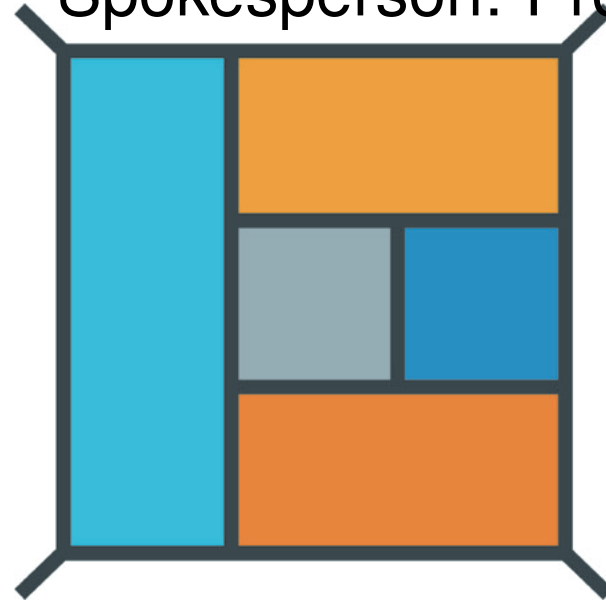


Humboldt-Universität zu Berlin

— 2020-2028 —

Spokesperson: Prof. Dr. Jan Plefka



RTG 2575:

Rethinking Quantum Field Theory

Proposed funding period: April 1st, 2020 to September 30th, 2024



*Rundgespräch: Theory Hub for Future
Circular Collider e⁺e⁻ Physics,
April 10th, 2019 July 2026*

Christophe Grojean

DESY (Hamburg)

Humboldt-Universität (Berlin)

rojean@desy.de)

DFG



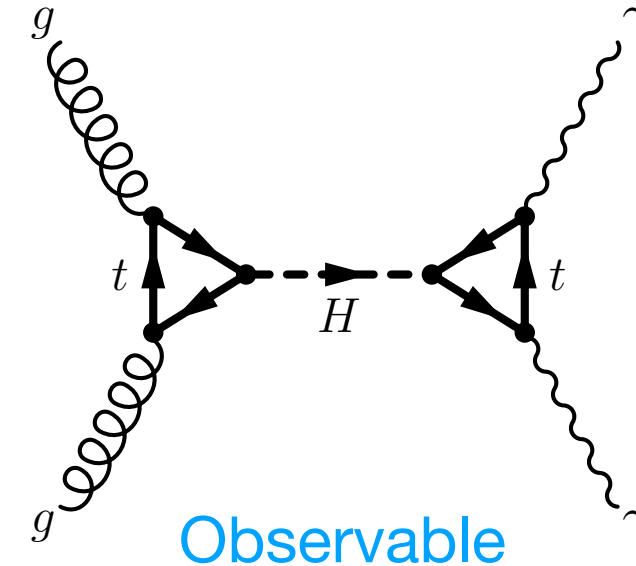
Quantum field theory: language to formulate **fundamental physics**

field content & symmetries

$$\mathcal{L} = \frac{1}{4} F_{\mu\nu} F^{\mu\nu} + i\bar{\psi}\not{D}\psi + |D_{\mu}\phi|^2 - V(\phi) + \bar{\psi}_L \hat{Y} \phi \psi_R + h.c.$$

Theory

path integral



Recent innovations $\Rightarrow$ Rethinking QFT!

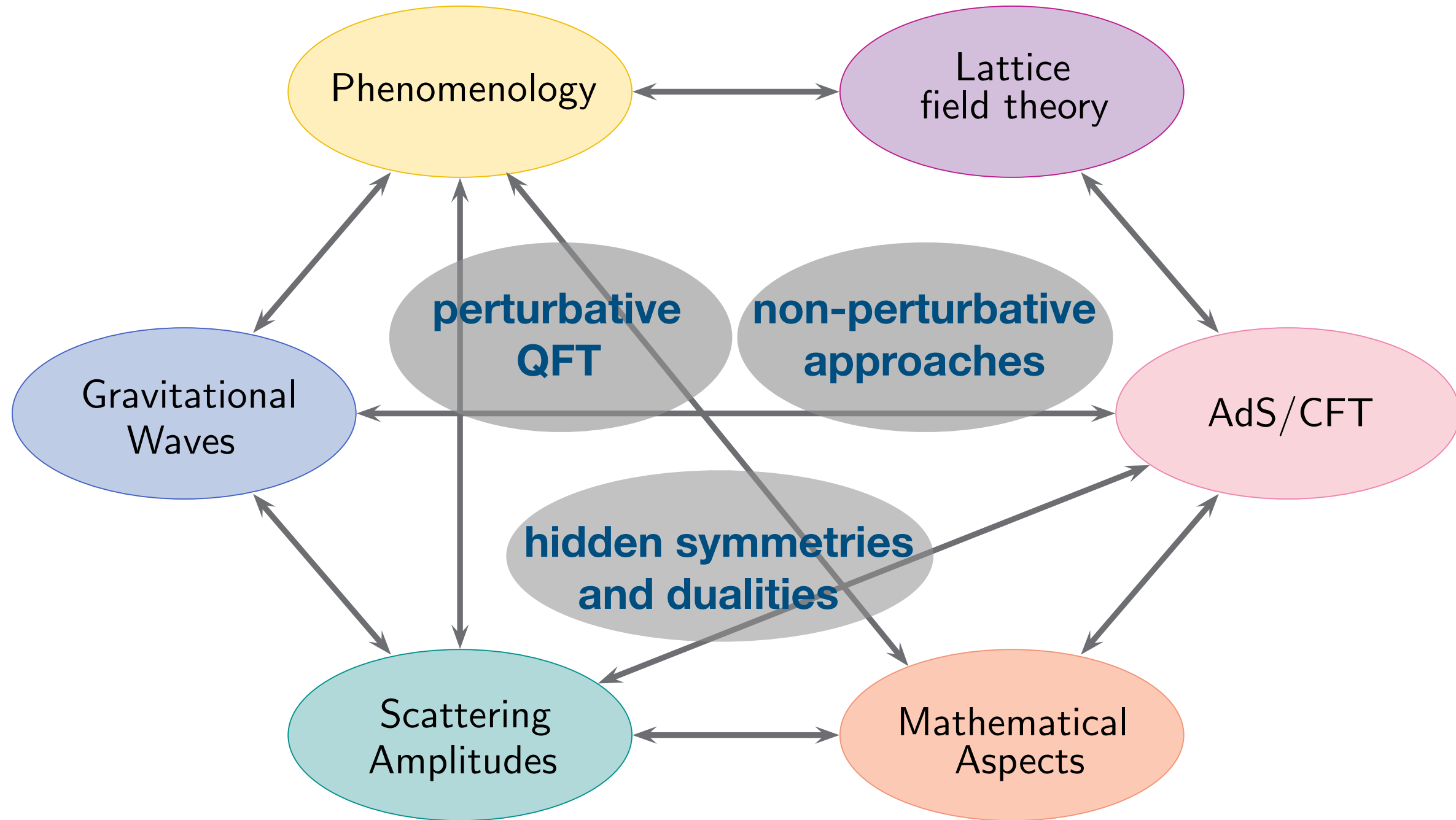
- ▶ Perturbation theory (on-shell approaches & multi-loop technology)
- ▶ Non-perturbative approaches (lattice field theory & AdS/CFT)
- ▶ Dualities and hidden symmetries in gauge theories and gravity
- ▶ Effective Field Theories (particle physics & gravity)

Need for high-precision predictions in Standard Model & class. Gravity



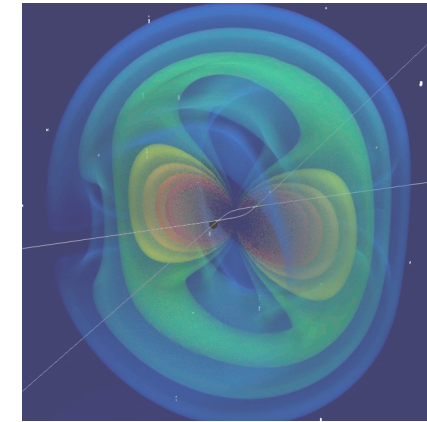
- 1) Train next generation of quantum field theorists providing a **broad methodological background** in QFT.
- 2) Further develop QFT innovations
- 3) Innovate applications in **particle physics & gravity**
- 4) **Foster synergies** between research branches involved

Research program



pQFT methods for high-precision gravitational wave physics

- ▶ **Worldline QFT** developed: State-of-the-art post-Minkowskian results for spinning black holes
- ▶ **Plans:** Effective one body for PM, radiative & spin effects in post-Newtonian expansion $\Rightarrow$ postdoc



Double copy: Gravity = (Yang-Mills) $\otimes$ (Yang-Mills)

- ▶ Embedding in Double field theory & L_∞ -algebras discovered
- ▶ Effective Field Theories 
- ▶ **Plans:** Homotopy algebras, EFT positivity constraints

$$e_{\mu\bar{\nu}} \sim A_\mu \otimes \bar{A}_{\bar{\nu}}$$

Research hi

Defect Conformal

- Wilson line corr

Recommended font sizes:

Poster title: 100 - 120 pt

Body titles: 40 pt

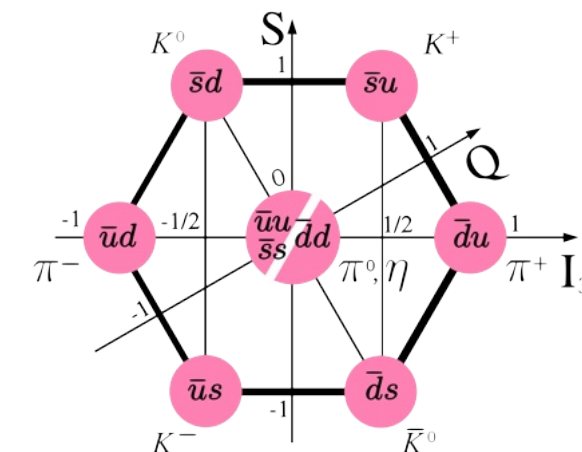
Body text: not smaller than 28pt

Lattice Field Thec

- 2d supersymmme
- High-precision p
radiative correct
- New: Multibaryc

Phenomenology

- Effective Field ~
- New: Heavy-qu





formal field theory (hep-th)

phenomenology (hep-ph)

lattice field theory (hep-lat)

gravit. waves (gr-qc)

Referent:



M. Staudacher



Precision Quantum Field Theory

(Habilitation)

Thema:

Zeit und Ort:



G. Borot

D 20, 16:40 Uhr

O 3BB / Zugang mit Browser (Firefox oder Chrome)



E. Malek

T mit ZIH-Login erreichen den Raum über folgenden Link:

<https://selfservice.zih.tu-dresden.de/link.php?m=54619&p=4a9ca2cf>

T mit ZIH-Login erreichen den Raum über folgenden Link:

<https://selfservice.zih.tu-dresden.de/link.php?m=54619&p=bb72e893>

Leiter:

NEW

Kurzfassung:

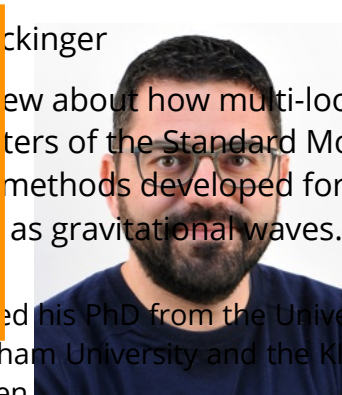
We present a new about how multi-loop calculations can be used to determine parameters of the Standard Model and study their behaviour. We show how methods developed for particle physics can be applied to other areas such as gravitational waves.

Biographie:

Peter Green received his PhD from the University of Freiburg in 2003. Afterwards, he spent time as postdoc at Durham University and the KIT. Since 2013 he is staff member in the theory group at DESY in Zeuthen.

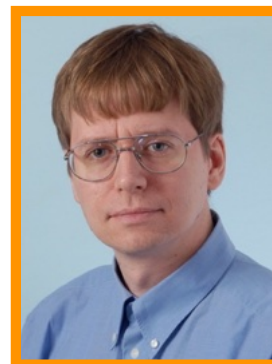


J. Green



A. Patella

NEW



P. Marquard



C. Grojean

NEW



J. Steinhoff



A. Buonanno

Funded PhDs

pheno
profiles
(7/34)

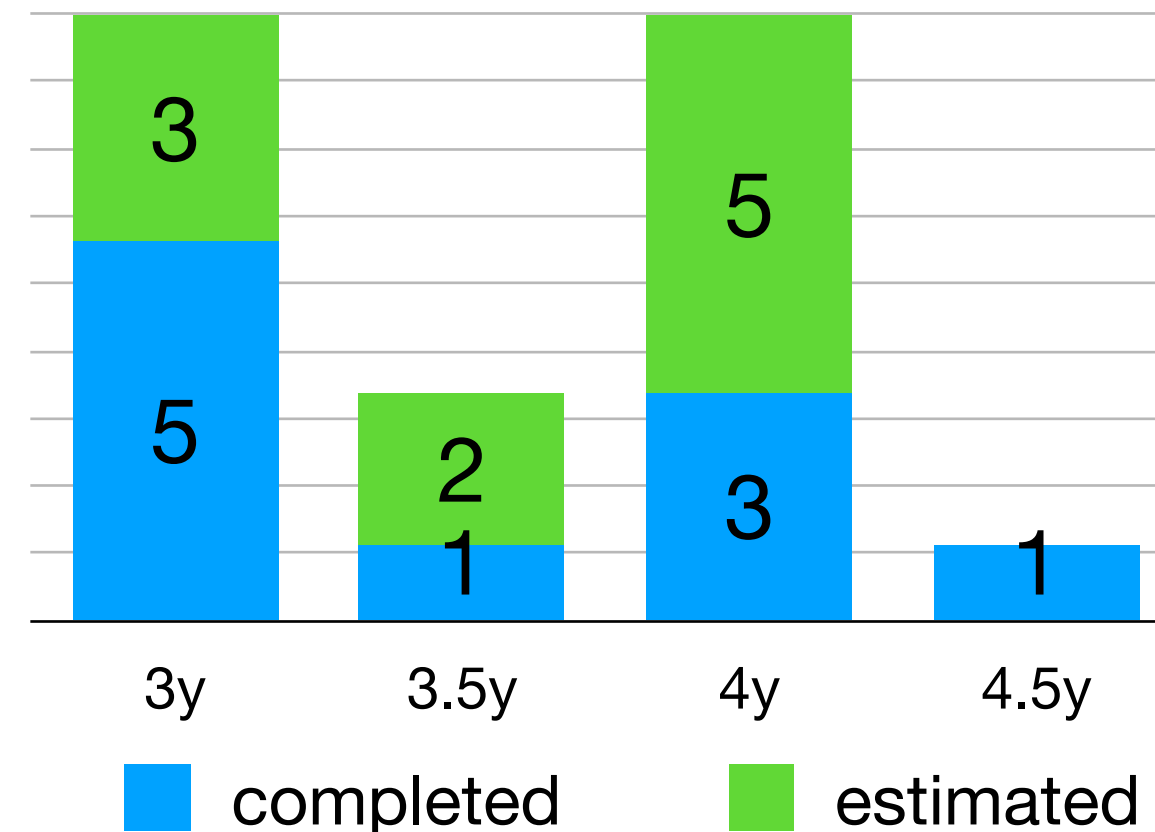
RTG-funded — PhD completed			
#	Name	Advisor	Thesis topic
1	Peveri, Giulia	Forini	Correlators on the Wilson line defect CFT
2	Broll, Alexander Roland	Sommer	Excited-state contamination in B-meson observables obtained from Lattice QCD
3	Costa, Ilaria	Forini/Patella	AdS/CFT via string sigma-models, perturbatively and beyond
→ 4	Artico, Daniele	Uwer	Numerical integration of multi-loop integrals
5	Codina, Tomas	Hohm	String α' -corrections and T-duality for cosmology and 2D black holes
6	Jakobsen, Gustav Uhre	Plefka	Gravitational scattering of compact bodies from worldline quantum field theory
→ 7	Meier, Tim	van Tongeren	Deformed integrable models and AdS/CFT
→ 8	Roosmale Nepveu, Jasper	Grojean	Beyond the Standard Model amplitudes
9	Barrat, Julien	Plefka	Line defects in conformal field theory: from weak to strong coupling
→ 10	Diaz-Jaramillo, Felipe	Hohm/Plefka	Double copy and double field theory
→ 11	Xu, Yingxuan	Uwer	Scattering amplitudes in QCD beyond NLO
→ 12	Cotellucci, Alessandro	Patella	Isospin breaking corrections with the Rome123 method and C $\star$ boundary conditions
13	Kade, Moritz	Staudacher	Exact solutions of integrable fishnet models
14	Patil, Raj	Steinhardt	Analytic predictions for gravitational waves
15	Sczusso, Davide	Borot	Low-dimensional quantum field theories and topological recursion
16	Sauer, Benjamin	Plefka	High precision black hole scattering

RTG-funded — ongoing			
#	Name	Advisor	Thesis topic
→ 1	Lauk, Mika	Patella	
2	Casale, Giuseppe	Hohm	
3	Stump, Andreas	Patella/Green	
4	Kallimani, Maria	Hohm	
5	Scherdin, Tobias	Staudacher	
→ 6	Stemplowski, Roman	Forini	
→ 7	Tabatt, Lucine	Grojean	
8	Bäske, Erik	Patella	
9	Lavino, Camilla	Hohm	
10	Stoldt, Kathrin	Plefka	
11	Cabello Gil, Julio	van Tongeren	
12	Eriksen, Carl Jordan	Plefka	
13	Merkens, Lasse	Borot	
14	Scheutz, Thomas	Staudacher/Klabbers	
15	Bora, Pietro	Forini	
16	Papadimos, Konstantinos	Steinhardt	
17	Littera, Tiziano	Buonanno	
→ 18	Pfohl, Philip	Marquard	

- ▶ Started 04/20 with the pandemic! Delayed hiring and on-boarding processes

— status as of March 2024 —

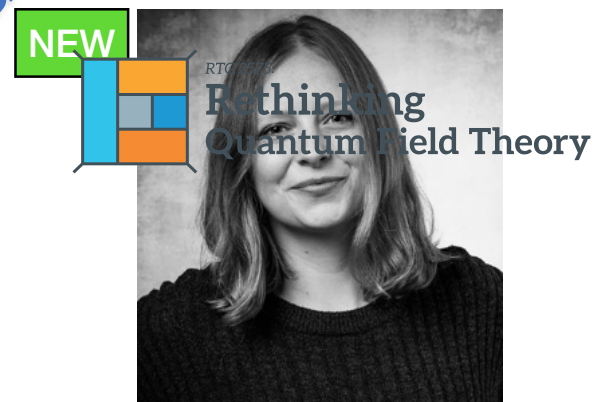
- ▶ Statistics of cohorts 20-23:
10 PhDs completed
10 in 2nd or 3rd year
7 in 1st year
- ▶ 0 drop outs
- ▶ Grades: 4x scl, 6x mcl



- ▶ Future careers of 10+2 graduates:
(4+2)x Postdoc positions, 2x RTG Startup funds, 4x private sector

2+3 RTG Postdocs

formal field theory (hep-th)



A. Spiering

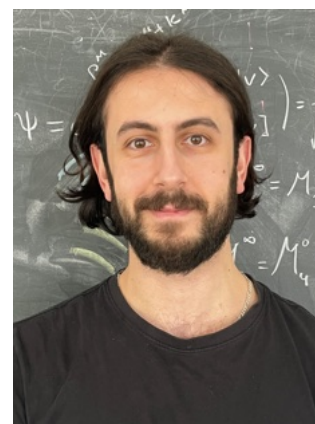
DFG



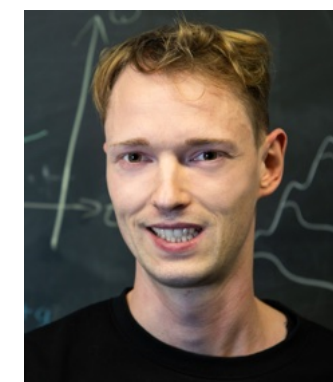
G. Mogull

phenomenology (hep-ph)

NEW



K. Haddad



G. Uhre
Jakobsen

lattice field theory (hep-lat)

DFG



J. Weber

gravit. waves (gr-qc)

► Lecture courses

- Type A/A+: Introductory
- Type B: Advanced topics in QFT (2 mandatory)
- Type C: Academic training, soft skills, computing (2+1 mandatory)

NEW

► Weekly young researcher seminar

Self organised by doctoral researchers w/o PIs!

► Monthly QFT colloquium

Bridges different research fields of RTG

So far: 18 invited speakers in past 4 years

► International workshop or school

(1 mandatory)

Annual retreat



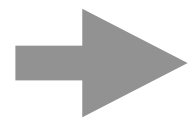
4 days in the fall outside of Berlin:

- ▶ External guest lecturer (past: Henn, Reffert, Wiese)
- ▶ Seminars of 2nd year PhDs & Posters for all others
- ▶ Careers beyond science talks
- ▶ Fosters interactions within RTG

Internship in neighbouring research group (1 mandatory)

NEW

- ▶ 4 weeks, fully immersed in host group
- ▶ Engage in small scale projects or sub-projects in larger collaboration

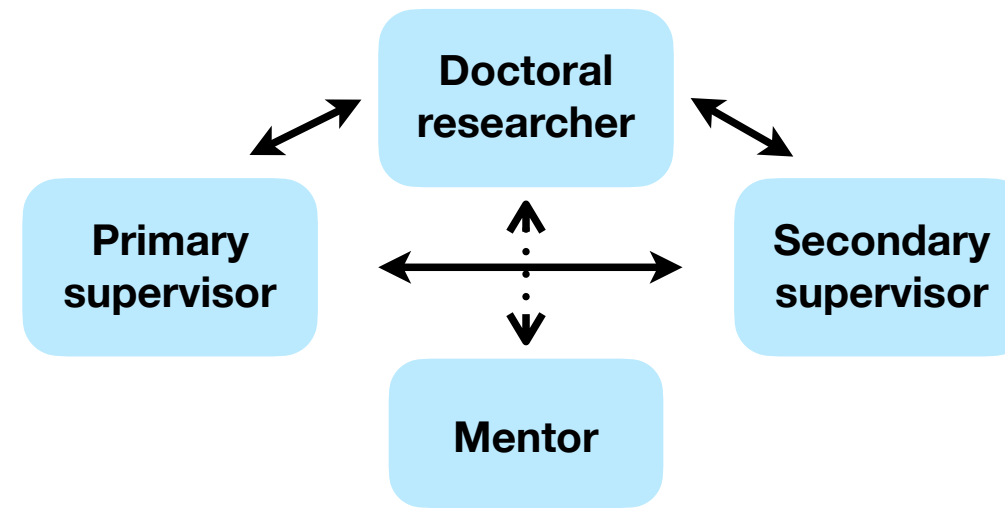


Doctoral students gain insight into new research fields guaranteeing a broad education in QFT

So far:

- ▶ 23 internships completed
- ▶ 3 joint intern/host group publications emerged!

Doctoral researchers:

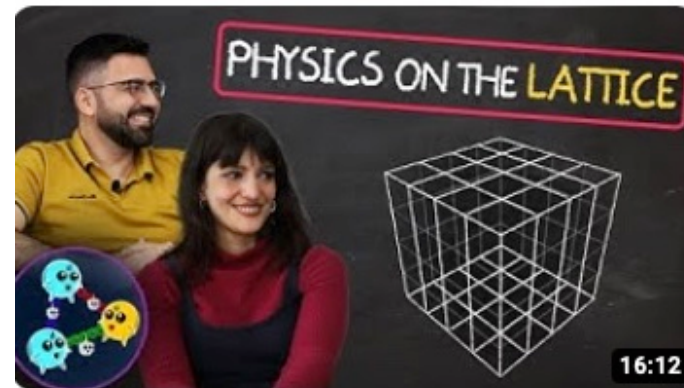


- ▶ Dual advisor concept
- ▶ Career development plan (CDP)
- ▶ Regular informal meetings with primary advisor
- ▶ Biannual CDP meetings with both advisors
- ▶ **Mentor** NEW

Outreach: YouTube channel



- ▶ Interviews on RTG research topics aimed at MINT students
- ▶ 10 episodes published including animations
- ▶ Flanked by Instagram, Tik-Tok teasers
- ▶ Completely student driven! $\Rightarrow$ see videos in poster session
- ▶ To be continued!



Symmetry is everywhere!



Noether's theorem
375 Aufrufe