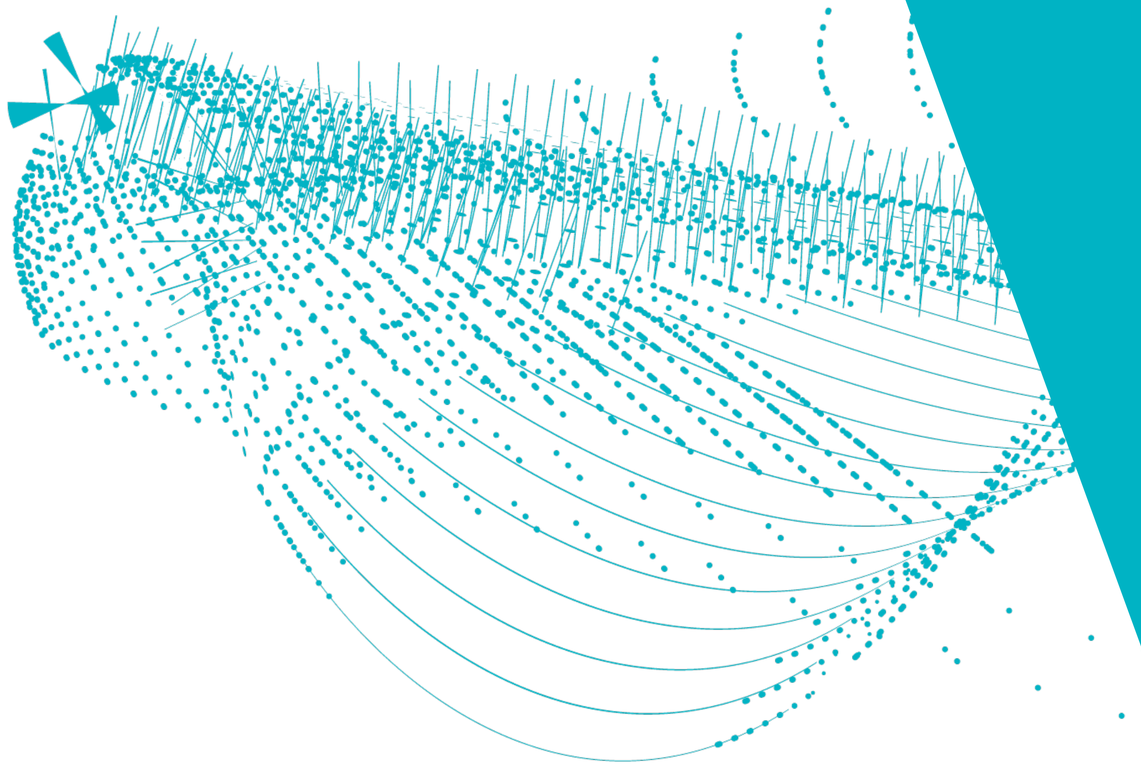
Nikhef



STAFF MEETING 17 OCTOBER 2019

THEORY NEWS OCTOBER 2019

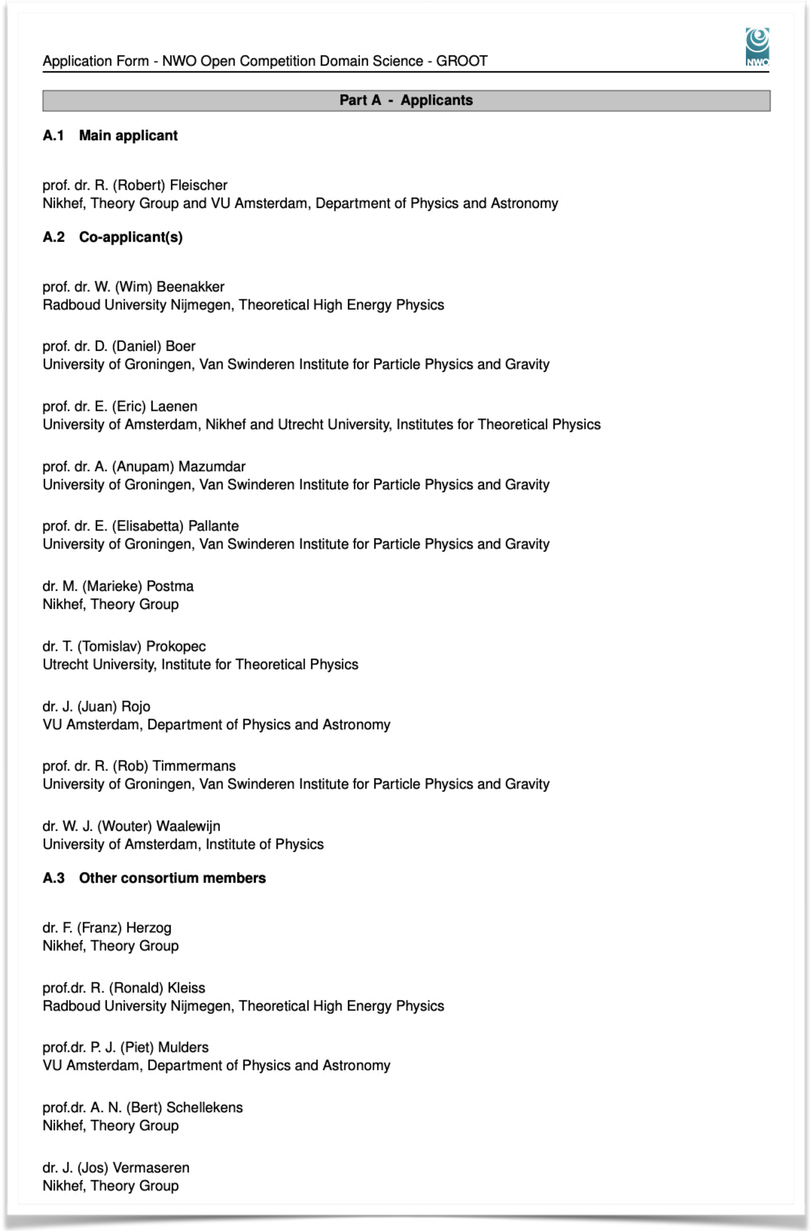
Robert Fleischer

NWO GROOT PROPOSAL

- Submitted full proposal in September:

  "Towards the zeptouniverse using theoretical particle physics as quantum microscope"

- Consortium of 11+5 theorists
- Nikhef+RU+RUG+UvA+VU+UU
- Asking for 7 PhD and 4 PD positions
- Budget 2.7 M€



Application Form - NWO Open Competition Domain Science - GROOT

Part A - Applicants

A.1 Main applicant

prof. dr. R. (Robert) Fleischer
Nikhef, Theory Group and VU Amsterdam, Department of Physics and Astronomy

A.2 Co-applicant(s)

prof. dr. W. (Wim) Beenakker
Radboud University Nijmegen, Theoretical High Energy Physics

prof. dr. D. (Daniel) Boer
University of Groningen, Van Swinderen Institute for Particle Physics and Gravity

prof. dr. E. (Eric) Laenen
University of Amsterdam, Nikhef and Utrecht University, Institutes for Theoretical Physics

prof. dr. A. (Anupam) Mazumdar
University of Groningen, Van Swinderen Institute for Particle Physics and Gravity

prof. dr. E. (Elisabetta) Pallante
University of Groningen, Van Swinderen Institute for Particle Physics and Gravity

dr. M. (Marieke) Postma
Nikhef, Theory Group

dr. T. (Tomislav) Prokopec
Utrecht University, Institute for Theoretical Physics

dr. J. (Juan) Rojo
VU Amsterdam, Department of Physics and Astronomy

prof. dr. R. (Rob) Timmermans
University of Groningen, Van Swinderen Institute for Particle Physics and Gravity

dr. W. J. (Wouter) Waalewijn
University of Amsterdam, Institute of Physics

A.3 Other consortium members

dr. F. (Franz) Herzog
Nikhef, Theory Group

prof.dr. R. (Ronald) Kleiss
Radboud University Nijmegen, Theoretical High Energy Physics

prof.dr. P. J. (Piet) Mulders
VU Amsterdam, Department of Physics and Astronomy

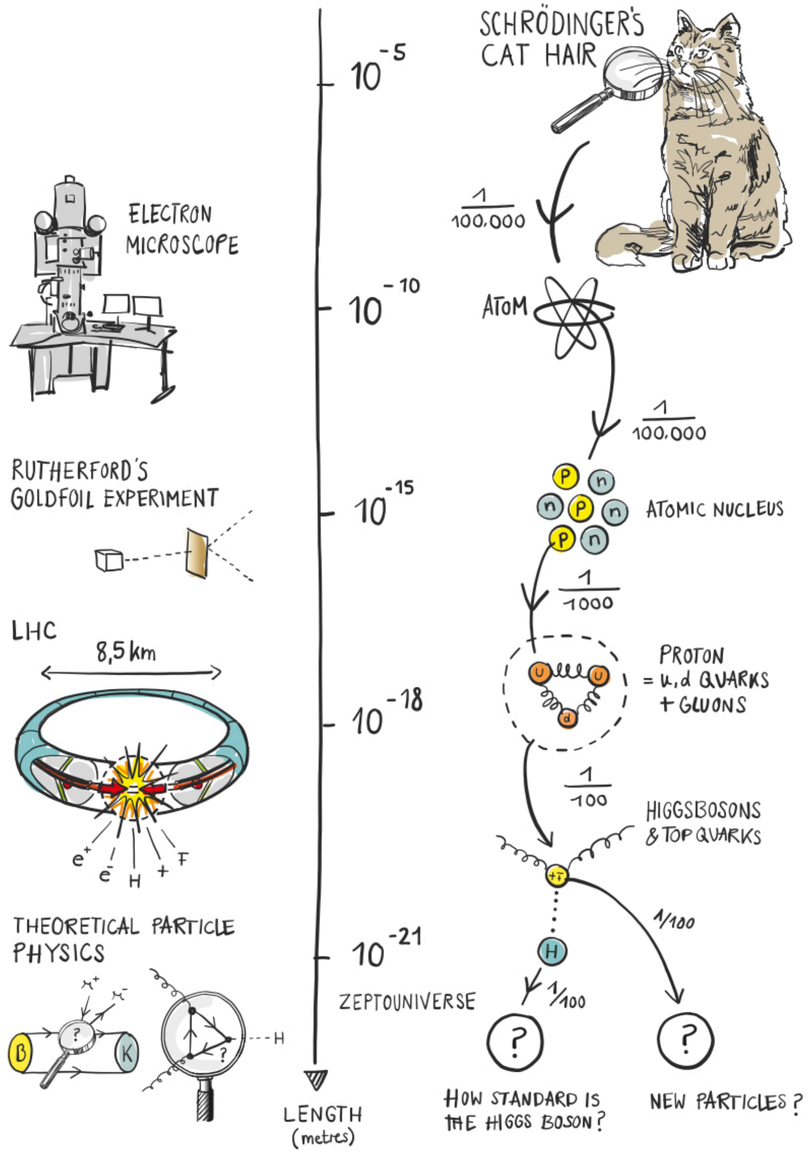
prof.dr. A. N. (Bert) Schellekens
Nikhef, Theory Group

dr. J. (Jos) Vermaseren
Nikhef, Theory Group

NWO GROOT PROPOSAL

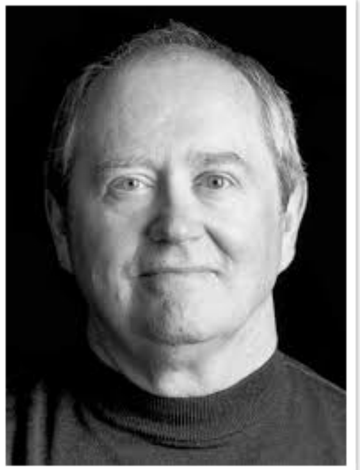
- Research topic:

A journey into the zeptouniverse:



(SHORT) VISIT CHRIS QUIGG

- *Two special colloquia:*



Colloquium/Symposium

Special Colloquium: "Beauty at High Precision / High Sensitivity" by Chris Quigg (Fermilab)

Tuesday, 29 October 2019 from **11:00** to **12:00** (Europe/Amsterdam)
at Nikhef

Description A little tour in beauty physics past and present, with thoughts on the future.

Colloquium/Symposium

Special Colloquium: "A Century of Noether's Theorem" by Chris Quigg (Fermilab)

Wednesday, 30 October 2019 from **11:00** to **12:00** (Europe/Amsterdam)
at Nikhef

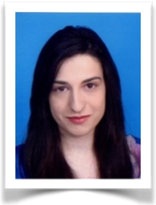
Description In the summer of 1918, Emmy Noether published the theorem that now bears her name, establishing a profound two-way connection between symmetries and conservation laws. The influence of this insight is pervasive in physics; it underlies all of our theories of the fundamental interactions and gives meaning to conservation laws that elevates them beyond useful empirical rules. Noether's papers, lectures, and personal interactions with students and colleagues drove the development of abstract algebra, establishing her in the pantheon of twentieth-century mathematicians. This colloquium, based on arxiv/1902.01989, traces her path from Erlangen through Göttingen to a brief but happy exile at Bryn Mawr College in Pennsylvania, illustrating the importance of "Noether's Theorem" for the way we think today.

SOCIAL MEDIA & WEBSITE

- Theory channels:

Instagram

Twitter



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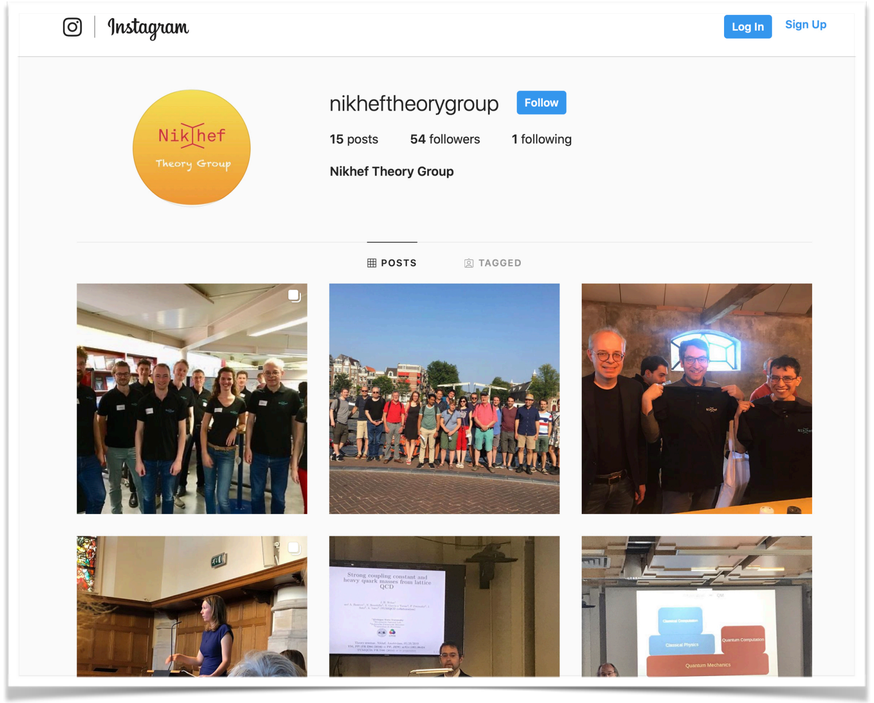
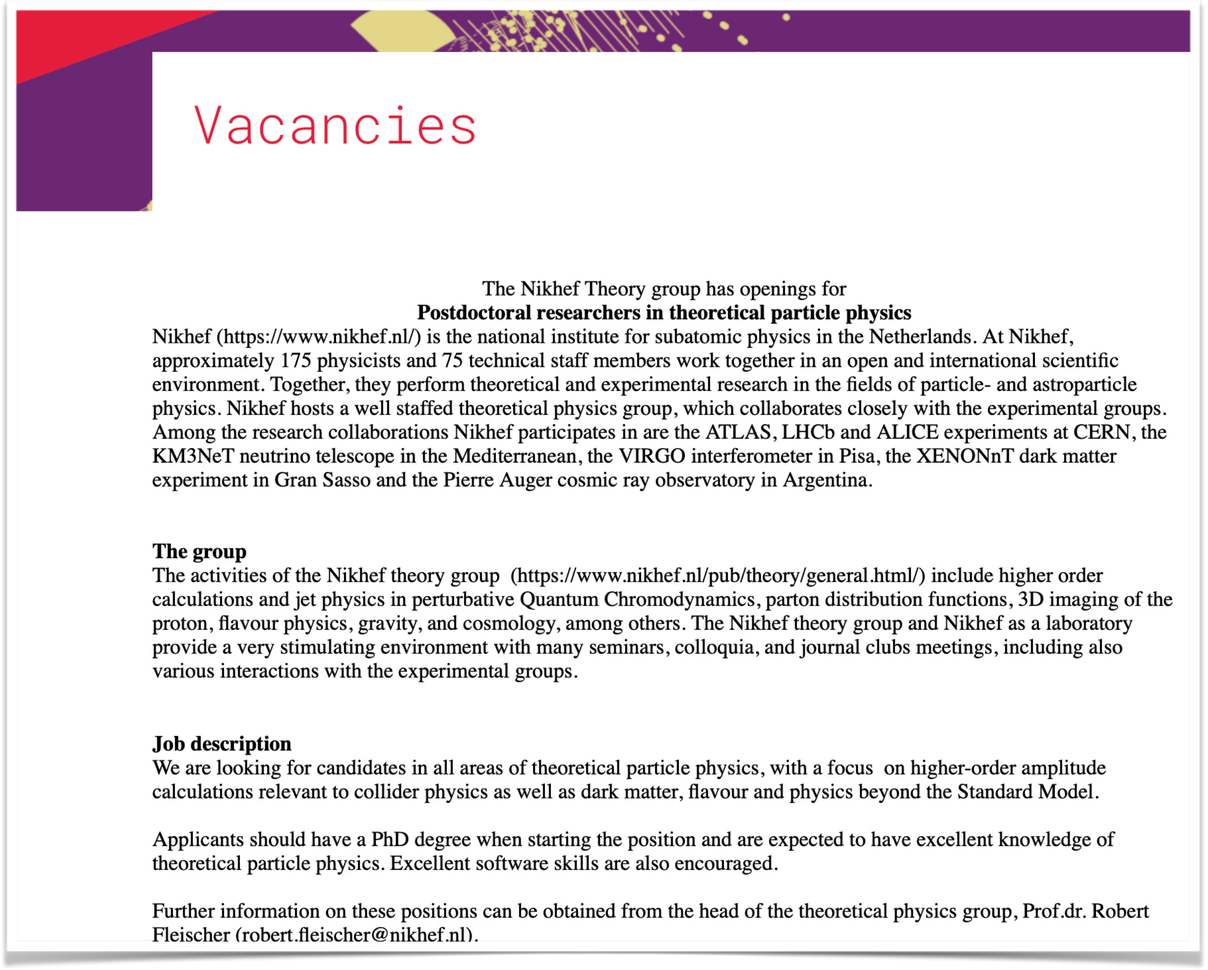


- Redesigning the *group website* with Melissa van der Sande:

for other groups…

POSTDOC POSITIONS

- We have two postdoc positions to fill this autumn:
  - Higher-order amplitude calculations (Vidi grant Franz Herzog)
  - Dark matter (Vidi Kallia Petraki)



Vacancies

The Nikhef Theory group has openings for
Postdoctoral researchers in theoretical particle physics

Nikhef (https://www.nikhef.nl/) is the national institute for subatomic physics in the Netherlands. At Nikhef, approximately 175 physicists and 75 technical staff members work together in an open and international scientific environment. Together, they perform theoretical and experimental research in the fields of particle- and astroparticle physics. Nikhef hosts a well staffed theoretical physics group, which collaborates closely with the experimental groups. Among the research collaborations Nikhef participates in are the ATLAS, LHCb and ALICE experiments at CERN, the KM3NeT neutrino telescope in the Mediterranean, the VIRGO interferometer in Pisa, the XENONnT dark matter experiment in Gran Sasso and the Pierre Auger cosmic ray observatory in Argentina.

The group
The activities of the Nikhef theory group (https://www.nikhef.nl/pub/theory/general.html/) include higher order calculations and jet physics in perturbative Quantum Chromodynamics, parton distribution functions, 3D imaging of the proton, flavour physics, gravity, and cosmology, among others. The Nikhef theory group and Nikhef as a laboratory provide a very stimulating environment with many seminars, colloquia, and journal clubs meetings, including also various interactions with the experimental groups.

Job description
We are looking for candidates in all areas of theoretical particle physics, with a focus on higher-order amplitude calculations relevant to collider physics as well as dark matter, flavour and physics beyond the Standard Model.

Applicants should have a PhD degree when starting the position and are expected to have excellent knowledge of theoretical particle physics. Excellent software skills are also encouraged.

Further information on these positions can be obtained from the head of the theoretical physics group, Prof.dr. Robert Fleischer (robert.fleischer@nikhef.nl).

RESEARCH SNAPSHOTS

Papers & cakes

Nikhef 2019-043

Triple Higgs boson production to six b-jets at a 100 TeV proton collider

Anomalous self-couplings and gauge-singlet scalars

Andreas Papaefstathiou[a,1,2], **Gilberto Tetlalmatzi-Xolocotzi**[b,2], **Marco Zaro**[c,2]

[1]Institute for Theoretical Physics Amsterdam and Delta Institute for Theoretical Physics, University of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands
[2]Nikhef, Theory Group, Science Park 105, 1098 XG, Amsterdam, The Netherlands

September 23, 2019

Abstract We investigate the production of three Higgs bosons at a proton-proton collider running at a centre-of-mass energy of 100 TeV, all of which decay into b-jets. This final state encapsulates by far the largest fraction of the total cross section of triple Higgs boson production, approximately 20%. We examine, by constructing detailed phenomenological analyses, two scenarios: (i) one in which the triple and quartic Higgs boson self-couplings are modified independently by new phenomena with respect to their Standard Model (SM) values and (ii) an extension of the SM by a gauge-singlet scalar that could drive first-order electroweak phase transition, within the context of the so-called xSM. In the former, we find that competitive constraints of $\mathcal{O}(1)$ can be placed on the quartic coupling and in the latter we demonstrate that it will be possible to obtain important information on the structure of the extended scalar sector.

tude better than today and to improve by almost an order of magnitude the discovery reach for new particles.

A particular "flagship" target of the FCC will be the investigation of the Higgs potential, through the measurement of the Higgs boson's (h) self-interactions that can be written, post-electroweak symmetry breaking (EWSB), as:

$$V(h) = \frac{1}{2}m_h^2 h^2 + \lambda_3 v_0 h^3 + \frac{1}{4}\lambda_4 h^4 \,, \qquad (1)$$

where $v_0 \simeq 246$ GeV is the Higgs vacuum expectation value (vev), $m_h \simeq 125$ GeV is the Higgs boson mass and the self-couplings take the values $\lambda_3 = \lambda_4 = m_h^2/2v_0^2 \equiv \lambda_{\rm SM}$ within the SM. Legacy LHC measurements are expected to provide an $\lesssim \mathcal{O}(1)$ measurement of the triple coupling, λ_3, with respect to its SM value [6, 7], and no significant direct information on the quartic self-coupling λ_4. On the other hand,

On the phenomenology of sphaleron-induced processes at the LHC and beyond

Andreas Papaefstathiou,[a,b] **Simon Plätzer,**[c] **Kazuki Sakurai,**[d]

[a]*Institute for Theoretical Physics Amsterdam and Delta Institute for Theoretical Physics, sity of Amsterdam, Science Park 904, 1098 XH Amsterdam, The Netherlands.*
[b]*Nikhef, Theory Group, Science Park 105, 1098 XG, Amsterdam, The Netherlands.*
[c]*Particle Physics, Faculty of Physics, University of Vienna, Vienna, Austria.*
[d]*Institute of Theoretical Physics, Faculty of Ph... PL–02–093 Warsaw, Poland.*

E-mail: apapaefs@cern.ch, simon.plaetze
kazuki.sakurai@fuw.edu.pl

Abstract: We investigate the phenomenologi
lepton-number-violating processes at hadron c
ton/sphaleron configurations of the electrowea
role in the generation of baryon asymmetry in
the other hand, at colliders (that represent th
rate and observability of such processes are st
oretical considerations, we construct a modern
Herwig Monte Carlo framework, that aims t
dominant processes. We perform a detailed
Large Hadron Collider, at 13 TeV proton-pro
energy upgrade at 27 TeV and the proposed Fu
We derive constraints on the expected rates fo
find that all three colliders are capable of prov
of instanton/sphaleron-induced processes at v

Nikhef/2019-042

The Partonic Content of Nucleons and Nuclei

Juan Rojo

Department of Physics and Astronomy, VU University, NL-1081 HV Amsterdam, and Nikhef Theory Group, Science Park 105, 1098 XG Amsterdam, The Netherlands

Abstract

Deepening our knowledge of the partonic content of nucleons and nuclei represents a central endeavour of modern high-energy and nuclear physics, with ramifications in related disciplines such as astroparticle physics. There are two main scientific drivers motivating these investigations of the partonic structure of hadrons. On the one hand, addressing fundamental open issues in our understanding in the strong interactions such as the origin of the nucleon mass, spin, and transverse structure; the presence of heavy quarks in the nucleon wave function; and the possible onset of novel gluon-dominated dynamical regimes. On the other hand, pinning down with the highest possible precision the substructure of nucleons and nuclei is a central component for theoretical predictions in a wide range of experiments, from proton and heavy ion collisions at the Large Hadron Collider to ultra-high energy neutrino interactions at neutrino telescopes. In this Article, I present a succinct non-technical overview of our modern understanding of the quark, gluon, and photon substructure of nucleons and nuclei, focusing on recent trends and results and discussing future perspectives for the field.

Invited Review Article to appear in the Oxford Research Encyclopedia of Physics

Stay tuned …