, August 2017, [arXiv:1705.05653].

[6] V. F. Suleimanov, J. Poutanen, **J. Nättilä**, J. J. E. Kajava, M. G. Revnivtsev, and K. Werner. The direct cooling tail method for X-ray burst analysis to constrain neutron star masses and radii. *MNRAS*, 466:906–913, April 2017, [arXiv:1611.09885].

[5] J. J. E. Kajava, **J. Nättilä**, J. Poutanen, A. Cumming, V. Suleimanov, and E. Kuulkers. Detection of burning ashes from thermonuclear X-ray bursts. *MNRAS*, 464:L6–L10, January 2017, [arXiv:1608.06801].

[4] **J. Nättilä**, A. W. Steiner, J. J. E. Kajava, V. F. Suleimanov, and J. Poutanen. Equation of state constraints for the cold dense matter inside neutron stars using the cooling tail method. *A&A*, 591:A25, June 2016, [arXiv:1509.06561].

[3] **J. Nättilä**, V. F. Suleimanov, J. J. E. Kajava, and J. Poutanen. Models of neutron star atmospheres enriched with nuclear burning ashes. *A&A*, 581:A83, September 2015, [arXiv:1507.01525].

[2] J. J. E. Kajava, **J. Nättilä**, O.-M. Latvala, M. Pursiainen, J. Poutanen, V. F. Suleimanov, M. G. Revnivtsev, E. Kuulkers, and D. K. Galloway. The influence of accretion geometry on the spectral evolution during thermonuclear (type I) X-ray bursts. *MNRAS*, 445:4218–4234, December 2014, [arXiv:1406.0322].

[1] J. Poutanen, **J. Nättilä**, J. J. E. Kajava, O.-M. Latvala, D. K. Galloway, E. Kuulkers, and V. F. Suleimanov. The effect of accretion on the measurement of neutron star mass and radius in the low-mass X-ray binary 4U 1608-52. *MNRAS*, 442:3777–3790, August 2014, [arXiv:1405.2663].

Proceedings

[3] S. Bogdanov, et. al (including **J. Nättilä**). Snowmass 2021 Cosmic Frontier White Paper: The Dense Matter Equation of State and QCD Phase Transitions. September, 2022. [arXiv:2209.07412].

[2] E. Annala, T. Gorda, A. Kurkela, **J. Nättilä**, and A. Vuorinen. Constraining the properties of neutron-star matter with observations. In *12th INTEGRAL Conference*, Geneva, Switzerland, 11-15 February 2019 [arXiv:1904.01354].

[1] P. Soffitta, R. Bellazzini, E. Bozzo, V. Burwitz, A. Castro-Tirado, E. Costa, T. Courvoisier, H. Feng, S. Gburek, R. Goosmann, and et al. (incl. **J. Nättilä**) XIPE: the x-ray imaging polarimetry explorer. In *Space Telescopes and Instrumentation 2016: Ultraviolet to Gamma Ray*, volume 9905 Proceedings, page 990515, July 2016. doi.org/10.1117/12.2233046.

Theses

[3] **J. Nättilä**. X-ray bursts as a tool to constrain the equation of state of the ultra-dense matter inside neutron stars. PhD thesis, University of Turku, Finland, 2017. ISBN:978-951-29-7057-5.

[2] **J. Nättilä**. Mass and radius constraints for neutron stars using the cooling tail method. Master's thesis, University of Oulu, Finland, 2013. oulu-201312041966.

[1] **J. Nättilä**. Spectral analysis of X-ray bursts from neutron stars: IGR J1747–2721 (*Neutronitähtien röntgenpurkaukset ja niiden spektrianalyysi: IGR J1747–2721*). Bachelor's thesis, University of Oulu, Finland, 2012.

Open-source software

[6] **Runko**, Modern C++14/PYTHON3 toolbox for kinetic plasma simulations. https://github.com/natj/runko

[5] **CORGI**, C++14 grid infrastructure for massively parallel multi-physics simulations. https://github.com/natj/corgi

[4] **mpi4cpp**, User-friendly C++14 MPI headers with template metaprogramming. https://github.com/natj/mpi4cpp

[3] **Bender, ray tracing code**, General relativistic ray tracing code for computing radiation from rapidly rotating oblate neutron stars in JULIA/PYTHON3. https://github.com/natj/bender

[2] **Hydro, modular 2D hydrodynamical code** with unsplitted HLLC Rieman solver, second order Runge-Kutta time-stepping, and linear piecewise reconstruction written in pure JULIA. https://github.com/natj/hydro

[1] **CellularAutomata.jl**, JULIA library for 1/2D elementary and totalistic Cellular automata modeling. https://github.com/natj/CellularAutomata.jl

+ Smaller libraries and software available at https://github.com/natj.