

Joonas Nättilä

joonas.nattila@su.se

Sex: Male

Born: June 25th, 1989, Tornio, Finland

Nationality: Finnish citizen

Languages: Finnish (native), English, Swedish

Nordita

Roslagstullsbacken 17

SE-10691, Sweden

Tel: +358 453577992

<http://natj.github.io>

Research interests

High-energy astrophysics: accretion (accretion disks); compact objects (neutron stars, black holes)

Plasma physics: collisionless plasma dynamics; turbulence; particle acceleration

Nuclear physics: equation of state of cold ultra-dense matter

General relativity: ray tracing

Statistics: Bayesian inference; Monte Carlo methods

Computer sciences: high-performance computing; parallelization paradigms; machine learning; Julia language

Mathematics: cellular automata models; topology

Employment

2018 –2019 | **Nordita Fellow**, Nordita, Stockholm, Sweden.

Education

2014–2017 | **Ph.D. in Astrophysics (with honours)**, University of Turku, Finland.
Supervisor: Prof. Juri Poutanen, Director of Tuorla Observatory.
Title: X-ray bursts as a tool to constrain the equation of state of the ultra-dense matter inside neutron stars

2012–2013 | **M.Sc. in Astronomy**, University of Oulu, Finland.

2008–2012 | **B.Sc. in Physics**, University of Oulu, Finland.

Teaching

2018 | **Lecturer, Introduction to Julia**, CSC, Finland.
Lecturer for an introductory course on the Julia programming language.

2015—2018
(4 times) | **Lecturer, High Performance Computing Summer School**, CSC, Finland.
Lecturer & tutor for Finnish IT Center for Science HPC Summer School.

2015—2017
(3 times) | **Lecturer, Software tools in Physics**, University of Turku, Finland.
Lecturer of the “Introduction to Unix” section of the course (3 ECTS).

2016 | **Teaching Assistant, Optics**, University of Turku, Finland.
Exercise assistant of Optics course (6 ECTS).

2011—2013
(3 times) | **Teaching Assistant, Thermophysics**, University of Oulu, Finland.
Exercise assistant of Thermophysics summer course (6 ECTS).

2012 | **Teaching Assistant, Electricity and Magnetism**, University of Oulu, Finland.
Exercise assistant of Electricity and Magnetism summer course (4 ECTS).

2011 – 2012
(2 times) | **Assistant, Laboratory Exercises in Physics 1**, University of Oulu, Finland.
Assistant in Laboratory Exercises in Physics 1 (3 ECTS), in the fall and spring semesters.

2011 | **Teaching Assistant, Mathematics of Physics**, University of Oulu, Finland.
Exercise assistant of Mathematics of Physics summer course (6 ECTS).

2011
(2 times) | **Teaching Assistant, Waveforms and Optics**, University of Oulu, Finland.
Exercise assistant of Waveforms and Optics (6 ECTS) in spring and summer courses.

Mentoring & Supervision

Co-supervised 2 M.Sc. thesis, 1 B.Sc thesis. Currently co-supervising 1 PhD thesis.

2017–	Tuomo Salmi , PhD student, University of Turku, Finland. Neutron star mass and radius constraints from pulse profile modeling.
2015–2017	Jere Kuuttila , M.Sc. thesis research project, University of Turku, Finland. X-ray burst time evolution dependency on the spectral state.
2015–2016	Tuomo Salmi , M.Sc. thesis research project, University of Turku, Finland. Neutron star mass and radius constraints from pulse profile modeling.
2014–2015	Jere Kuuttila , B.Sc. thesis research project, University of Turku, Finland. X-ray bursts as standard candles.

Awards & Recognitions

2018	Turku Finnish University Society Prize for best doctoral dissertation
2018	Väisälä Prize 2018: Prize for outstanding thesis in Astronomy
2018	PCS Best Doctoral Thesis 2017
2016	Nordita Visiting Ph.D. Fellow, Nordita, Stockholm, Sweden.

Presentations & Talks

7 invited, 19 contributed talks.

Invited:

2018	Time for Accretion , Sigtuna, Sweden.
2018	Astronomers' days , Kuusamo, Finland.
2018	Fire and Ice: Hot QCD meets cold and dense matter , Saariselkä, Finland.
2017	Holographic dense QCD and neutron stars , ENS, Paris.
2016	From quarks to gravitational waves: Neutron stars as a laboratory for fundamental physics , CERN.
2016	COSPAR 2016, E1.1: Accreting Neutron Stars and Stellar-mass Black Hole , Istanbul, Turkey. (<i>Conference canceled!</i>)
2016	JINA-CEE Symposium: Neutron Stars in the Multi-Messenger Era , Ohio, USA.

Contributed:

2018	Astropasmas: Particle acceleration and transport , Rende, Italy.
2018	Tuorla-Tartu meeting , Turku, Finland.
2018	Astropasmas seminar , Princeton, USA.
2018	High energy astro group meeting , Columbia University, USA.
2018	Nordita Seminar , Nordita, Sweden.
2017	Astrophysics Seminar , Helsinki, Finland.
2017	Exascale thinking of particle energization problems , Nordita, Sweden.
2016	INT-16-2b: Phases Of Dense Matter Workshop , Seattle, USA.
2016	Nordita Workshop on accretion onto magnetized neutron stars , Stockholm, Sweden.
2015	Workshop on Relativistic Astrophysics , Kavalto, Finland.
2015	University of Maryland, Colloquium speaker , Washington, USA.
2015	University of Tennessee, Colloquium speaker , Tennessee, USA.
2015	The Neutron Star Radius, And All That Jazz , Montreal, Canada.
2015	40 years of X-ray bursts: Extreme explosions in dense environments , Madrid, Spain.
2014	ESAC (visiting scientist presentation) , Madrid, Spain.
2014	Physics of Neutron Stars Conference , St. Petersburg, Russia.
2014	Astronomers' Days , Savonlinna, Finland.
2013	European Week of Astronomy and Space Science , Turku, Finland.
2012	Astronomers' Days , Porvoo, Finland.

Funding

Research

- | | |
|-----------|--|
| 2015–2017 | UTUGS Physical and Chemical Sciences funded 3yr. Ph.D. scholarship
Constraining neutron star mass and radius. |
| 2014–2015 | ~ 23 000 eur Väisälä Foundation grant
Magnetar atmosphere models: breaking the barrier between observations and theory |
- + Some smaller travel grants (~ 10k eur).

Observation time

- | | |
|------|--|
| 2018 | NuSTAR/INTEGRAL/XMM-Newton ToO time (30ks/170ks/100ks)
Co-I, Proposal 1540022: Measuring the High Energy Emission of Millisecond X-Ray Pulsars in Outburst |
|------|--|

Supercomputer time

- | | |
|------|--|
| 2018 | ~ 60k CPUh SNIC/Kebnekaise, PI: Relativistic plasma in silico (testing of PLASMABox). |
|------|--|

Professional Societies and Services

- | | |
|-------|---|
| 2018– | IAU Junior member |
| 2016– | eXTP Dense Matter science working group |
| 2015– | ESA XIPE satellite Science Team (SWG2.2 Accreting Millisecond Pulsars) |
| 2014– | Member of organizing committee for CSC HPC Summer Schools |
| 2013– | Member of JuliaLang organization (Open source community for Julia programming language) |
| 2012– | Member of Finnish Astronomical Society |
| 2017 | Organizer & Convener for CompCoffee meetings (weekly meetings to discuss computational problems)
Referee for Monthly Notices of Royal Astronomical Society, Astronomy & Astrophysics |

Conference organization

- | | |
|------|---|
| 2017 | Nordita Workshop: Exascale thinking of particle energization problems , Stockholm, Sweden.
Member of the scientific and local organizing committee. |
| 2015 | Workshop on Relativistic Astrophysics , Kavalto, Finland.
Member of the local organizing committee. |
| 2015 | PCS Annual Seminar day , University of Turku, Finland.
Chairman & member of the organizing committee. |

Public outreach

My research has been presented in various local (Finnish) media: [tiedetuubi.fi](#) (30.11.2016), [Turun Sanomat](#) (10.11.2017), [Turkulainen](#) (10.11.2017), [Tähdet & Avaruus](#) (25.11.2017), [Aamuset](#) (8.12.2017), [Tekniikka & Talous](#) (8.12.2017), [Verkkouutiset](#) (8.12.2017). And in international media: [Cosmos](#) 27.11.2017.

Open source software

PlasmaBox, Modern C++-14/PYTHON3 toolbox for kinetic plasma simulations.
<https://github.com/natj/plasmabox>

CORGI, C++-14 template grid infrastructure for massively parallel multi-physics simulations.
<https://github.com/natj/corgi>

mpi4cpp, User-friendly MPI headers for modern C++ with template metaprogramming.
<https://github.com/natj/mpi4cpp>

Bender, ray tracing code, general relativistic ray tracing code for computing radiation from rapidly rotating oblate neutron stars. <https://github.com/natj/bender>

Hydro, modular 2d hydrodynamical code with unsplitted HLLC Riemann solver, second order Runge-Kutta time-stepping, and linear piecewise reconstruction. <https://github.com/natj/hydro>

CellularAutomata.jl, Julia library for elementary and totalistic Cellular automata modeling.
<https://github.com/natj/CellularAutomata.jl>

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

Publications — Joonas Nättilä

15 publications, 227 citations; h-index 7, g-index 15, i10-index 7 ([ADS](#)).

Peer-reviewed scientific articles

- [15] 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.
- [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*, *in press*, May 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

- [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 of *Proc. SPIE*, page 990515, July 2016.

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.