

## Curriculum Vitae

Name: Natalia Chepiga  
Nationality: Ukrainian  
Place of birth: Kharkiv, Ukraine  
Date of birth: December 27, 1988  
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Address: Kavli Institute of Nanoscience,  
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Languages: Russian, English, Ukrainian (all fluent),  
French(B1), Dutch(B1), German(A2)



## Expertise:

Condensed matter physics, quantum many-body physics and strongly correlated systems, computational physics and algorithm development (Tensor Networks, Density Matrix Renormalization Group algorithm, Exact Diagonalization), quantum phase transitions, conformal field theory, chiral melting, Rydberg atoms and other systems with constrained Hilbert space (non-abelian anyons, quantum dimers and quantum loops, supersymmetric models), quantum magnetism, low-dimensional quantum systems, topologically ordered states, systems with multi-component Hilbert space

## Education:

- 04/13 – 04/17    Docteur ès sciences, Institute of Physics, École Polytechnique Fédérale de Lausanne,  
Supervisor: prof. Frédéric Mila  
Thesis Title: ***Dimerization and exotic criticality in spin-S chains***  
*Private defense: 21/02/2017; Public defense: 23/03/2017*  
**Distinction** from Doctoral School of Physics, EPFL
- 08/11 – 02/13    Master in Physics, École Polytechnique Fédérale de Lausanne,  
Supervisor: prof. Frédéric Mila  
Thesis Title: ***Topological phase transitions in spin ladders***
- 09/07 – 07/11    BSc in Applied Physics with First Class Honors, V.N.Karazin Kharkiv National  
University, Department of Theoretical Nuclear Physics  
Supervisor: Sergey I. Shevchenko  
Thesis Title: ***Description of the electrons-holes superfluidity in terms of the order parameter***
- 09/00 – 06/07    High School Certificate with First Class Honors

## Employment:

01/21-    **Assistant professor**, Kavli Institute of Nanoscience, the faculty of Applied Sciences, Delft

University of Technology, Netherlands

- 01/19-12/20 **Postdoc** in the group of **prof. P. Corboz** at the University of Amsterdam, Netherlands.  
The work has been supported by the Swiss National Science Foundation (grant number P400P2\_183847) and by prof. Corboz's funds.
- 05/17-12/18 **Postdoc** in the group of **prof. S.R. White** at the University of California, Irvine, USA.  
The work has been supported by the Swiss National Science Foundation (grant number P2ELP2\_172271) and by prof. White's funds.
- 04/13 – 04/17 **Doctoral assistant** at the Chair of condensed matter theory, Institute of Physics, École Polytechnique Fédérale de Lausanne, Supervisor: prof. Frédéric Mila

### **Publications:**

18. **Natalia Chepiga** and Frédéric Mila,  
*Lifshitz point at commensurate melting of 1D Rydberg atoms*  
**Phys. Rev. Research**, **3**, 023049 (2021)
17. **Natalia Chepiga** and Frédéric Mila,  
*Kibble-Zurek exponent and chiral transition of the period-4 phase of Rydberg chains*  
**Nature Communications**, **12**, 414 (2021)
16. Mario Motta, Claudio Genovese, Fengjie Ma, Zhi-Hao Cui, Randy Sawaya, Garnet Kin-Lic Chan, **Natalia Chepiga**, Phillip Helms, Carlos Jimenez-Hoyos, Andrew J. Millis, Ushnish Ray, Enrico Ronca, Hao Shi, Sandro Sorella, Edwin M. Stoudenmire, Steven R. White, Shiwei Zhang (Simons collaboration on the many-electron problem)  
*Ground-state properties of the Hydrogen chain: insulator-to-metal transition, dimerization, and magnetic phases*  
**Phys. Rev. X** **10**, 031058 (2020)
15. **Natalia Chepiga**, Steven R. White,  
*Critical properties of a comb lattice*  
**SciPost Phys.** **9**, 013 (2020)
14. **Natalia Chepiga**, Ian Affleck, and Frédéric Mila,  
*Floating, critical, and dimerized phases in a frustrated spin-3/2 chain*  
**Phys. Rev. B** **101**, 174407 (2020)
13. Laurens Vanderstraeten, Elisabeth Wybo, **Natalia Chepiga**, Frank Verstraete, and Frédéric Mila,  
*Spinon confinement and deconfinement in a spin-1 chain*  
**Phys. Rev. B** **101**, 115138 (2020);
12. **Natalia Chepiga** and Frédéric Mila,  
*Dimerization and effective decoupling in two spin-1 generalizations of the spin-1/2 Majumdar-Ghosh chain*  
**Phys. Rev. B** **100**, 104426 (2019);

11. **Natalia Chepiga** and Steven R. White,  
*Comb tensor networks*  
Phys. Rev. B **99**, 235426 (2019)
10. **Natalia Chepiga** and Frédéric Mila,  
*DMRG investigation of constrained models: from quantum dimer and quantum loop ladders to hard-boson and Fibonacci anyon chains*  
SciPost Phys. **6**, 033 (2019);
9. **Natalia Chepiga** and Frédéric Mila,  
*Floating phase versus chiral transition in a 1D hard-boson model*  
**Phys. Rev. Lett.** **122**, 017205 (2019)
8. **Natalia Chepiga** and Frédéric Mila,  
*Rigorous decoupling between edge states in frustrated spin chains and ladders*  
Phys. Rev. B **97**, 174434 (2018)
7. **Natalia Chepiga** and Frédéric Mila,  
*Exact zero modes in frustrated Haldane chain*  
Phys. Rev. B **96**, 060409 (2017), Rapid Communication
6. **Natalia Chepiga** and Frédéric Mila,  
*Excitation spectrum and Density Matrix Renormalization Group iterations*  
Phys. Rev. B **96**, 054425 (2017)
5. L.Wang, **N.Chepiga**, D.-K.Ki, L.Li, F.Li, W.Zhu, Y.Kato, O.S.Ovchinnikova, F.Mila, I.Martin, D.Mandrus, A.F.Morpurgo,  
*Controlling the topological sectors of magnetic solitons in exfoliated  $\text{Cr}_{1/3}\text{NbS}_2$  crystals*  
**Phys. Rev. Lett.** **118**, 257203 (2017), Editor's Suggestion
4. **Natalia Chepiga**, Ian Affleck, and Frédéric Mila,  
*Spontaneous dimerization, critical lines, and short-range correlations in a frustrated spin-1 chain*  
Phys. Rev. B **94**, 205112 (2016)
3. **Natalia Chepiga**, Ian Affleck, and Frédéric Mila,  
*Comment on "Frustration and Multicriticality in the Antiferromagnetic Spin-1 Chain"*  
Phys. Rev. B **94**, 136401 (2016)
2. **Natalia Chepiga**, Ian Affleck, and Frédéric Mila,  
*Dimerization transitions in spin-1 chains*  
Phys. Rev. B **93**, 241108 (2016), Rapid Communication
1. **Natalia Chepiga**, Frédéric Michaud, and Frédéric Mila,  
*Berry phase investigation of spin-S ladders*  
Phys. Rev. B **88**, 184418 (2013)

**Pre-prints:**

### Invited talks:

- 02/21 Entanglement in Strongly Correlated Systems, Benasque, Spain, *Supersymmetric point in a ladder of constrained fermions*
- 12/20 European Tensor Network online series, *Chiral transitions in chains of Rydberg atoms*
- 11/19 Delta-ITP triangle meetings: Quantum and Topological Matter, University of Utrecht, The Netherlands, *Comb tensor networks*
- 07/19 Computational Approaches to Quantum Many-body Problems, ISSP, Kashiwa, Japan, *Practical introduction to MPS + Comb tensor networks + DMRG for constrained models (in total: 3 hours of lectures)*
- 03/19 DPG Frühjahrstagung 2019, Regensburg, Germany, *DMRG investigation of constrained models: from quantum dimer and quantum loop ladders to hard-boson and Fibonacci anyon chains*
- 02/19 Constrained Many-body Dynamics, MPI PKS, Dresden, Germany, *DMRG investigation of constrained models: from quantum dimer and quantum loop ladders to hard-boson and Fibonacci anyon chains*
- 06/18 TOPMAT, Paris-Saclay, France, *DMRG investigation of quantum dimer ladders*

### Contributed talks:

- 01/21 Waiting for Highly Frustrated Magnetism 2021, Dresden, Germany, *Floating, critical and dimerized phases in a frustrated spin-3/2 chain*
- 12/20 Exploring quantum many-body physics with ultra-cold atoms and molecules, Bad Honnef, Germany, *Kibble-Zurek exponent and chiral transition of the period-4 phase of Rydberg chains*
- 02/20 Entanglement in Strongly Correlated Systems, Benasque, Spain, *Ashkin-Teller transition of Rydberg atoms with two-site blockade*
- 01/20 Physics@Veldhoven 2020, Veldhoven, The Netherlands, *Simulating constrained models with tensor networks*
- 09/19 Korrelationstage 2019, Dresden, Germany, *Comb tensor networks*
- 10/18 Topological phases in condensed matter and cold atom systems, Cargèse, Corsica, France *Constrained DMRG as a byway to investigate critical properties of frustrated magnets*
- 06/18 Trends in quantum magnetism, Bad Honnef, Germany, *DMRG investigation of quantum dimer ladders*
- 02/18 Entanglement in Strongly Correlated Systems, Benasque, Spain, *DMRG investigation of quantum dimer ladders*
- 11/17 Novel Quantum States in Condensed Matter 2017, Kyoto, Japan, *Spontaneous dimerization, critical lines, and exact zero modes in a frustrated spin-1 chain*
- 06/17 Many Electron Collaboration Summer School, Stony Brook, USA, *Excitation spectrum and Density Matrix Renormalization Group iterations*
- 02/17 Entanglement in strongly correlated systems, Benasque, Spain, *Dimerization and exotic criticality in spin-S chains*
- 09/16 Recent Progress in Low-Dimensional Quantum Magnetism, Lausanne, Switzerland, *Critical lines and short-range correlations in a frustrated spin-1 chain*
- 07/16 Swiss Physical Society Meeting, Lugano, Switzerland, *Dimerization transitions in spin-1 chains*
- 07/16 Swiss Workshop on Materials with Novel Electronic Properties 2016, Les Diablerets,

- Switzerland, *Dimerization transitions in spin-1 chains*
- 05/16 Japan-Swiss Workshop 'Trends in Theory of Correlated Materials', PSI, Villigen, Switzerland, *Dimerization transitions in spin-1 chains*
- 10/14 Japan-Swiss Workshop 'Trends in Theory of Correlated Materials', Tokyo, Japan, *Berry phase investigation of spin-S ladders*
- 07/14 Swiss Physical Society Annual Meeting, Fribourg, Switzerland, *Berry phase investigation of spin-S ladders*

### Seminars:

- 02/21 Harvard Condensed Matter Theory Seminar, Harvard, USA; *Chiral transitions in chains of Rydberg atoms*
- 12/20 University of Amsterdam, The Netherlands; host: P.R.Corboz, *Constrained tensor networks: a new approach to quantum criticality*
- 02/20 TU Delft, The Netherlands; *Tensor network investigation of constrained models: from quantum dimer and quantum loop ladders to chains of Rydberg bosons*
- 06/19 University of Nottingham, UK; host: Juan P. Garrahan, *Constrained DMRG as a byway to investigate critical properties of frustrated magnets*
- 02/19 University of Amsterdam, The Netherlands; host: P.R.Corboz, *Floating phase versus chiral transition in constrained models*
- 10/18 University of California, Irvine, USA; host: Steven R.White, *Floating phase versus chiral transition in constrained models: from hard-boson chain to quantum dimer and quantum loop ladders*
- 03/18 HISKP, Universität Bonn, Germany; host: Corinna Kollath, *DMRG investigation of quantum dimer ladders*
- 02/18 Max-Planck-Harvard Institute for Quantum Optics, Garching, Germany; host: Ignacio Cirac, *Frustrated spin chains: exotic criticality, exact zero modes and quantum dimer model.*
- 11/17 Perimeter Institute, Waterloo, Canada; host: Guifre Vidal, *Spontaneous dimerization, critical lines and exact zero modes in frustrated spin-1 chain.*
- 10/17 University of British Columbia, host: Ian Affleck, *Exact zero modes in frustrated spin chains*

### Poster presentations:

- 04/21 Korrelationstage 2021, Dresden, Germany, *Chiral transitions in chains of Rydberg atoms*
- 10/18 Topological phases in condensed matter and cold atom systems, Cargese, Corsica, France, *A comb tensor network*
- 09/17 Korrelationstage 2017, Dresden, Germany, *Dimerization and exotic criticality in spin-S chains*
- 09/16 8th International Conference on Highly Frustrated Magnetism, Taipei, Taiwan, *Dimerization transitions in spin-1 chains*
- 01/15 Theory Winter School on New Trends in Frustrated Magnetism, Tallahassee, Florida, USA, *Frustration and spontaneous dimerization in spin-1 chain*
- 10/13 School on Advanced Algorithms for Correlated Quantum Matter, Würzburg, Germany, *Berry phase investigation of spin-S ladders*
- 07/13 Swiss Workshop on Materials with Novel Electronic Properties, Les Diablerets,

Switzerland, *Berry phase investigation of frustrated quantum magnets*

### Grants:

02/19-09/20 **PostdocMobility** by the Swiss National Science Foundation, University of Amsterdam, The Netherlands. Project title: Further development of infinite Projected Entangled Pair States (iPEPS): network of clusters and hard constraints

04/17-09/18 **EarlyPostdocMobility** by the Swiss National Science Foundation, University of California, Irvine, USA. Project title: Efficient Density Matrix Renormalization Group (DMRG) algorithm for two-dimensional systems and its applications.

### Reviewing activities:

Physical Review Letters, Physical Review Research, Physical Review B, SciPost, New Journal of Physics

### Member of committees:

03/21 Member of Schelto Crone's PhD committee at the University of Amsterdam, Netherlands

01/20 Member of the poster prize committee at Physics@Veldhoven 2020, Veldhoven, Netherlands

01/2021- Member of the European Tensor Network ([quantumtensor.pks.mpg.de](http://quantumtensor.pks.mpg.de))

2017-2020 Postdoc mobility fellow of the Swiss National Science Foundation

### Selected Awards:

12/17 Distinction from Doctoral School of Physics, EPFL for the thesis *Dimerization and exotic criticality in spin-S chains*

10/11 – 02/13 Excellence scholarship provided by École Polytechnique Fédérale de Lausanne

09/07 – 06/11 Government scholarships for university students with outstanding results

09/03 – 08/08 President of Ukraine Scholarship; Kharkiv City Mayor Scholarship

09/03 – 06/11 Several diploma including 1<sup>st</sup> and 2nd prizes in Olympiads in Physics; 1st prize in Ukrainian Competition of Research projects

### Teaching experience:

09/14 – 01/17 Teaching Assistant in '**Physique Statistique I**' at EPFL

02/16 – 06/16 Teaching Assistant in '**Mathematical Methods for Physicists**' at EPFL

02/15 – 06/15 Teaching Assistant in '**Physique Statistique II**' at EPFL

09/13 – 12/13 Teaching Assistant in '**Statistiques et probabilités**' at EPFL

11/07 – 06/11 High School Teacher in Advanced Physics and Mathematics at Private Boiko School, Ukraine

08/08 – 08/09 Summer School Teacher for Granted Youth (supported by Kharkov City Council)

Courses to improve teaching skills:

04/21 DEVELOP, TU Delft, ~40 hours on the development of own course from scratch

05/21 SUPERVISE, TU Delft, ~40 hours on how to manage the group and supervise students

**Supervision:**

Randy Sawaya's PhD project on Hubbard model with long-range interactions, University of California Irvine (co-supervised);

Robin Kaech's master project on critical Ising chains, EPFL (co-supervised);

Guillaume Meyrat's master project on quantum dimer model, EPFL (co-supervised);

Samuel Gozel's master project on dynamics in spin-3/2 chain, EPFL (co-supervised)

**Outreach:**

Public lectures at "The day of science"(2016) and "The night of science"(2018) and AskMeAnything sessions (2017, 2020) at Private Boiko school, Ukraine.

**Volunteer projects:**

08/10 Environmental volunteer program in Vichy, France

07/10 Camp leader in the international volunteer project, Lyubotin, Kharkiv district, Ukraine

08/09 Volunteer in Summer Camp in Spangenberg, Germany

11/07 Team leader in Ukraine-China exchange program in Shitzyatjuan, China

**References:**

1. Prof. Frédéric Mila, École Polytechnique Fédérale de Lausanne, [frederic.mila@epfl.ch](mailto:frederic.mila@epfl.ch)
2. Prof. Philippe Corboz, University of Amsterdam, [P.R.Corboz@uva.nl](mailto:P.R.Corboz@uva.nl)
3. Prof. Ian Affleck, University of British Columbia, [iaffleck@phas.ubc.ca](mailto:iaffleck@phas.ubc.ca)
4. Prof. Steven R. White, University of California, Irvine, [srwhite@uci.edu](mailto:srwhite@uci.edu)
5. Prof. Kareljan Schoutens, University of Amsterdam, [c.j.m.schoutens@uva.nl](mailto:c.j.m.schoutens@uva.nl)