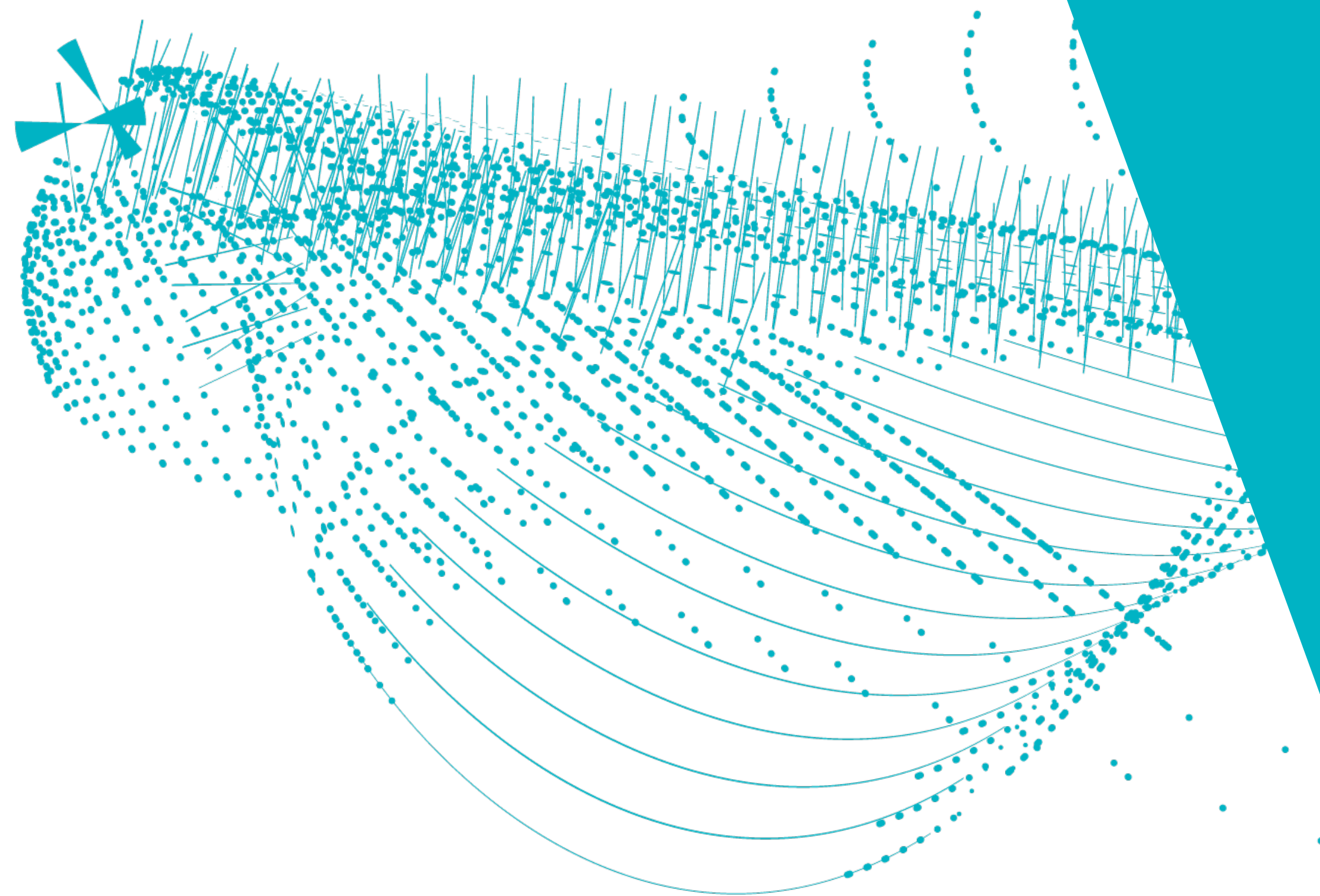




SAC MEETING, 13 APRIL 2023

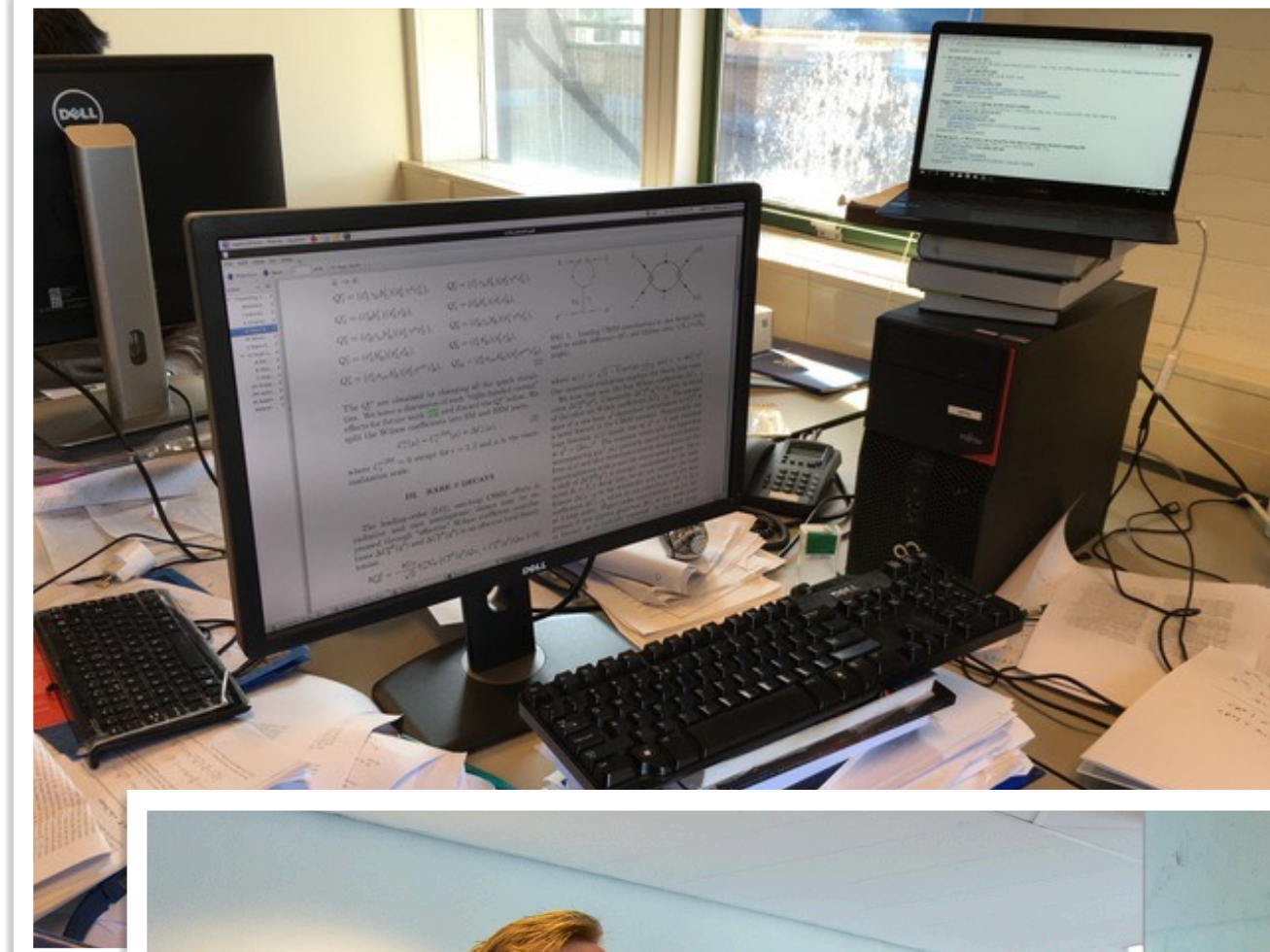
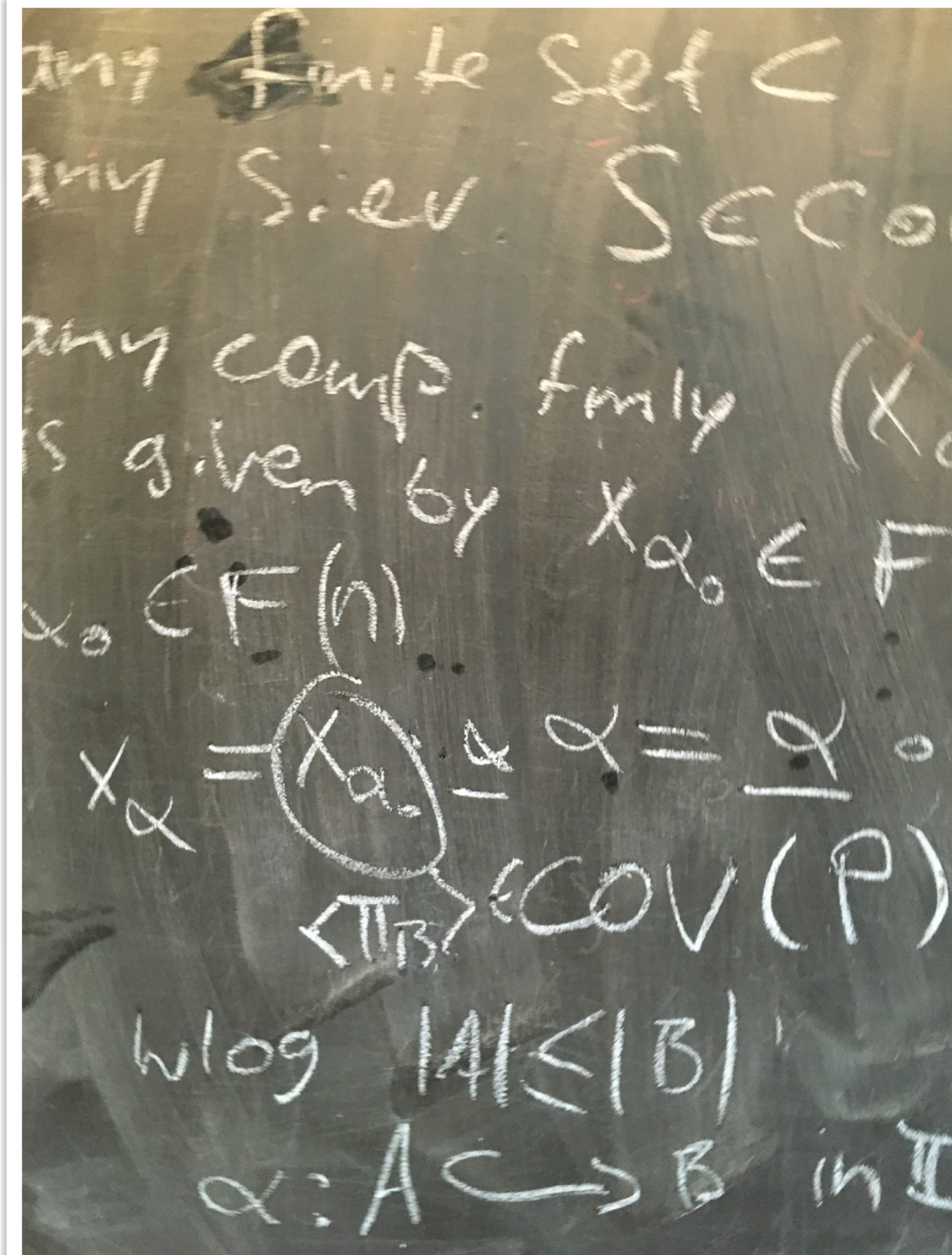
# NIKHEF THEORY

Robert Fleischer





# THEORETICAL PHYSICS “INSTRUMENTATION”



*Biggest resource/investment: talent!*



# DUTCH THEORETICAL PARTICLE PHYSICS

- Amsterdam: Nikhef, VU, UvA
- Nijmegen: Radboud Universiteit
- Groningen: Rijksuniversiteit
- Utrecht: Universiteit Utrecht
- Leiden: Universiteit Leiden
- Maastricht: Maastricht University



[No theoretical particle physics at Technical Universities]

## Nikhef Theory Groups

- *Large community:*
  - O(45) staff members
  - O(60) postdocs
  - O(100) PhD students



# NIKHEF THEORY GROUP AMSTERDAM

- Broad spectrum of research topics:
  - QCD and collider physics
  - Flavour physics: quarks & leptons
  - Dark matter
  - Cosmology
- Serves as a national centre for particle physics phenomenology.
- Exploit environment at Nikhef through close interactions with the experimental groups.





# THEORY GROUP WEBSITE:



← PEOPLE RESEARCH SOFTWARE ACTIVITIES EVENTS FOR STUDENTS OUTREACH VACANCIES CONTACT

ZOEKEN



Theoretical physics at Nikhef

About Nikhef's Theory group

Welcome to the website of the **Theory Group** of Nikhef! Here you will find information about [who we are](#), what are our [research interests](#), how to [contact us](#), as well as related information which would be useful for bachelor and master students looking for a [project/internship](#) within our group and for prospective applicants to open PhD, postdoc, and staff [positions](#). For more general information about the Nikhef institute and partnership please go [here](#).

- O(10) Staff Members
- 4 postdocs
- 16 PhDs
- 12 MSc students
- 5 Emeriti
- Visitors...

Instagram



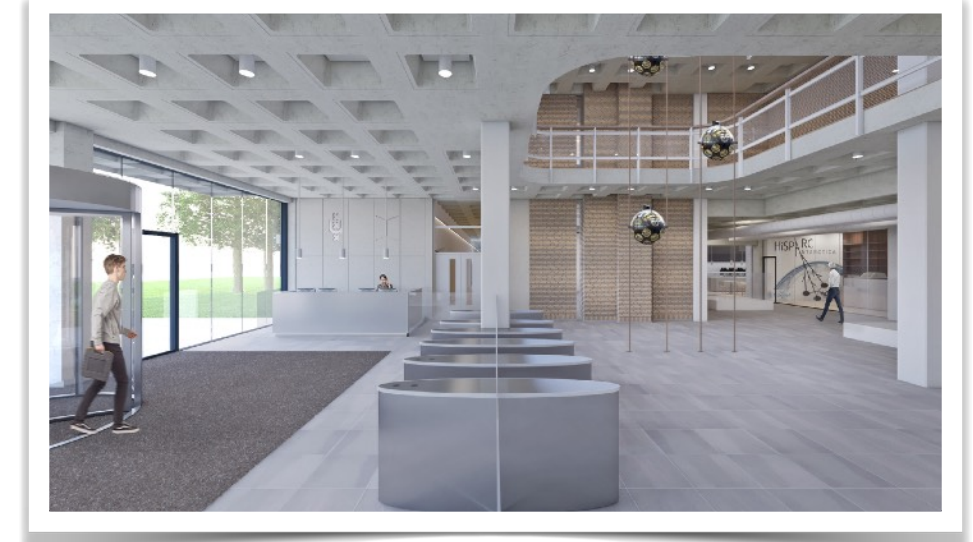
Twitter





# CURRENT SETTING

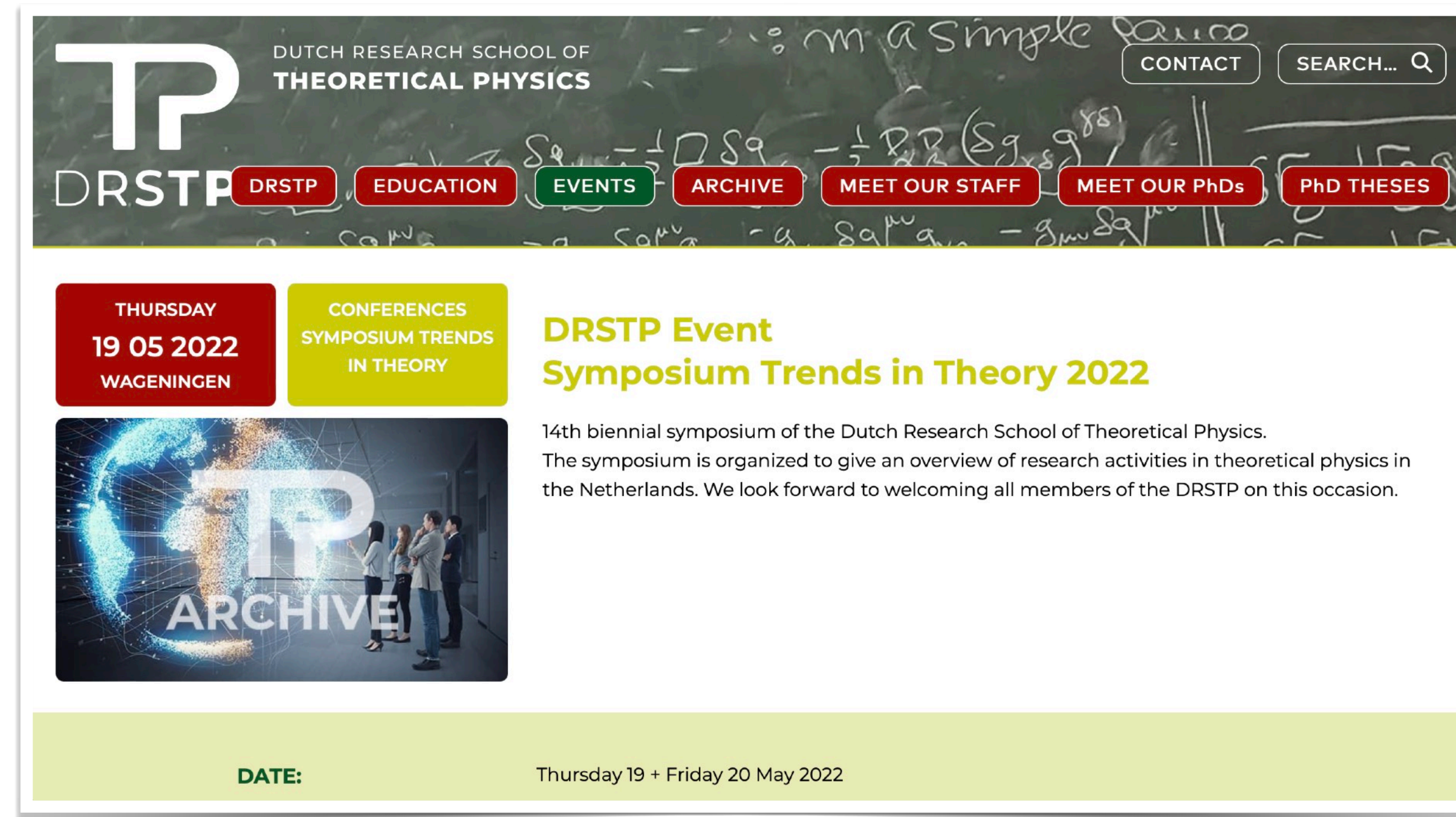
- Renovation in progress...
- Theory group located at CWI since March 2022 (when returning from covid).
- Challenging working conditions but still excellent spirit and output!
- We will again be located on the 3rd floor of the H building + *Veltman Centre*
- Looking forward to moving back asap in Summer (2023) ...





# VARIOUS REGULAR SCIENTIFIC ACTIVITIES

- Journal Clubs
- Theoretical Physics Seminars
- Activities within the PhD graduate school (DRSTP):
  - National Seminar Theoretical High-Energy Physics (2-times/year)
  - Trends in Theory (every other year)
- Involvement in Nikhef activities:
  - Colloquium
  - Theory Meets Experiment
  - ...



The screenshot shows the website of the Dutch Research School of Theoretical Physics (DRSTP). The header features the TP logo and the text 'DUTCH RESEARCH SCHOOL OF THEORETICAL PHYSICS'. Navigation buttons include 'CONTACT', 'SEARCH...', 'DRSTP', 'EDUCATION', 'EVENTS', 'ARCHIVE', 'MEET OUR STAFF', 'MEET OUR PhDs', and 'PHD THESES'. The main content area highlights the 'THURSDAY 19 05 2022 WAGENINGEN' event, 'CONFERENCES SYMPOSIUM TRENDS IN THEORY', and the 'DRSTP Event Symposium Trends in Theory 2022'. A description states: '14th biennial symposium of the Dutch Research School of Theoretical Physics. The symposium is organized to give an overview of research activities in theoretical physics in the Netherlands. We look forward to welcoming all members of the DRSTP on this occasion.' A 'TP ARCHIVE' image is also visible. At the bottom, a green bar indicates the 'DATE: Thursday 19 + Friday 20 May 2022'.



# “THEORY DAY” MEETINGS

- *Mini Workshops* to connect the Dutch theo/pheno community.
- Include a student session without staff members being present.
- Successfully revived “in-person” and restructured after the pandemic.
- Recent meeting in Nijmegen.

[Jordy de Vries, Anders Rehult & Coenraad Marinissen +Susanne Westhoff (RU), Keri Vos (UM), ...]





# FOCUS SESSIONS AT NWO PHYSICS...

**Auditorium** H

**"Persisting Puzzles in Particle Physics: What is the matter with matter?"**

**Chairs**

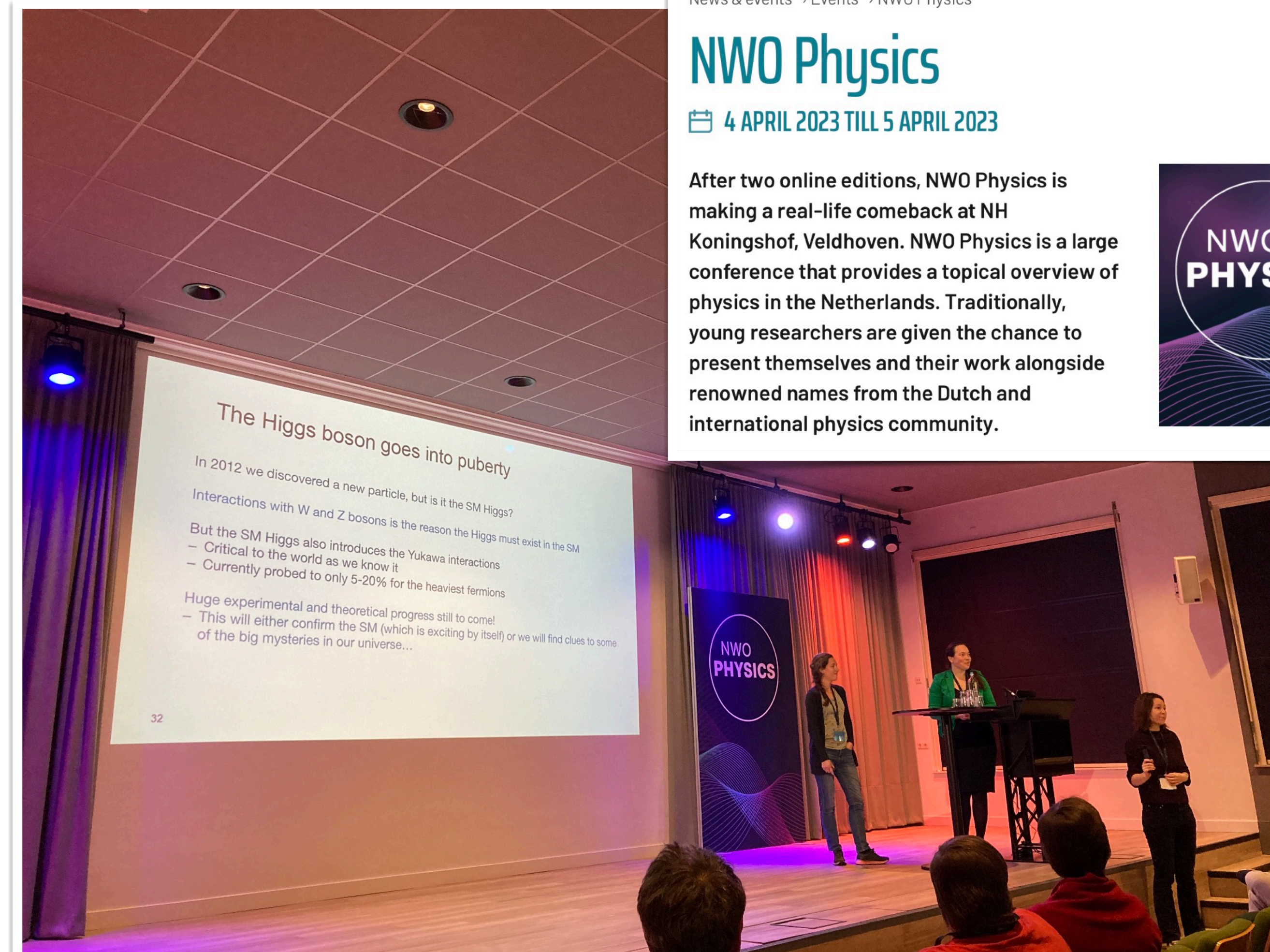
**Keri Vos [UM]**  
**Jorinde van de Vis [UU]**

**Susanne Westhoff [RU]**  
Dark matter at colliders

**Danny van Dijk [University of Durham]**  
Flavour Anomalies as Antennas for New Physics

**Melissa van Beekveld [Nikhef]**  
The Hierarchy Puzzle

**Jordy de Vries [Nikhef]**  
The Puzzle of Neutrino Masses

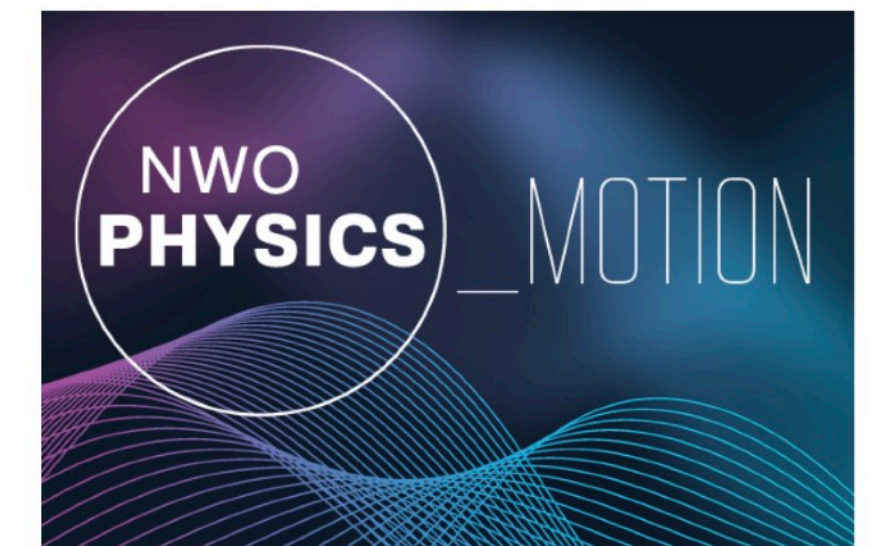


News & events › Events › NWO Physics

## NWO Physics

📅 4 APRIL 2023 TILL 5 APRIL 2023

After two online editions, NWO Physics is making a real-life comeback at NH Koningshof, Veldhoven. NWO Physics is a large conference that provides a topical overview of physics in the Netherlands. Traditionally, young researchers are given the chance to present themselves and their work alongside renowned names from the Dutch and international physics community.



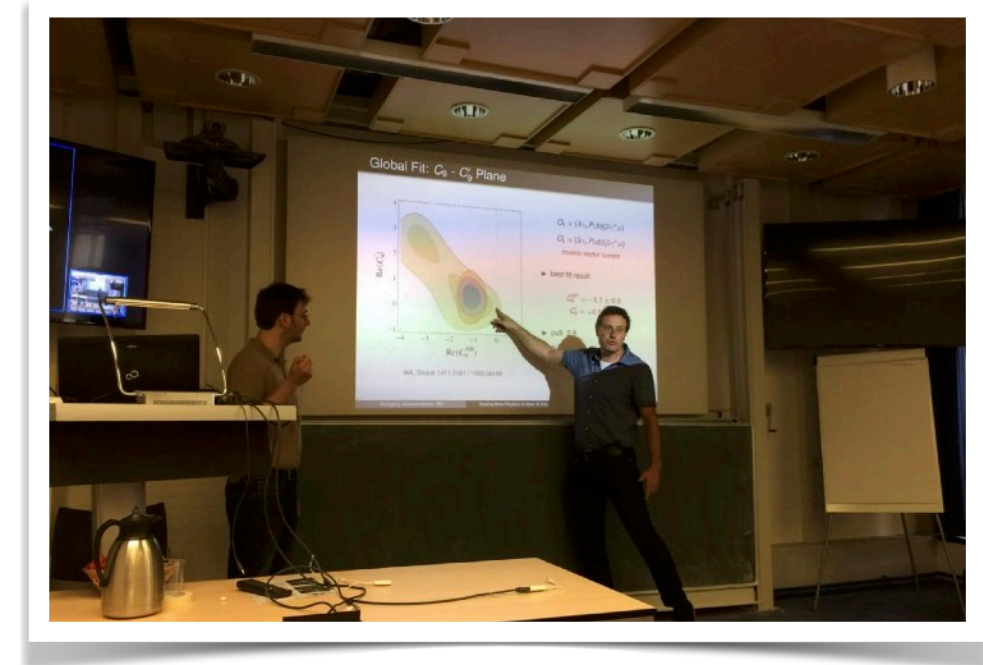


# INTERACTION THEORY-EXPERIMENT @ NIKHEF

*Utilize the structure of Nikhef...*

- Theorists learn about experimental challenges, may point out new observables, ...
- Sometimes joint papers Theory-Experiment
- Series “Theory meets Experiment”:
  - Informal mini-workshops
  - Rare B decays, axions, lepton flavour violation, ...
  - Suggestions are very welcome!

[R.F., Marcel Merk (LHCb), Tristan du Pree (ATLAS)]



Mini Nikhef Workshop: Theory Meets Experiment - W mass			
📅 Friday 3 Jun 2022, 14:00 → 17:30 Europe/Amsterdam			
Description LOCATION: Meeting room 'Day' in the 'Startup Village' at Amsterdam Science Park			
14:00 → 14:15	Introduction	Speakers: Marcel Merk, Robert Fleischer, Tristan du Pree	🕒 15m
14:15 → 15:15	Theory overview (SM, PDFs, QCD)	Speaker: Juan Rojo 📎 rojo-TheoryMeetsE...	🕒 1h
15:15 → 15:30	Experimental aspects at LHCb	Speaker: Wouter Hulsbergen 📎 WmassAtLHCb.pdf	🕒 15m
15:30 → 15:45	Coffee		🕒 15m
15:45 → 16:00	Experimental aspects at LEP	Speaker: Ivo van Vulpen 📎 2022_06_03_Theor...	🕒 15m
16:00 → 16:30	BSM interpretations	Speaker: Jordy de Vries 📎 W-mass Nikhef.pdf	🕒 30m
16:30 → 17:00	Discussion		🕒 30m
17:00 → 17:30	Drinks		🕒 30m



# NEXT SCHEDULED MEETING: JUNE 2023

## Mini Nikhef Workshop: Theory Meets Experiment - Neutrinoless Double Beta Decay

Friday 9 Jun 2023, 11:00 → 18:00 Europe/Amsterdam

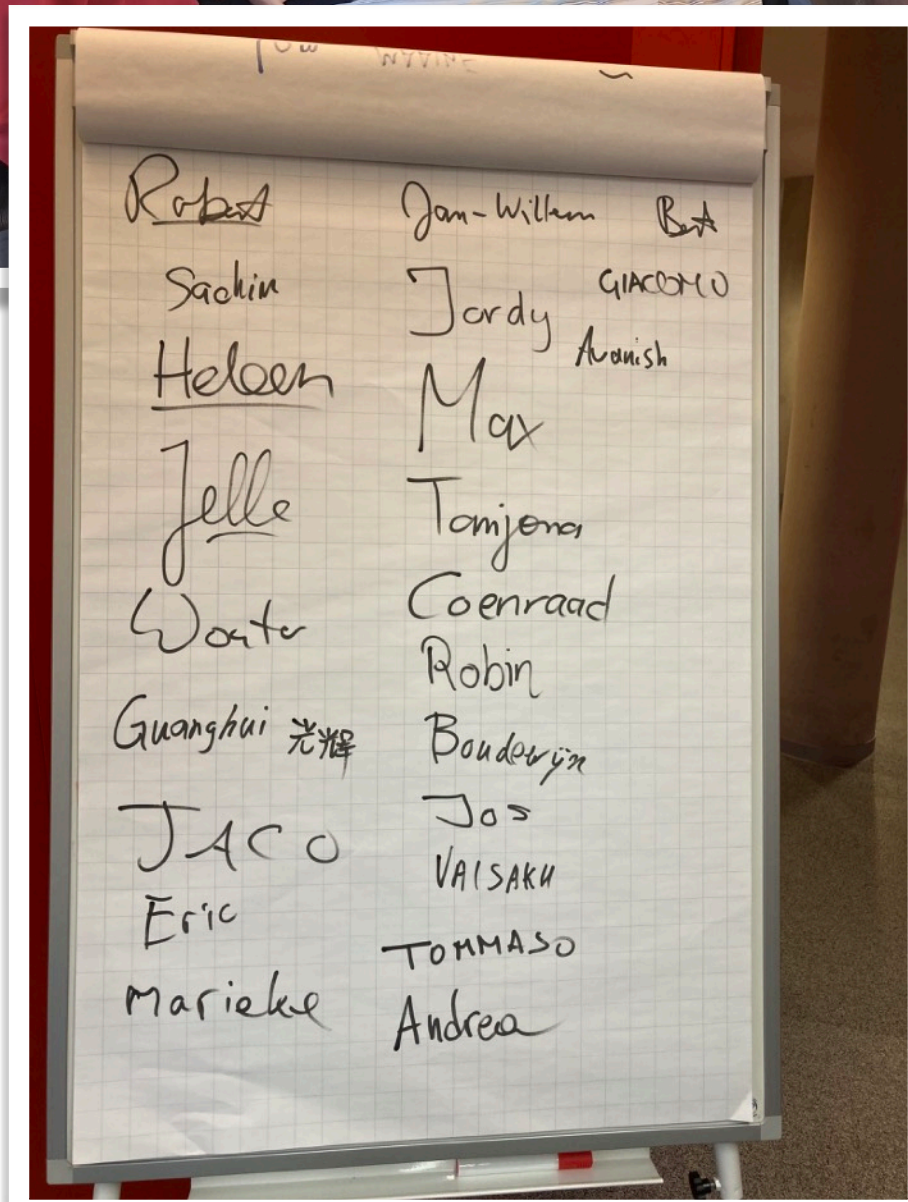
**Description** Theory Meets Experiment on Neutrinoless Double Beta Decay

Location: CWI (Z011/Z009)

11:00	→ 12:00	<b>Theory of Neutrinoless Double Beta Decay</b>	🕒 1h
		Speaker: Jordy de Vries (UvA & Nikhef)	
14:00	→ 14:05	<b>Opening of Afternoon Session</b>	🕒 5m
		Speakers: Marcel Merk, Robert Fleischer, Tristan du Pree	
14:05	→ 14:30	<b>Neutrinoless Double Beta Searches at KamLAND-ZEN</b>	🕒 25m
		Speaker: Kelly Weerman	
14:30	→ 15:00	<b>Sterile Neutrinos and Leptogenesis</b>	🕒 30m
		Speaker: Marieke Postma	
15:00	→ 15:30	<b>Long-lived particle searches at the LHC and FPF</b>	🕒 30m
		Speaker: Flavia de Almeida Dias	
15:30	→ 16:00	<b>Motivation for sterile neutrinos and alternative masses</b>	🕒 30m
		Speaker: Jordy de Vries (UvA & Nikhef)	
16:00	→ 16:30	<b>Discussion</b>	🕒 30m
16:30	→ 18:00	<b>Borrel</b>	🕒 1h 30m



# SOCIAL “THEORY” EVENTS...





# NEW STAFF APPOINTMENTS

- **Susanne Westhoff: *Nijmegen***
  - Joined in spring 2022 from the University of Heidelberg
  - Effective Field Theories, long-lived particles, dark matter, ...
- **Melissa van Beekveld: *Nikhef/NWO-I***
  - Will join in October 2023 from the University of Oxford
  - Collider physics, event generators, resummation, SUSY, ...



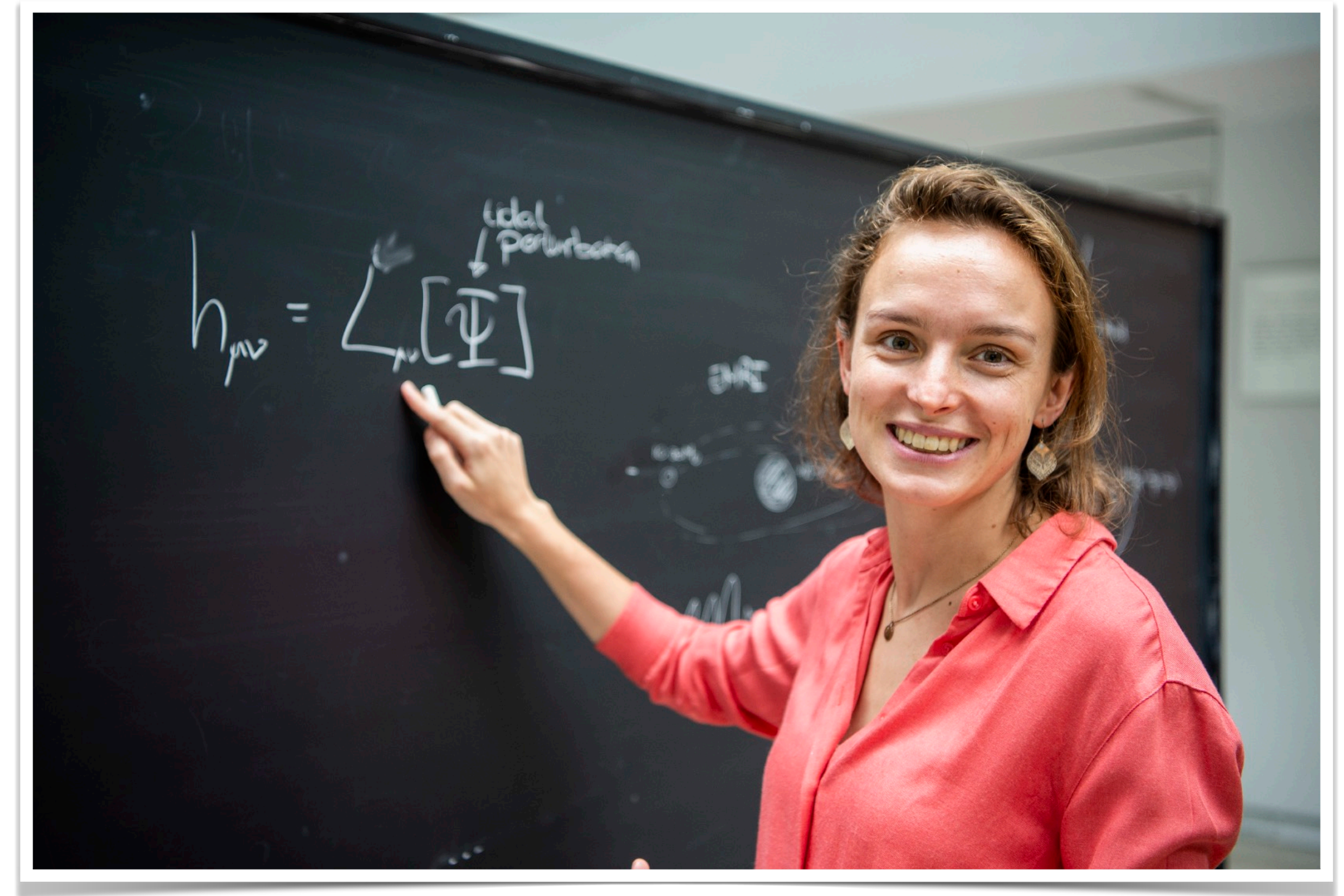


# NEW ADDITION: GRAVITATIONAL WAVES

- Béatrice Bonga: *Nijmegen*

- Gravitational waves
- Black holes
- Resonances
- Cosmological constant
- QFT on curved spacetime

Complements Gideon Koekoek (Maastricht University)  
and Jan-Willem van Holten (Nikhef + Leiden “retired”).



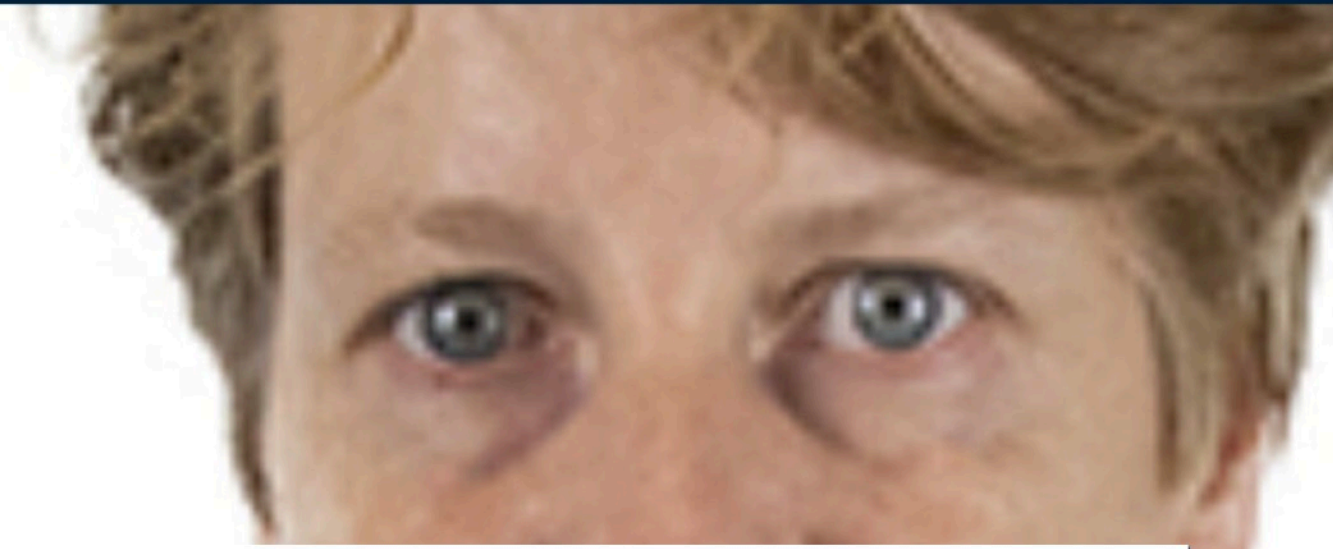


# PROFESSORSHIPS

Nikhef

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## Marieke Postma appointed professor of Theoretical Cosmology in Nijmegen

11 January 2023

**Nikhef theoretical physicist Marieke Postma has been appointed professor of Theoretical cosmology and beyond the standard model particle physics at the Faculty of Science at Radboud University.**

In her research, Postma looks at the implications of subatomic physics for the evolution of the universe, and vice versa. “The now gigantic universe was minuscule just after the big bang, almost 14 billion years ago; the cosmos thus harbors information on both the largest cosmological and the smallest subatomic scales. How can the possible existence of new particles and forces be tested with cosmology?”

Nikhef

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## Nikhef-theoretician Juan Rojo appointed full professor at Vrije Universiteit

22 September 2022

**As of 1 September, Nikhef-physicist Juan Rojo has been appointed Professor of Theoretical Physics at the Vrije Universiteit Amsterdam. His chair is embedded in the Physics and Astronomy department.**

Rojo is an expert in the phenomenology of elementary particle interactions, in particular concerning the quark and gluon internal substructure of the proton. He is also well-known by pioneering the application of artificial intelligence (AI) for particle physics.

Rojo studied Physics at the University of Barcelona in Spain, where he obtained his doctorate in 2006. Subsequently he worked as

HOME

NEWS

→

NIKHEF-THEORETICIA...

### Related Programme



→



**Theoretical physics**

Nikhef’s Theoretical Physics group performs theoretical research on a wide range of

*Many congratulations!*



# NEW APPOINTMENTS ERIC LAENEN



## Eric Laenen (Nikhef) elected vice-president CERN-council



3 February 2022

**Theoretical physicist Eric Laenen of Nikhef has been appointed vice-president of the CERN-council, the highest governing body of the European particle lab.**

This was announced in Geneva. Laenen is a professor at Utrecht University and University of Amsterdam and is a representative for the Netherlands in the CERN-council.


Previously, Eric Laenen was program leader of the theory department at Nikhef. In 2020, he was also closely involved in drawing up the new strategy for particle physics in Europe, which decided on research into a new accelerator at CERN.

In the council, the currently 23 CERN member states determine the policy of the accelerator lab founded in 1954. The council also appoints the lab's director general, presently the Italian physicist Fabiola Gianotti.



## Eric Laenen appointed director of Institute of Physics at UvA

18 May 2022



**Nikhef researcher Prof. Eric Laenen is the new director of the UvA Institute of Physics (IoP), appointed for a period of three years. As director of the IoP, Laenen aims to strengthen ties within the institute and with partner institutes in the FNWI and at the Amsterdam Science Park.**

Laenen will be added to the IoP board as an additional member, alongside the heads of the three underlying institutes. Prof. Daniel Bonn remains head of the Van der Waals-Zeeman Institute, Prof. Jan de Boer head of the Institute for Theoretical Physics, and current IoP director Prof. Paul de Jong remains head of the Institute for High Energy Physics.

*Many congratulations!*



# BERT SCHELLEKENS FEST

- Honour Bert Schellekens on the occasion of his “retirement”.
- Very nice event with impressive participation and talks: Indico

### Bert Schellekens Fest

Friday 13 May 2022, 10:00 → 18:00 Europe/Amsterdam

Z011 (CWI/Nikhef)

**Description**

Retirement Bert Schellekens

Organisers:  
Robert Fleischer (Nikhef and VU, Amsterdam)  
Beatriz Gato Rivera (IFF-CSIC, Madrid)

Program for the scientific meeting of Bert's Fest on 13 May, 2022

Nikhef, Seminar Room: Z011

NOTE: the two talks in the morning and the last talk by E. Kiritsis are intended for a general audience of particle physicists, theorists as well as experimentalists.






*Many thanks to Beatriz Gato Rivera!*

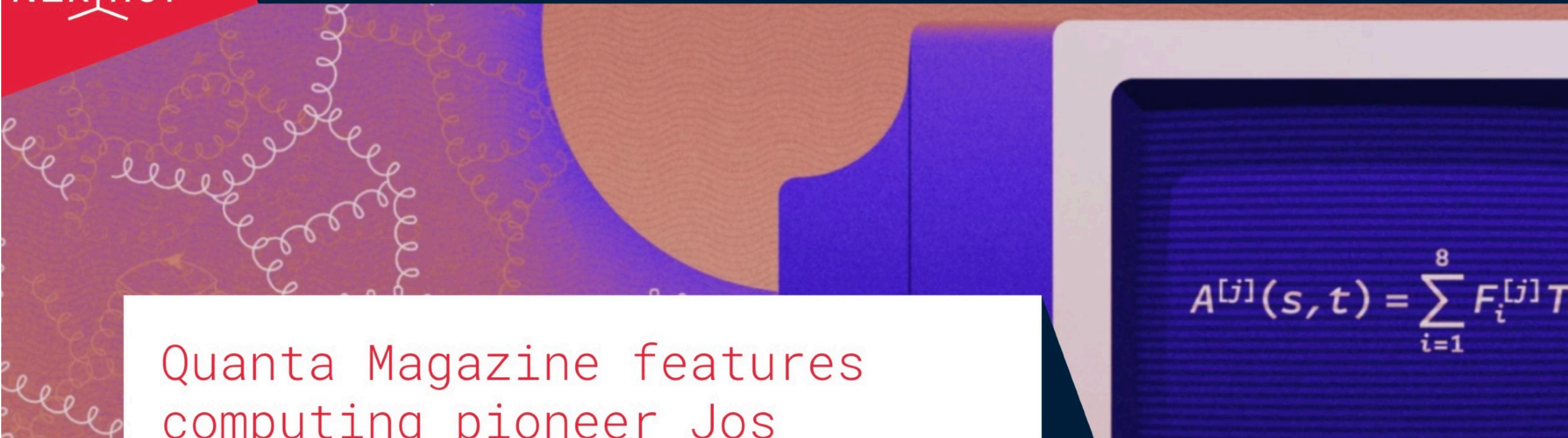


# FORM



Menu 

Search  → Datacenter → Contact  
→ Intranet → Dutch


$$A^{[j]}(s, t) = \sum_{i=1}^8 F_i^{[j]} T$$

Quanta Magazine features  
computing pioneer Jos  
Vermaseren and his FORM



HOME FOCUSBLO... → QUANTA MAGAZINE FE...

8 December 2022

The American science magazine Quanta is running a major **article this month on FORM**, a computer algebra program widely used in theoretical particle physics.

The program is the brainchild of Nikhef theorist emeritus Jos Vermaseren. It is also in danger of falling out of use due to lack of support, despite all its advantages, Quanta warns.

PARTICLE PHYSICS  
**Crucial Computer Program for Particle Physics at Risk of Obsolescence**

28  

Maintenance of the software that's used for the hardest physics calculations rests almost entirely with a retiree. The situation reveals the problematic incentive structure of academia.

Challenge to preserve FORM: *get community involved...*



# “SNAPSHOTS” OF RESEARCH (I)

**nature**

[Explore content](#) ▾ [About the journal](#) ▾ [Publish with us](#) ▾

[nature](#) > [articles](#) > [article](#)

Article | [Open Access](#) | [Published: 17 August 2022](#)

## Evidence for intrinsic charm quarks in the proton

[The NNPDF Collaboration](#)

[Nature](#) **608**, 483–487 (2022) | [Cite this article](#)

**43k** Accesses | **7** Citations | **373** Altmetric | [Metrics](#)

## Flow-oriented perturbation theory

Michael Borinsky,<sup>a</sup> Zeno Capatti,<sup>b</sup> Eric Laenen<sup>c,d,e</sup> and Alexandre Salas-Bernárdez<sup>f</sup>

## Power counting energy flow polynomials

Pedro Cal,<sup>a,b,c</sup> Jesse Thaler<sup>d,e</sup> and Wouter J. Waalewijn<sup>b,c</sup>

## First extraction of inclusive $V_{cb}$ from $q^2$ moments

Florian Bernlochner,<sup>a</sup> Matteo Fael,<sup>b</sup> Kevin Olschewsky,<sup>c</sup> Eric Persson,<sup>a</sup>  
Raynette van Tonder,<sup>d</sup> K. Keri Vos<sup>e,f</sup> and Maximilian Welsch<sup>a</sup>



# “SNAPSHOTS” OF RESEARCH (II)

PHYSICAL REVIEW LETTERS **129**, 121801 (2022)

## Pion-Induced Radiative Corrections to Neutron $\beta$ Decay

Vincenzo Cirigliano<sup>1,2,\*</sup>, Jordy de Vries<sup>3,4,†</sup>, Leendert Hayen<sup>5,6,‡</sup>,  
Emanuele Mereghetti<sup>1,§</sup> and André Walker-Loud<sup>7,||</sup>

Jan 2023

## New Perspectives for Testing Electron-Muon Universality

Robert Fleischer<sup>a,b</sup>, Eleftheria Malami<sup>a,c</sup>, Anders Rehult<sup>a</sup>, and K. Keri Vos<sup>a,d</sup>

<sup>a</sup>Nikhef, Science Park 105, NL-1098 XG Amsterdam, Netherlands

<sup>b</sup>Department of Physics and Astronomy, Vrije Universiteit Amsterdam,  
NL-1081 HV Amsterdam, Netherlands

## Resolving the flavor structure in the MFV-SMEFT

Sebastian Bruggisser<sup>a,b</sup>, Danny van Dyk<sup>c,d,e</sup> and Susanne Westhoff<sup>a,f,g</sup>

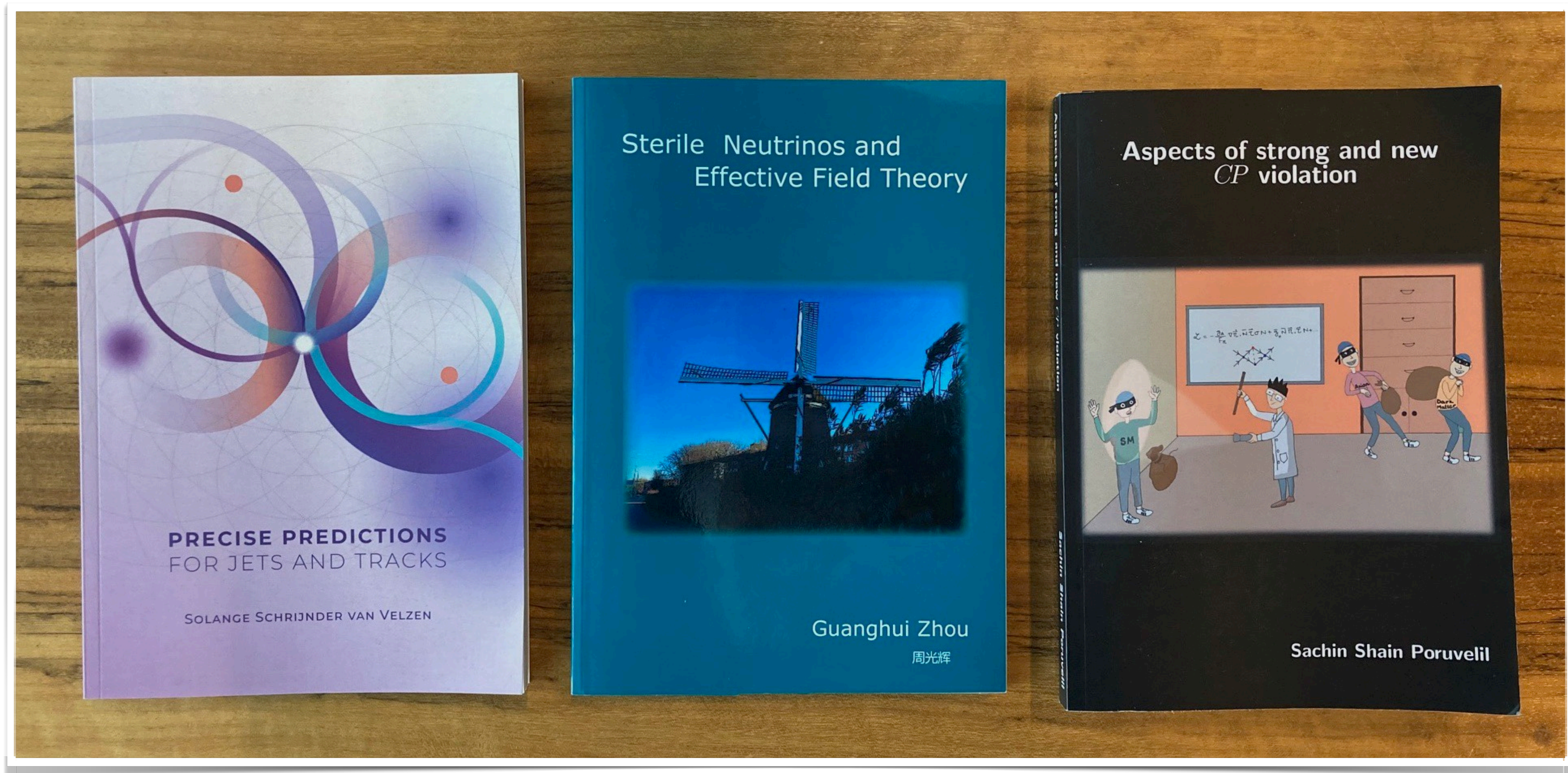
## SIMPLY add a dark photon

Pieter Braat<sup>a,b</sup> and Marieke Postma<sup>a,c</sup>

*+ many more papers and results ...*



# RECENT PHD THESES





# FUNDING:

- Two main pillars for our funding:
  - NWO-I: Nikhef mission budget
  - University consortium partners
- Grant applications:
  - We continue to apply: NWO, ERC, ...
  - Biggest last success:  
VIDI grant Jordy de Vries in 2021  
on topics about sterile neutrinos
  - Interview rounds in current round...
- New SUMMIT call:
  - Theory will be part of Nikhef proposal

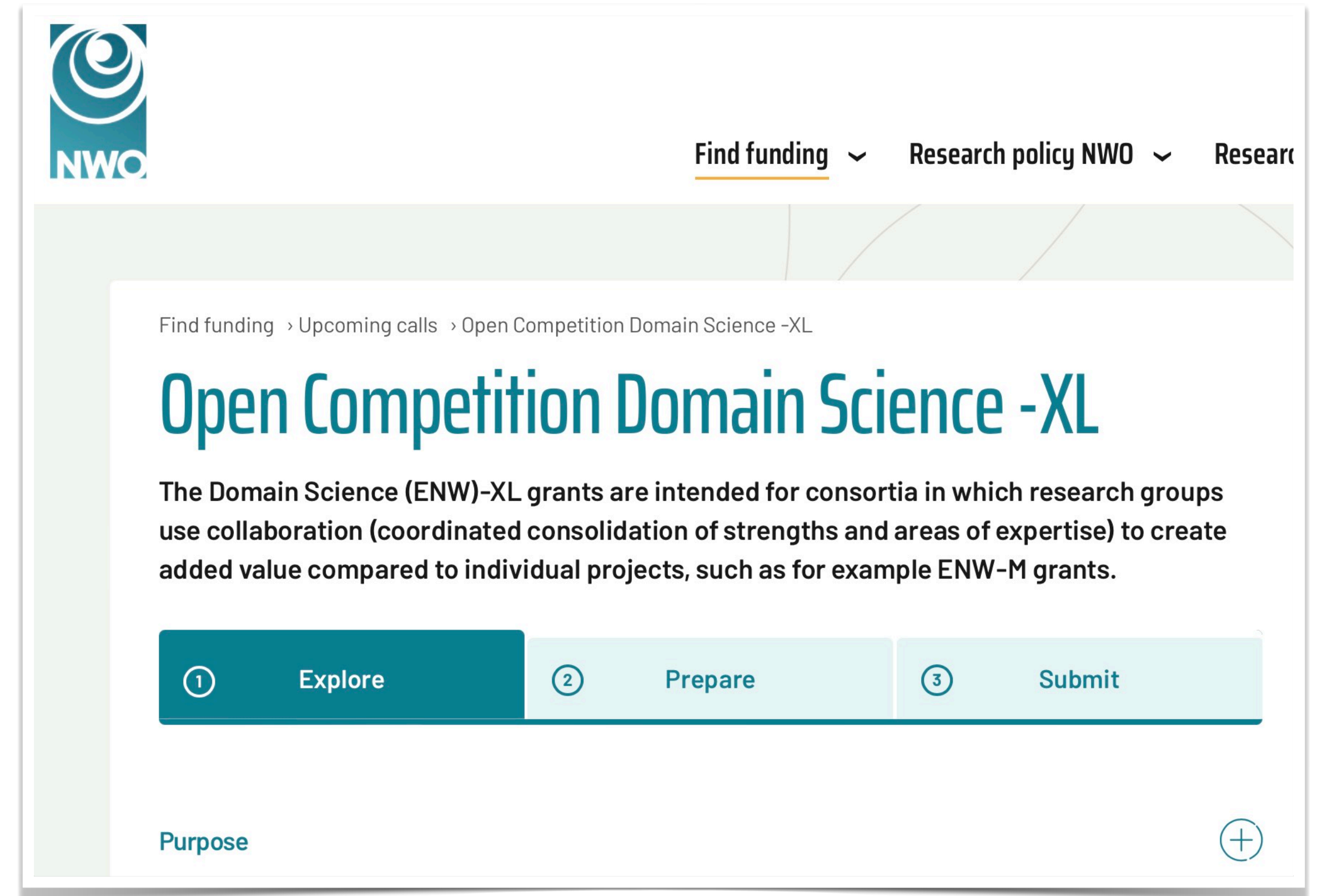
Nikhef





# NWO ENW-XL CONSORTIUM GRANTS

- 2019-2020: R.F., et al.:  
Towards the zeptouniverse using  
theoretical particle physics as  
quantum microscope: *not granted...*
- 2021-2022: E. Pallante, et al.:  
A Roadmap to the Microscopic  
Universe: Particle Physics Meets  
Gravity: *not granted...*
- 2023-2024:  
Series of more focused proposals...

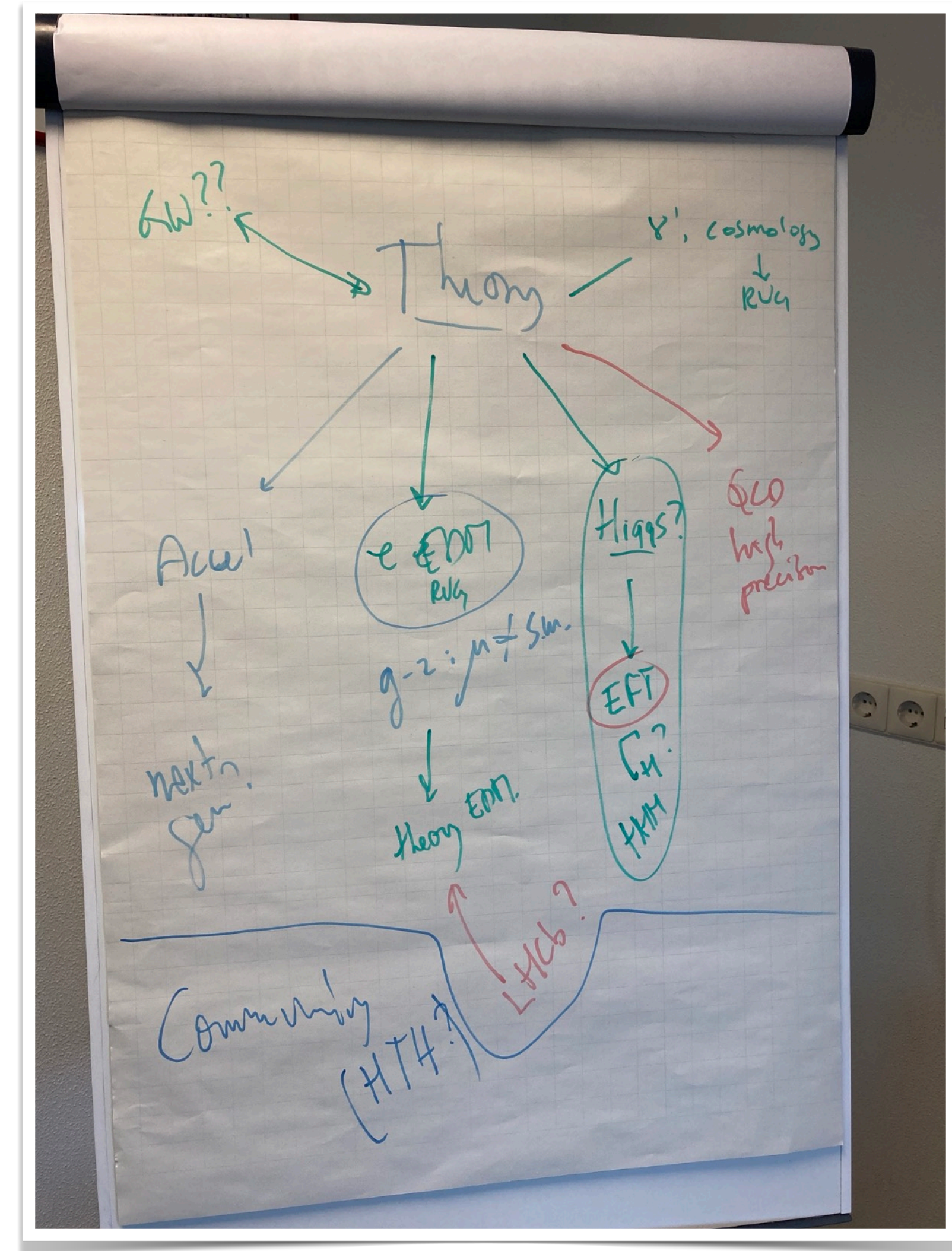




# FUTURE AMBITIONS: VISTA30 EXERCISE

We have made a survey in summer 2022 among the theory group staff members with the help of Juan Rojo and Jordy de Vries as preparation.

Had various fruitful meetings and discussions, which led to the following poster...





# Nikhef Theory @Vista30

## Ambitions for the Next Decade



### Key Scientific Drivers

- **Stress-testing the Standard Model** at colliders, flavour probes, and low-energy precision tests
- **Searching for New Physics** at all scales
- Answering fundamental questions:
  - What is the nature of **neutrinos**?
  - Does **Dark Matter** have a particle explanation?
- Further revealing the **structure of the proton**

### Short-Term Ambitions (1-5 years)

- Perform high-precision calculations for searches of **BSM physics**, building up on our world-class expertise in QCD, flavour, EFTs, ...
- Understand existing **anomalies** via interpretation and novel validation tests
- Develop **theory framework** for SM precision tests and new searches at the HL-LHC and future experiments, such as the Electron Ion Collider, Forward Physics Facility, ...
- Explore new research directions in:
  - **astroparticle and neutrino physics & cosmology**
  - theoretical physics applications of **artificial intelligence & quantum computing** (e.g. Monte Carlo simulations)
- Strengthen our role as the **Dutch National Center for Theoretical Particle Physics**
- **Continue actively pursuing funding opportunities (NWO-XL, ....)**
- Fill **vacant NWO-I staff position**



### SWOT Analysis

#### Strengths

- World-class research and visibility, strengthened by junior and diverse hires

#### Weaknesses

- Lost expertise in highest-order computations and BSM physics

#### Opportunities

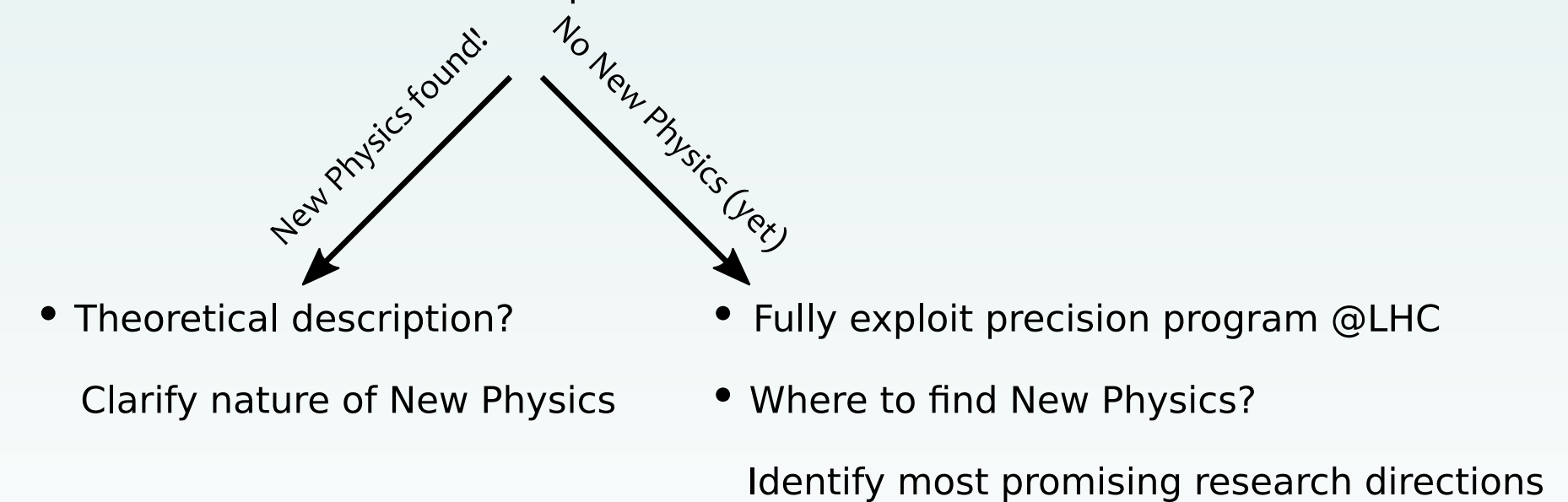
- Synergies with the Nikhef experimental programme
- Synergies within the theory community

#### Threats

- Funding situation
- Staff positions through Nikhef/NWO-I are limited

### Long-Term Ambitions (5-15 years)

Depends strongly on results from (HL-)LHC and other HEP/APP experiments:



**For all possible paths,  
a rich theoretical particle physics programme is crucial!**



# LOOKING FORWARD TO THE FUTURE

- Theoretical physics research...
- Further strengthen our role as the national centre for theoretical particle physics.
- Continue to play an active role in the Nikhef consortium, links with experiment, discussions about future colliders, etc., ...
- Nearer future: fill NWO-I staff position

