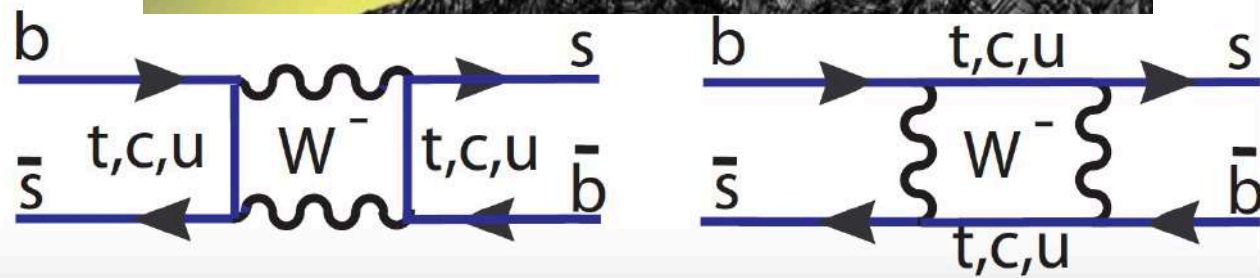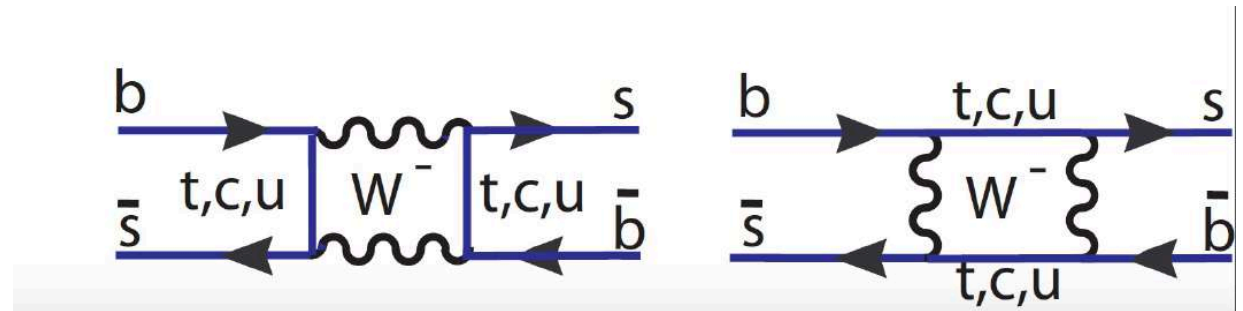# What comes beyond the anomalies?

Precision Calculations in Flavour Physics
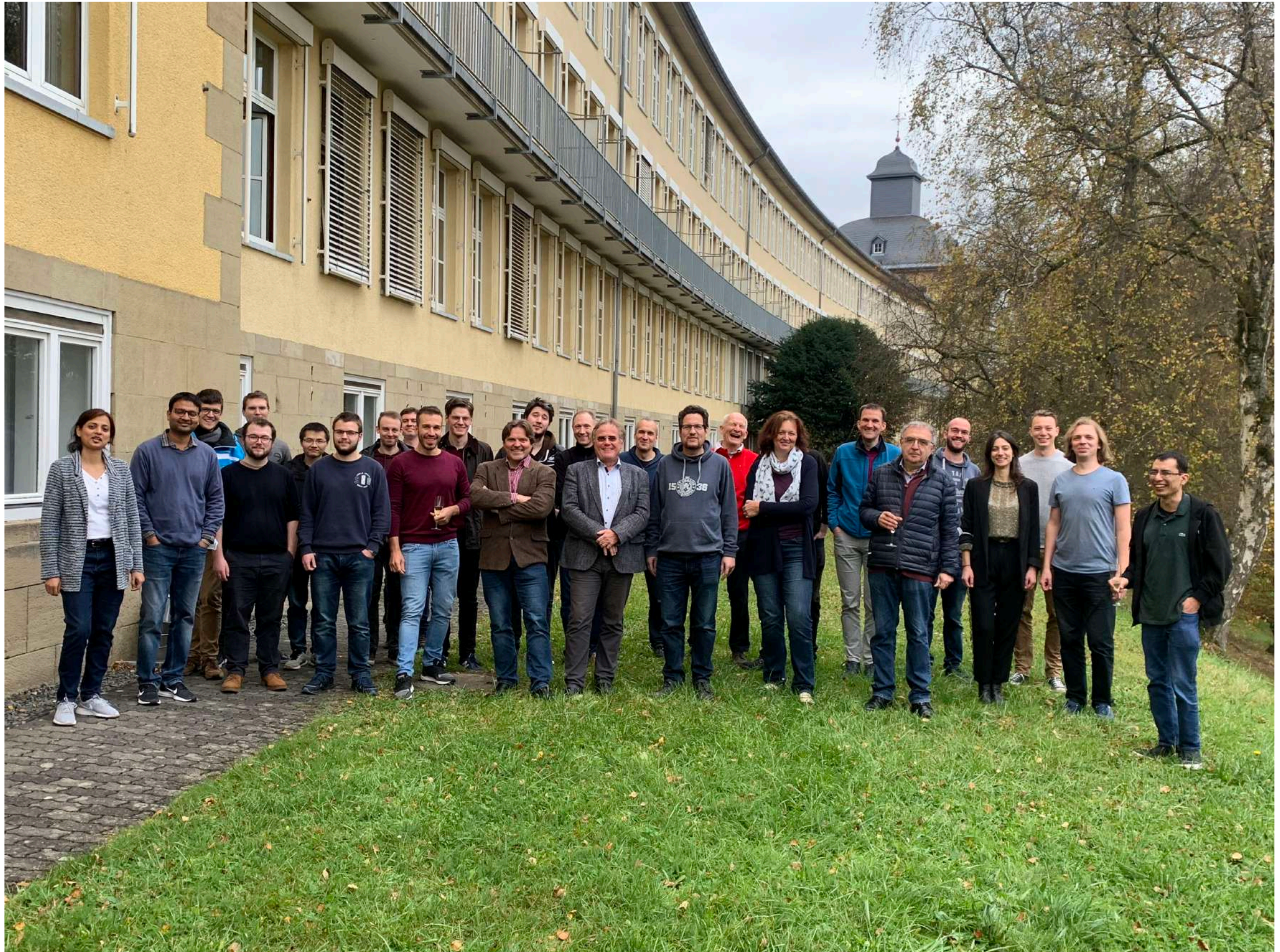

Alexander Lenz, Siegen

Journal Club

14.12.2022

Jahresrückblick 2022:

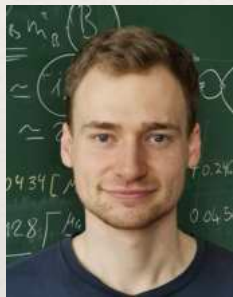## Precision Calculations in Particle Physics

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What was your personal TP1 Highlight in 2022?

Fully back at the Campus
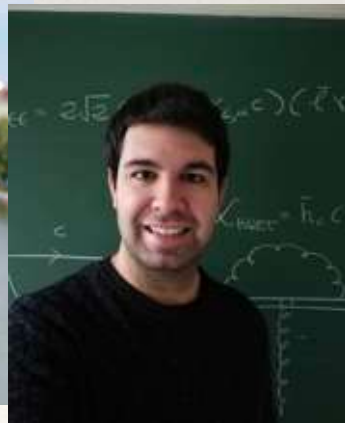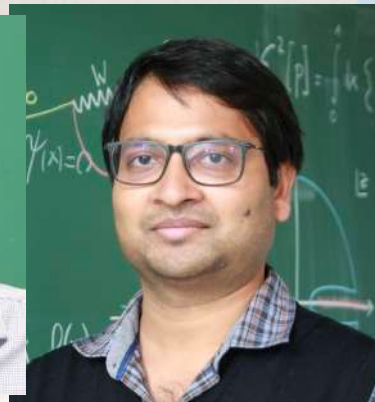
2022@TP1

New TP1 members - welcome to
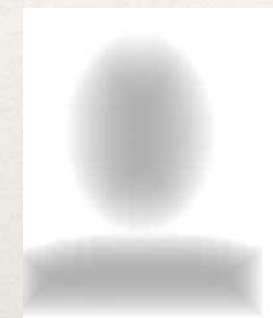
Pia Bredt (HH), Dennis Horstmann , Vlad Shtabovenko (KIT), Philipp Lüghausen (TUM), Elefetheria Malami (NIKHEF), Ilija Milutin (Radboud), Zachary Wüthrich (ETH), Pecan (Durham)

Finished PhDs   Good-bye to

Kevin Olschewsky   Kevin Brune   Robin Brüser   Oscar Cata Goutam Das   Rusa Mandal   Daniel Moreno

2022@TP1

TP1 Workshops:

- 53. Herbstschule für Hochenergiephysik 2022 (Maria Laach, 5.-15.9.2022)
- SMEFT'2022 : WE-Heraeus Summer School (11.-17.7.2022)
- Quirks in Quark Flavour Physics (Zadar, Croatia, 13. - 18.6.2022)
- Status and Prospects of Non-leptonic B meson decays (Siegen, 31.5.-2.6.2022)
- Challenges in Semileptonic B Decays (Barolo, Italy, 19.-23.4.2022)
- DPG Test-talks (18.3.2022)
- Charming Clues for Existence - MIAPP programme (Munich, 7.3.-1.4.2022)
- Flavour-Physics-school in Neckarzimmern (6.-8.2.2022)

Mikhail Shifman
19. Juni ·

The official title of the conference was "Quirks and Quarks in Flavor Physics", but in fact it was mostly devoted to heavy quark physics. I was invited by Blaženka Melić, whom I know for many years from various others physics places where we met from time to time. Currently, she is the Head of the Division of Theoretical Physics at Ruđer Bošković Institute in Zagreb, the main Croatian physics institute.

I am very happy that I came. I was amazed by the vibrancy of this field. The heavy quark theory, unlike some other areas, feeds on experimental results from LHCb and BELL II, which continue to come uninterrupted. This is a very healthy relationship. My last serious engagement with heavy quarks (HQ) was in ~2000. Then I completely shifted to SUSY. Well ... the HQ field is not only alive and well, it thrives, evolves, grows and expands, and attracts many young researchers. What a music for my heart. I devoted at least 10 years of my career to HQ, maybe more, in the 1980s and 1990s, and I see it was not in vain. Real physics, not fantasy science.

Danny van Dyk @DannyD82 · Jun 16
Good morning from #Quirks2022. This morning session is started by Aleksey Rusov. He's talking about CP asymmetries in flavour-specific non-leptonic decays, a joint project with @alexlenz42, @TJGershon, and @DrNicole1865

Quirks 2022
Alexei Pivovarov
Siegen University

2022@TP1

Alexander Lenz @alexlenz42 · Mar 10
Is this the charming clue for existence?
@MIAPP #charmingclues
munich-iapp.de/charmingclues

Alexander Lenz @alexlenz42 · Jun 2
Hade a great workshop! Thanks to everyone for coming to Siegen! Colour-allowed non-leptonic tree-level decays deviate more and more from the QCD factorisation expectation indico.scc.kit.edu/event/2641/ #therealanomaly
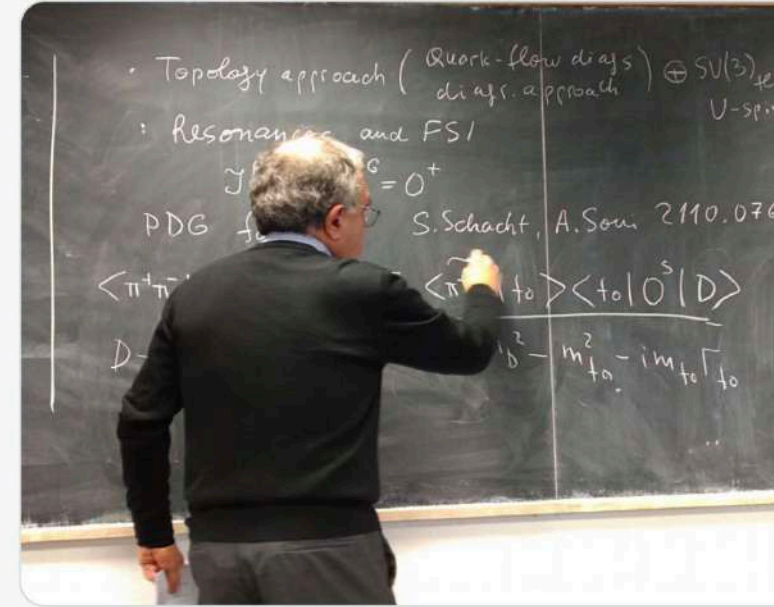
Herbstschule Maria Laach @AthanasiusReal · Sep 9
Comrade Александр (@alexlenz42) discovering that today's students don't know about the glorious November revolution any more

Alexander Lenz @alexlenz42 · Mar 10
I just opened the fridge @MIAPP #charmingclues
........munich-iapp.de/charmingclues

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SFB prolongation

APL: Tobias Huber
International PhD prize: Maria Laura Piscopo
STAR: Gilberto Tetlalmatzi-Xolocotzi (Orsay)
DFG Walter Benjamin: Maria Laura Piscopo
HYT:Anastasia Boushmelev
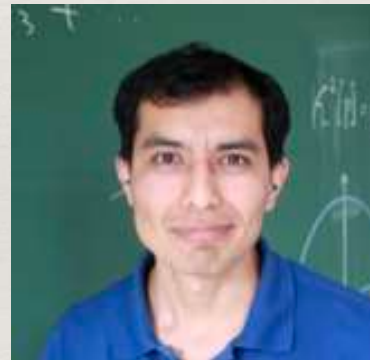
Universität Siegen @UniSiegen · Nov 28
Der Transregio-#Sonderforschungsbereich „Phänomenologische #Elementarteilchenphysik nach der Higgs-Entdeckung" geht in die Verlängerung. Damit wird in Siegen weiter auf internationalem Spitzenniveau an elementaren Fragen des Universums geforscht.u-si.de/rB9gp
Show this thread

Collaborative Research Center is extended

Sonderforschungsbereich wird verlängert

2022@TP1

Outreach:

Higgs@10   Studientag Physik
50a Uni Siegen - ENC   Pupils in TP1
50a Uni Siegen - Unteres Schloss

Alexander Lenz @alexlenz42 · Jul 9
Entertaining our visitors at @UniSiegen : Hunt your BBQ in the forests around Siegen #higgs10

Alexander Lenz @alexlenz42 · May 12
Open Day at the Emmy Noether Campus in Siegen - come and join the fun with "Big Bang on the road" @UniSiegen @stadt_siegen #Siegen @RadioSiegen

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Outreach:

Physik	Bewerber	Vorjahr	Jetzt
ausland.	1.	1.	1
Bachelor.	42.	26.	34 -> 42
LAG.	17.	5.	7
LA	5	2	4
Master	159.	6.	4
Prom.	7.	8.	9
Fak iV		1189	1137
Uni		5953.	5788

9. Februar 2022, 09:00 Uhr · 33× gelesen

SZ +

Universität Siegen

Studientag Physik begeistert Oberstufen-Schüler

Autor: Dr. Andreas Goebel (Redakteur)
aus Betzdorf

2 Bilder

Prof. Dr. Carsten Busse (r.) übergibt seinem Kollegen Prof. Dr. Alexander Lenz eine schwere Kugel, die der nach vorn schleudern wird. Die Kraft überträgt sich auch auf das Skateboard, auf dem er sitzt. · Foto: goeb · hochgeladen von Dominik Jung

future

Das Forschungsmagazin der Universität Siegen 2022
University of Siegen Research Magazine

Materie und Quantensysteme / Matter and Quantum Systems

Die mysteriöse Welt des Allerkleinsten
The Mysterious World of Ultra-Tiny Particles

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Shaping a Humane Future

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Visitors:
Oliver Atkinson, Christoph Englert
Blazenka Melic
James Gratrex, Ivan Nisandzic
Anna Hasenfratz

Seminars and journal club again in real life!
Talk - lottery:1. Session about renormalons by Jan

2022@TP1

Particle physics in 2022: some historical remarks
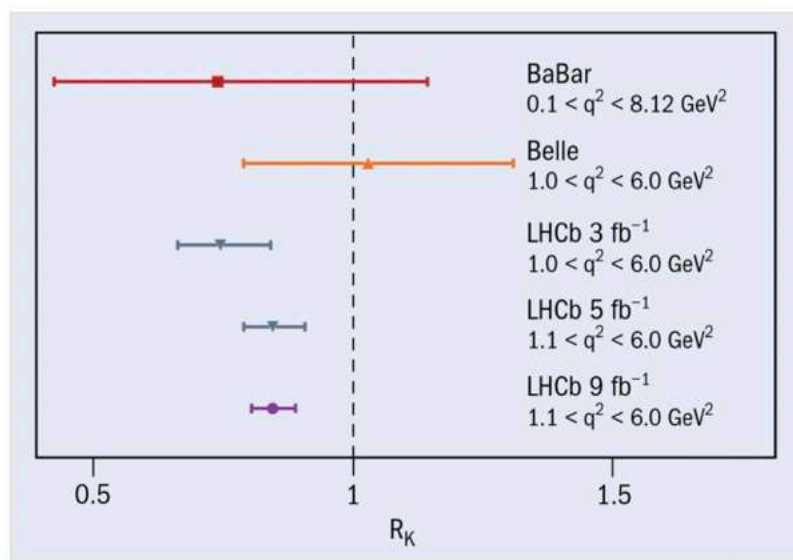1994 onwards: precise ratios differ from the expected value of one
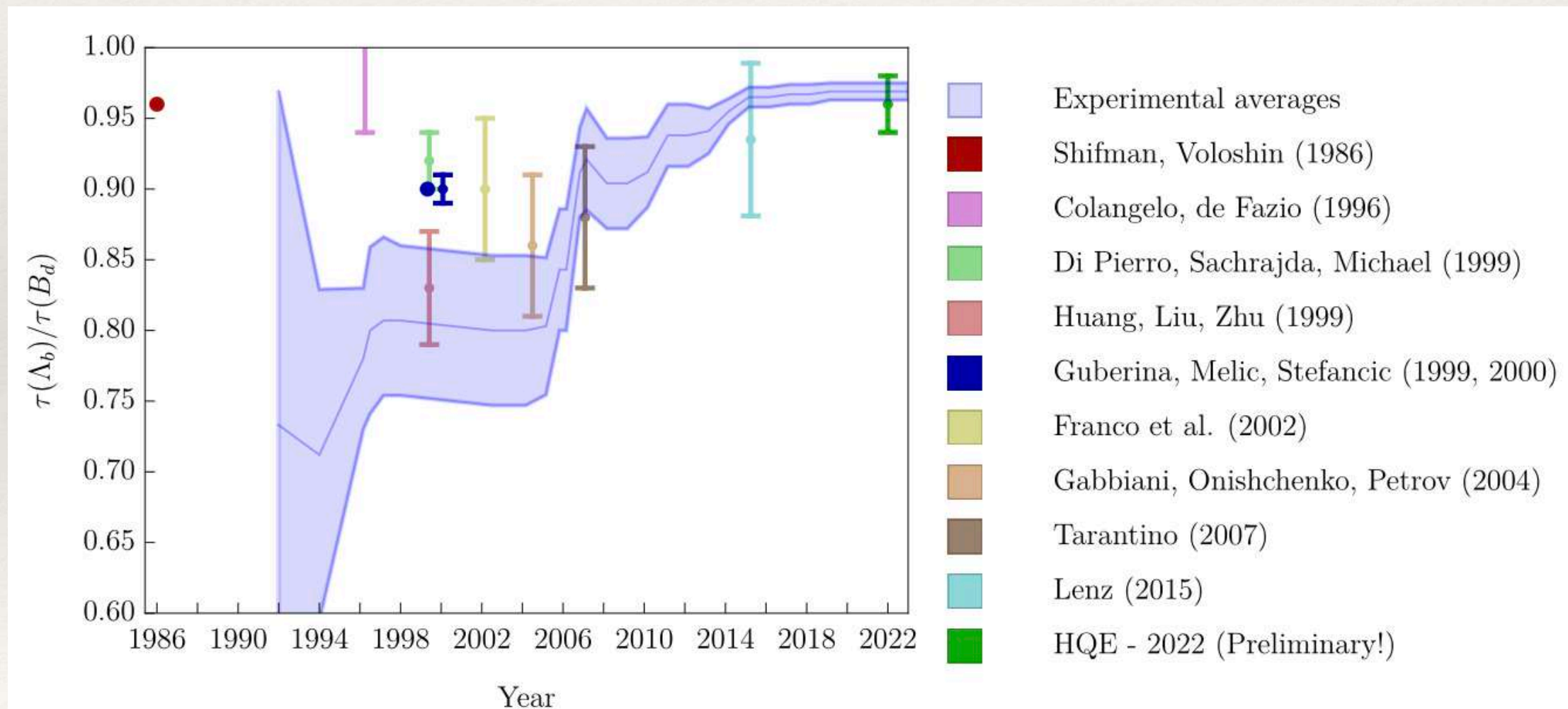
2022@TP1

Particle physics in 2022:

2012 onwards: precise ratios differ from the expected value of one

Comparison between R_K measurements In addition to the LHCb result, the measurements by the BaBar and Belle collaborations, which combine $B^+ \to K^+\ell^+\ell^-$ and $B^0 \to K_S^0\ell^+\ell^-$ decays, are also shown. Credit: LHCb

Systematic Parametrization of the Leading
B-meson Light-Cone Distribution Amplitude

Thorsten Feldmann*

Theoretische Physik 1, Universität Siegen, Walter-Flex-Straße 3, D-57068 Siegen, Germany

Philip Lüghausen†

Excellence Cluster ORIGINS, Technische Universität München, D-85748 Garching, Germany and
Physik Department T31, Technische Universität München, D-85748 Garching, Germany

Danny van Dyk‡

Physik Department T31, Technische Universität München, D-85748 Garching, Germany
(Dated: March 30, 2022)

We propose a parametrization of the leading B-meson light-cone distribution amplitude (LCDA) in heavy-quark effective theory (HQET). In position space, it uses a conformal transformation that yields a systematic Taylor expansion and an integral bound, which enables control of the truncation error. Our parametrization further produces compact analytical expressions for a variety of derived quantities. At a given reference scale, our momentum-space parametrization corresponds to an expansion in associated Laguerre polynomials, which turn into confluent hypergeometric functions $_3F_1$ under renormalization-group evolution at one-loop accuracy. Our approach thus allows a straightforward and transparent implementation of a variety of phenomenological constraints, regardless of their origin. Moreover, we can include theoretical information on the Taylor coefficients by using the local operator production expansion. We showcase the versatility of the parametrization in a series of phenomenological pseudo-fits.

On the contribution of the electromagnetic dipole operator $\mathcal{O}_7$
to the $\bar{B}_s \to \mu^+\mu^-$ decay amplitude

Thorsten Feldmann,* Nico Gubernari,† Tobias Huber,‡ and Nicolas Seitz§

Theoretische Physik 1, Center for Particle Physics Siegen (CPPS),
Universität Siegen, Walter-Flex-Straße 3, D-57068 Siegen, Germany
(Dated: November 9, 2022)

Abstract

We construct a factorization theorem that allows to systematically include QCD corrections to the contribution of the electromagnetic dipole operator in the effective weak Hamiltonian to the $B_s \to \mu^+\mu^-$ decay amplitude. We first rederive the known result for the leading-order QED box diagram, which features a double-logarithmic enhancement associated to the different rapidities of the light quark in the B_s meson and the energetic muons in the final state. We provide a detailed analysis of the cancellation of the related endpoint divergences appearing in individual momentum regions, and show how the rapidity logarithms can be isolated by suitable subtractions applied to the corresponding bare factorization theorem. This allows us to include in a straightforward manner the QCD corrections arising from the renormalization-group running of the hard matching coefficient of the electromagnetic dipole operator in soft-collinear effective theory, the hard-collinear scattering kernel, and the B_s-meson distribution amplitude. Focusing on the contribution from the double endpoint logarithms, we derive a compact formula that resums the leading-logarithmic QCD corrections.

New Sum Rules for the $B_c \to J/\psi$ Form Factors

M. BORDONE,* A. KHODJAMIRIAN,♭ TH. MANNEL♭

* Theoretical Physics Department, CERN, 1211 Geneva 23, Switzerland
♭ Center for Particle Physics Siegen (CPPS), Theoretische Physik 1,
Universität Siegen, D-57068 Siegen, Germany

Abstract

We derive new sum rules for the form factors of the $B_c \to J/\psi \, \ell\nu_\ell$ semileptonic transitions, employing the vacuum-to-B_c correlation function of the J/ψ-interpolating and $b \to c$ weak currents. In the heavy quark limit and at a space-like momentum transfer to the weak current, a local operator-product expansion is valid for this correlation function. As a result, in the leading power, the non-perturbative input is reduced to the decay constant of B_c meson. Furthermore, applying hadronic dispersion relation in the J/ψ channel, we find that a non-vanishing OPE spectral density in the duality interval of J/ψ emerges only at $\mathcal{O}(\alpha_s)$. We calculate this density in the relevant kinematic regime. The $B_c \to J/\psi$ form factors at space-like momentum transfer are then calculated from the new sum rules.

Cornering the Two Higgs Doublet Model Type II

Oliver Atkinson,ᵃ Matthew Black,ᵇ Alexander Lenz,ᵇ Aleksey Rusov,ᵇ James Wynneᶜ

ᵃSUPA, School of Physics & Astronomy, University of Glasgow, Glasgow G12 8QQ, UK
ᵇPhysik Department, Universität Siegen, Walter-Flex-Str. 3, 57068 Siegen, Germany
ᶜIPPP, Department of Physics, University of Durham, DH1 3LE, UK

E-mail: o.atkinson.1@research.gla.ac.uk, Matthew.Black@uni-siegen.de,
Alexander.Lenz@uni-siegen.de, rusov@physik.uni-siegen.de,
jameswynne38@gmail.com

ABSTRACT: We perform a comprehensive study of the allowed parameter space of the Two Higgs Doublet Model of Type II (2HDM-II). Using the theoretical framework flavio we combine the most recent flavour, collider and electroweak precision observables with theoretical constraints to obtain bounds on the mass spectrum of the theory. In particular we find that the 2HDM-II fits the data slightly better than the Standard Model (SM) with best fit values of the heavy Higgs masses around 2 TeV and a value of $\tan\beta \approx 4$. Moreover, we conclude that the wrong-sign limit is disfavoured by Higgs signal strengths and excluded by the global fit by more than three standard deviations and potential deviations from the alignment limit can only be tiny. Finally we test the consequences of our study on electroweak baryogenesis via the program package BSMPT and we find that the allowed parameter space strongly discourages a strong first order phase transition within the 2HDM-II.

2022@TP1

Particle physics by TP1 in 2022:
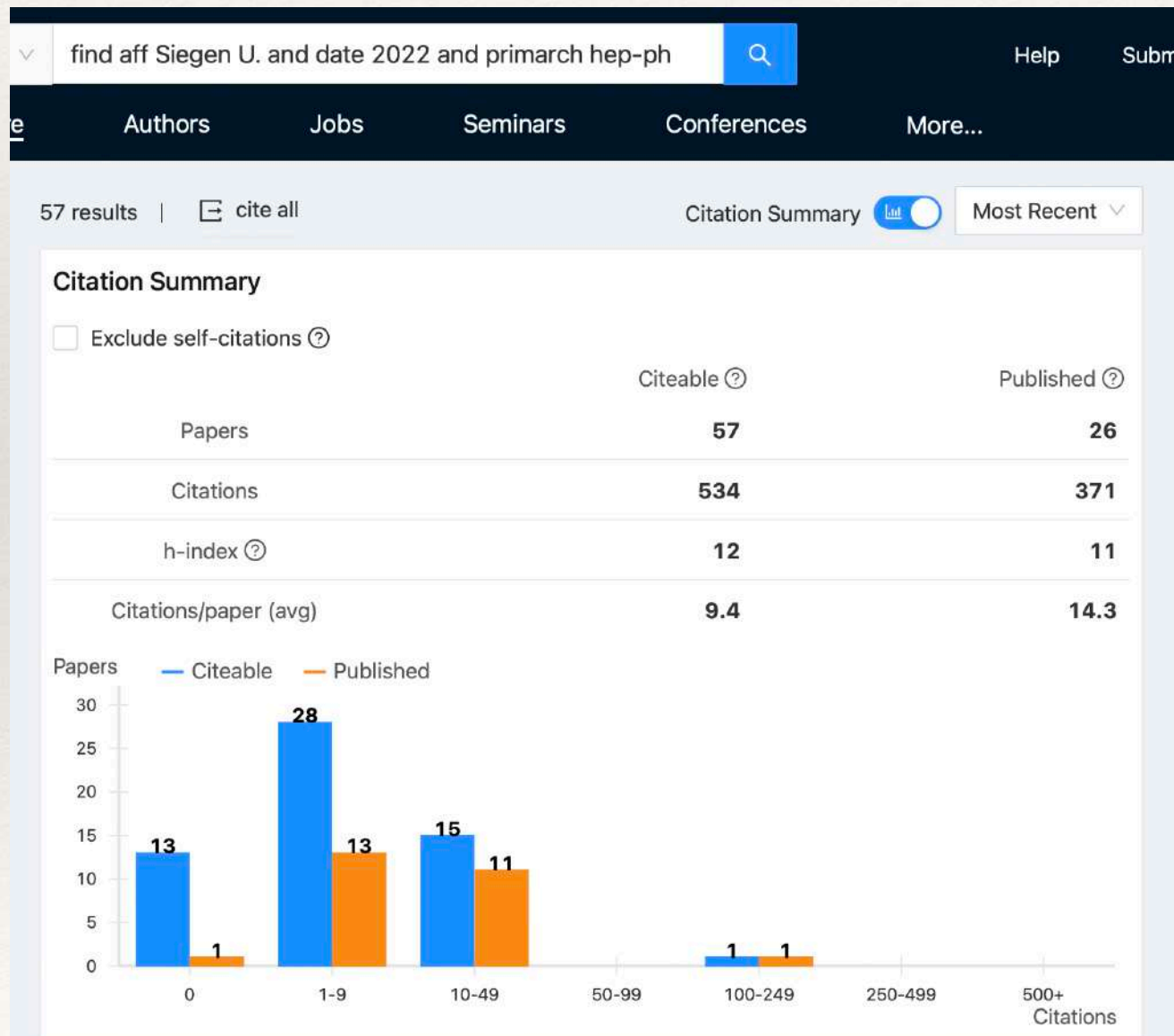
The NNLO quark beam function for jet-veto resummation

Guido Bell, Kevin Brune, Goutam Das, and Marcel Wald

Theoretische Physik 1, Center for Particle Physics Siegen, Universität Siegen, Germany

E-mail: bell@physik.uni-siegen.de, brune@physik.uni-siegen.de,
goutam.das@uni-siegen.de, marcel.wald@uni-siegen.de

ABSTRACT: We consider the quark beam function that describes collinear initial-state radiation that is constrained by a veto on reconstructed jets. As the veto is imposed on the transverse momenta of the jets, the beam function is subject to rapidity divergences, and we use the collinear-anomaly framework to extract the perturbative matching kernels to next-to-next-to-leading order (NNLO) in the strong-coupling expansion. Our calculation is based on a novel framework that automates the computation of beam functions in Mellin space and it provides the ingredients to extend jet-veto resummations for quark-initiated processes to NNLL′ accuracy.

$B \to D_1(2420)$ and $B \to D_1'(2430)$ form factors
from QCD light-cone sum rules

Nico Gubernari*, Alexander Khodjamirian†, Rusa Mandal‡, and Thomas Mannel§

Center for Particle Physics Siegen (CPPS), Theoretische Physik 1,
Universität Siegen, 57068 Siegen, Germany

Abstract

We perform the first calculation of form factors in the semileptonic decays $B \to D_1(2420)\ell\nu_\ell$ and $B \to D_1'(2430)\ell\nu_\ell$ using QCD light-cone sum rules (LCSRs) with B-meson distribution amplitudes. In this calculation the c-quark mass is finite. Analytical expressions for two-particle contributions up to twist four are obtained. To disentangle the D_1 and D_1' contributions in the LCSRs, we suggest a novel approach that introduces a combination of two interpolating currents for these charmed mesons. To fix all the parameters in the LCSRs, we use the two-point QCD sum rules for the decay constants of D_1 and D_1' mesons augmented by a single experimental input, that is the $B \to D_1(2420)\ell\nu_\ell$ decay width. We provide numerical results for all $B \to D_1$ and $B \to D_1'$ form factors. As a byproduct, we also obtain the D_1- and D_1'-meson decay constants and predict the lepton-flavour universality ratios $R(D_1)$ and $R(D_1')$.

B-meson decay into a proton and dark antibaryon from
QCD light-cone sum rules

Alexander Khodjamirian and Marcel Wald

Center for Particle Physics Siegen (CPPS), Theoretische Physik 1,
Universität Siegen, D-57068 Siegen, Germany

The recently developed B-Mesogenesis scenario predicts decays of B mesons into a baryon and hypothetical dark antibaryon Ψ. We suggest a method to calculate the amplitude of the simplest exclusive decay mode $B^+ \to p\Psi$. Considering two models of B-Mesogenesis, we obtain the $B \to p$ hadronic matrix elements by applying QCD light-cone sum rules with the proton light-cone distribution amplitudes. We estimate the $B^+ \to p\Psi$ decay width as a function of the mass and effective coupling of the dark antibaryon.

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Particle physics in 2022:

FEYNMAN INTEGRAL REDUCTION USING GRÖBNER BASES

MOHAMED BARAKAT, ROBIN BRÜSER, CLAUS FIEKER, TOBIAS HUBER, AND JAN PICLUM

ABSTRACT. We investigate the reduction of Feynman integrals to master integrals using Gröbner bases in a rational double-shift algebra Y in which the integration-by-parts (IBP) relations form a left ideal. The problem of reducing a given family of integrals to master integrals can then be solved once and for all by computing the Gröbner basis of the left ideal formed by the IBP relations. We demonstrate this explicitly for several examples. We introduce so-called first-order normal-form IBP relations which we obtain by reducing the shift operators in Y modulo the Gröbner basis of the left ideal of IBP relations. For more complicated cases, where the Gröbner basis is computationally expensive, we develop an ansatz based on linear algebra over a function field to obtain the normal-form IBP relations.

$$\mathcal{E} = \left(\mathcal{E}^i_{j,c}\right)$$

$$:= J \cdot \underbrace{\left[I_L \otimes \left(\ell_1 \quad \cdots \quad \ell_L \quad k_1 \quad \cdots \quad k_E\right)\right]}_{=T^{LD' \times L(L+E)}} = \left(\frac{\partial P_c}{\partial \ell^\mu_i} B^\mu_j\right) \in T^{n \times L(L+E)} \subset \widetilde{T}^{n \times L(L+E)},$$

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Particle physics in 2022: Contribution to SNOWMASS initiative

CERN-TH-2022-036   FERMILAB-CONF-22-433-SCD-T   JLAB-THY-22-3582
MITP-22-020   MIT-CTP/5413   MS-TP-22-07   SI-HEP-2022-11

A lattice QCD perspective on weak decays of b and c quarks
Snowmass 2022 White Paper

Peter A. Boyle,[1,2] Bipasha Chakraborty,[3] Christine T. H. Davies,[4] Thomas DeGrand,[5] Carleton DeTar,[6] Luigi Del Debbio,[2] Aida X. El-Khadra,[7] Felix Erben,[2] Jonathan M. Flynn,[8] Elvira Gámiz,[9] Davide Giusti,[10] Steven Gottlieb,[11] Maxwell T. Hansen,[2] Jochen Heitger,[12] Ryan Hill,[2] William I. Jay,[13] Andreas Jüttner,[8,14,15] Jonna Koponen,[16] Andreas Kronfeld,[17] Christoph Lehner,[10] Andrew T. Lytle,[7,*] Guido Martinelli,[18] Stefan Meinel,[19] Christopher J. Monahan,[20,21] Ethan T. Neil,[5] Antonin Portelli,[2] James N. Simone,[17] Silvano Simula,[22] Rainer Sommer,[23,24] Amarjit Soni,[1] J. Tobias Tsang,[25] Ruth S. Van de Water,[17] Alejandro Vaquero,[6] Ludovico Vittorio,[26] and Oliver Witzel[27,†]

Submitted to the Proceedings of the US Community Study
on the Future of Particle Physics (Snowmass 2021)

Report of the Snowmass 2021 Topical Group on
Lattice Gauge Theory

Zohreh Davoudi (editor/topical-group convener)[1,2], Ethan T. Neil (editor/topical-group convener)[13],

Christian W. Bauer[9], Tanmoy Bhattacharya[5], Thomas Blum[6], Peter Boyle[7], Richard C. Brower[8], Simon Catterall[9], Norman H. Christ[10], Vincenzo Cirigliano[11], Gilberto Colangelo[12], Carleton DeTar[13], William Detmold[14,15], Robert G. Edwards[16], Aida X. El-Khadra[17], Steven Gottlieb[18], Rajan Gupta[5], Daniel C. Hackett[14], Anna Hasenfratz[5], Taku Izubuchi (topical-group convener)[1,10], William I. Jay[14], Luchang Jin[10], Christopher Kelly[2], Andreas S. Kronfeld[22], Christoph Lehner[22], Huey-Wen Lin[23,24], Meifeng Lin[10], Andrew T. Lytle[17], Stefan Meinel[25], Yannick Meurice[26], Swagato Mukherjee[7], Amy Nicholson[27], Sasa Prelovsek[28,29], Martin J. Savage[30], Phiala E. Shanahan[14,15], Ruth S. Van de Water[21], Michael L. Wagman[21], and Oliver Witzel[31]

A Muon Collider Facility for Physics Discovery   #6

Muon Collider Collaboration · D. Stratakis (Fermilab) et al. (Mar 15, 2022)

Contribution to: 2022 Snowmass Summer Study · e-Print: 2203.08033 [physics.acc-ph]

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Simulated Detector Performance at the Muon Collider   #5

Muon Collider Collaboration · N. Bartosik (INFN, Turin) et al. (Mar 15, 2022)

Contribution to: 2022 Snowmass Summer Study · e-Print: 2203.07964 [hep-ex]

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Muon Collider Physics Summary   #8

Chiara Aime (Pavia U. and INFN, Pavia), Aram Apyan (Brandeis U.), Mohammed Attia Mahmoud Mohammed (Fayoum U.), Nazar Bartosik (INFN, Turin), Fabian Batsch (CERN) et al. (Mar 14, 2022)

Contribution to: 2022 Snowmass Summer Study · e-Print: 2203.07256 [hep-ph]

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The physics case of a 3 TeV muon collider stage   #9

Muon Collider Collaboration · Jorge de Blas (Granada U., Theor. Phys. Astrophys.) et al. (Mar 14, 2022)

Contribution to: 2022 Snowmass Summer Study · e-Print: 2203.07261 [hep-ph]

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Promising Technologies and R&D Directions for the Future Muon Collider Detectors   #7

Muon Collider Collaboration · S. Jindariani (Fermilab) et al. (Mar 14, 2022)

Contribution to: 2022 Snowmass Summer Study · e-Print: 2203.07224 [physics.ins-det]

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Submitted to the Proceedings of the US Community Study
on the Future of Particle Physics (Snowmass 2021)

High precision in CKM unitarity tests in b and c decays

A. Lenz[1], S. Monteil[2]

[1] Siegen University, Theoretische Physik 1, Center for Particle Physics Siegen (CPPS), Walter-Flex-Str. 3, 57072 Siegen, Germany
[2] Université Clermont Auvergne, CNRS/IN2P3, LPC, Clermont-Ferrand, France

Event Generators for High-Energy Physics Experiments   #4

J.M. Campbell (Fermilab), M. Diefenthaler (Jefferson Lab), T.J. Hobbs (Fermilab and IIT, Chicago), S. Höche (Fermilab), J. Isaacson (Fermilab) et al. (Mar 21, 2022)

Contribution to: 2022 Snowmass Summer Study · e-Print: 2203.11110 [hep-ph]

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TF07 Snowmass Report: Theory of Collider Phenomena   #2

. Maltoni (Louvain U., CP3 and INFN, Bologna and U. Bologna, DIFA), S. Su (Arizona U.), J. Thaler (MIT, Cambridge, CTP and IAIFI, Cambridge and Unlisted and Harvard U.), T.K. Aarrestad (CERN), A. Aboubrahim (Munster U., ITP) et al. Oct 5, 2022)

Contribution to: 2022 Snowmass Summer Study · e-Print: 2210.02591 [hep-ph]

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2022@TP1: the chairs were working hard for you!

Summer BBQ 2.7.2022

Glühweinparty: 6.12.2022

2022@TP1: the chairs were working hard for you!

Meet your fellow PhDs:

- Fun event for connecting PhD students and Postdocs from different research groups
- A lot of getting to know each other games, like Ice-Breaker Bingo and Speed Dating
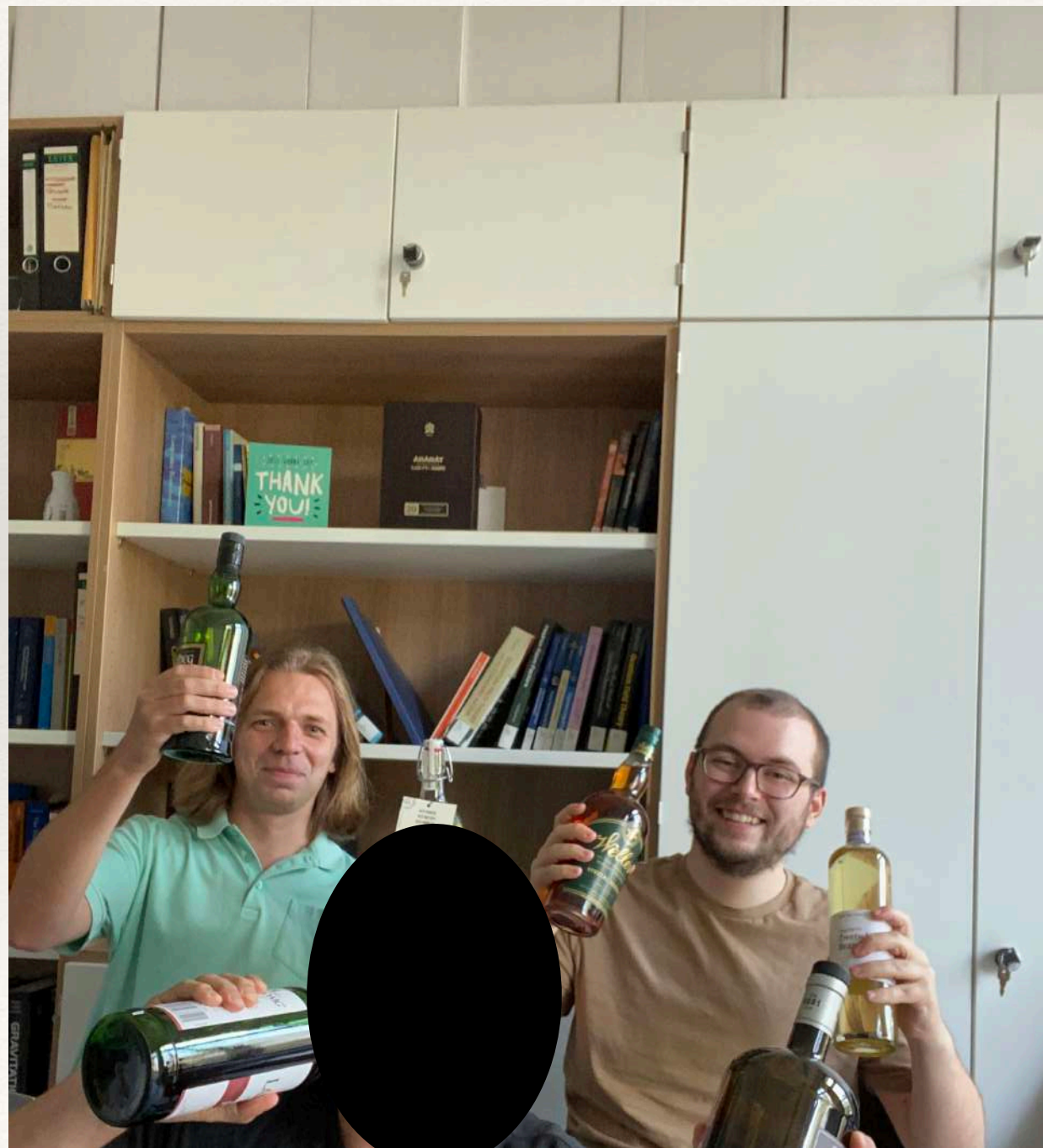- Conclude the evening in a restaurant

We will continue next year (next event either February or April) with events like
- (Powerpoint) Karaoke,
- Game evenings,
- Scottish Dance night,
- Flavour Mixing (Cocktail evening) etc.

2022@TP1

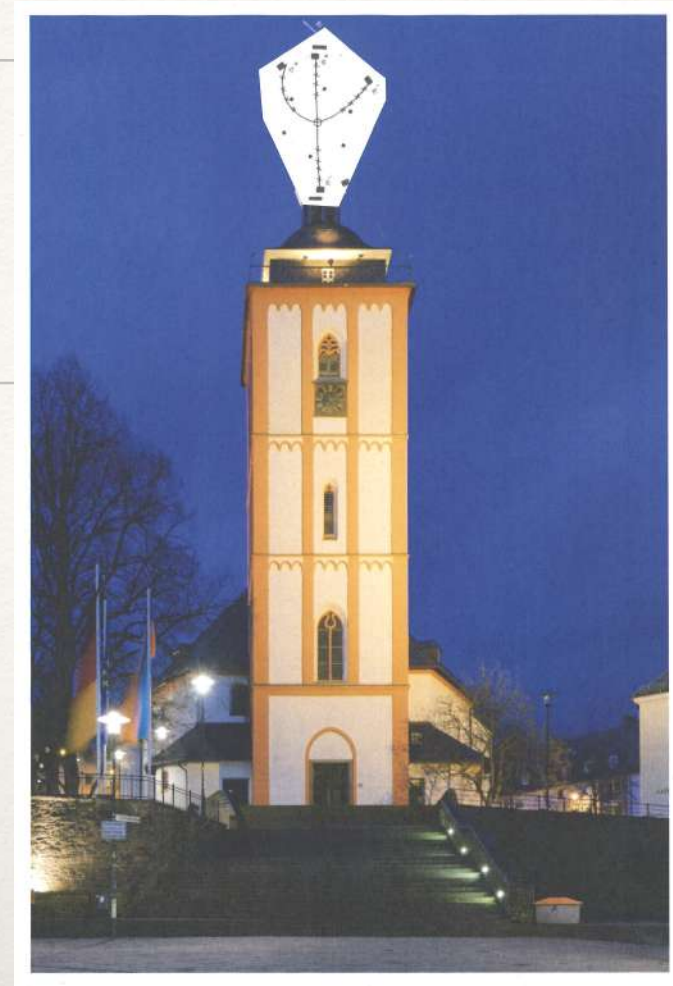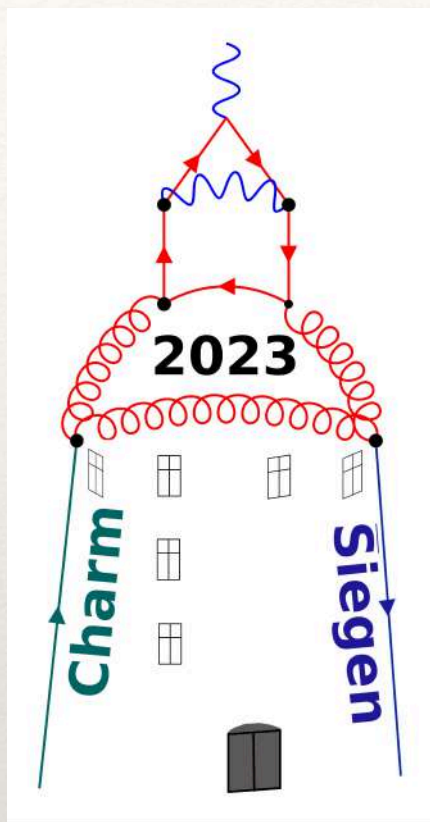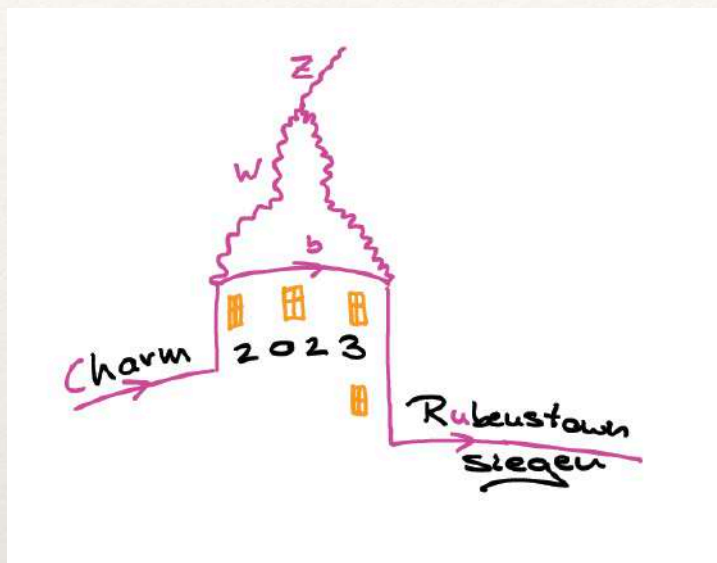What happens in my office, when I am not here:

2023@TP1

Another exciting year ahead of us

- 13.-16.2. Mathematical Structures in Feynman Integrals, **Siegen**
- 20.-24.3. Gradient Flow workshop, Trento
- ??? Annual SFB meeting
- 19.-23.6. Heavy Flavour 2023 - Quo Vadis?, Ardbeg, Scotland
- 17.-21.7. CHARM 2023, **Siegen**
- 54. Herbstschule für Hochenergiephysik, Maria Laach, 5.-15.9.2023

Alexander Lenz @alexlenz42 · Aug 30

How to make 35 friends for life and 500 enemies? Organise a physics workshop at Ardbeg Distillery with at most 35 places - first round of invitations will go out tomorrow… @Ardbeg @UniSiegen @IPPP_Durham @EdinburghUni

Heavy Flavour 2023
Quo vadis?

19.-23.6.2023
Ardbeg Distillery
Islay, UK

Recent progress and future developments in heavy flavour physics

International Invitation Committee:
Alexander Lenz (Siegen University)
Franz Muheim (Edinburgh University)
Michael Spannowsky (IPPP Durham)

💬 2   🔁 7   ♡ 44

Alexander Lenz @alexlenz42 · Aug 26

Finally I can announce the dates! Charming Science @UniSiegen

CHARM 2023
11th International Workshop on Charm Physics
17.-21.7.2023

Siegen, Germany

More info to come soon….   Contact: Alexander.lenz@uni-siegen.de

💬 1   🔁 6   ♡ 24

Visitors: Ben Allanach (May, Cambridge),Vicent Mateu, Rudi Rahn, Rusa Mandal (May to July), Javier Virto, Blazenka Melic, …

2023@TP1

2023@TP1

20.-24-3.2023 DPG Tagung Teilchenphysik, Dresden https://smuk23.dpg-tagungen.de

Anastasia Boushmelev - Illija Milutin - Ali Mohamed - Zachary Wüthrich - Philipp Lüghausen - Nicolas Seitz - Jakob Müller

DEADLINE: tomorrow

2023@TP1

Even more money for you….

2023@TP1

More things to look forward to

We will have our own INDICO….
We will have our own overleaf….

Confirmation of BSM origin of anomalies in $\bar{B}_s \to D_s^+ \pi^-$….
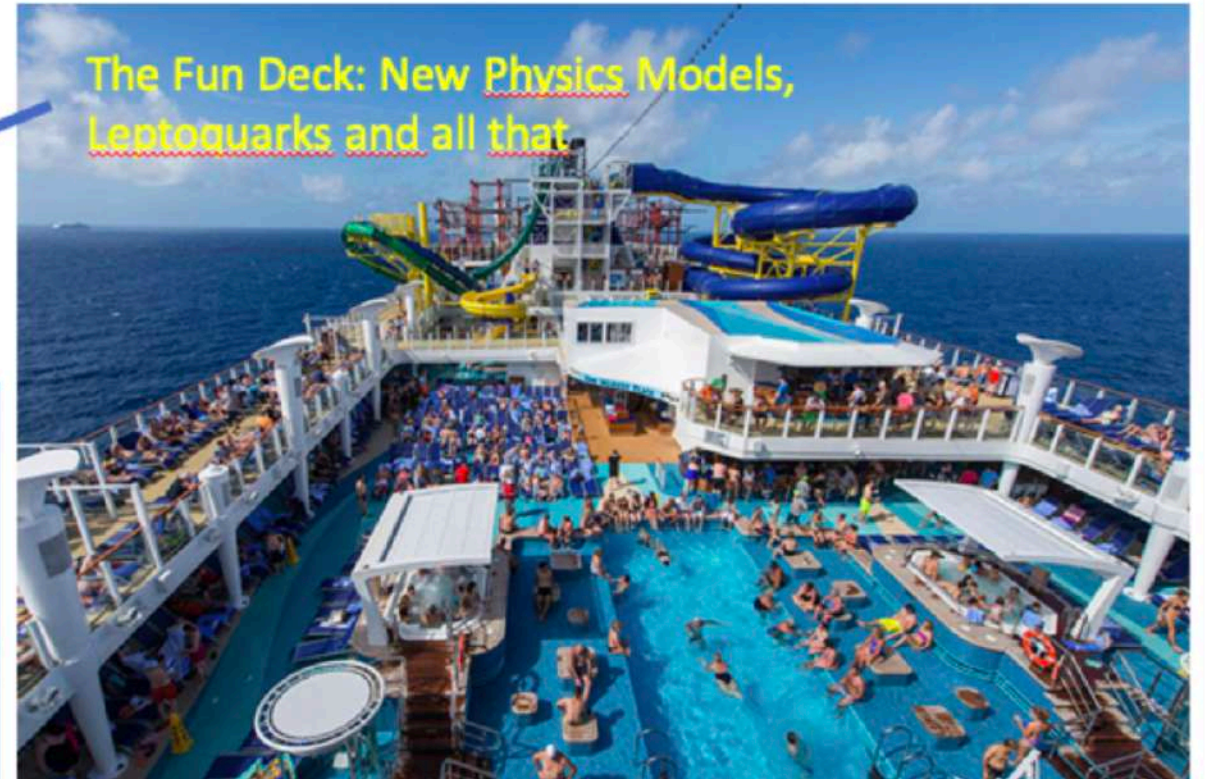
jDPG/Quantaclub events 2023:
- Physicist in Industry Talks
- Mathematicians vs. Exp Physicists vs. Theoretical Physicists

We will keep the ship moving in 2023!

The Fun Deck: New Physics Models, Leptoquarks and all that

Ship of Flavour Theory

The Machine Deck: QCD Loops, Hadronic Matrix Elements and all that

Thanks

Time to say thanks!

Last year you got a postcard and gingerbread

This year you got a mulled wine party and a talk

Thanks for your efforts in research
Thanks for your efforts in teaching, outreach,…
Thanks for your efforts in creating a pleasant working atmosphere

Thanks

SFB prolongation would not have been possible without the crucial contribution from our post-docs and PhDs!!!!

3.18 Project C1a
3 Project descriptions

[2] **Matteo Fael, Thomas Mannel,** and **K. Keri Vos.** The Heavy Quark Expansion for Inclusive Semileptonic Charm Decays Revisited. *JHEP*, 12:067, 2019.

[3] **Matteo Fael, Kay Schönwald,** and **Matthias Steinhauser.** Kinetic Heavy Quark Mass to Three Loops. *Phys. Rev. Lett.*, 125(5):052003, 2020.

[4] **Matteo Fael, Kay Schönwald,** and **Matthias Steinhauser.** Third order corrections to the semileptonic $b \to c$ and the muon decays. *Phys. Rev. D*, 104(1):016003, 2021.

[5] **Tobias Huber,** Tobias Hurth, Jack Jenkins, Enrico Lunghi, Qin Qin, and **K. Keri Vos.** Phenomenology of inclusive $\overline{B} \to X_s \ell^+ \ell^-$ for the Belle II era. *JHEP*, 10:088, 2020.

[6] **Thomas Mannel,** Daniel Moreno, and **Alexei A. Pivovarov.** Heavy quark expansion for heavy hadron lifetimes: completing the $1/m_b^3$ corrections. *JHEP*, 08:089, 2020.

[7] **Thomas Mannel,** Daniel Moreno, and **Alexei A. Pivovarov.** NLO QCD corrections to inclusive $b \to c \ell \bar{\nu}$ decay spectra up to $1/m_Q^3$. *Phys. Rev. D*, 105(5):054033, 2022.

[8] **Thomas Mannel** and **Alexei A. Pivovarov.** QCD corrections to inclusive heavy hadron weak decays at Λ_{QCD}^3/m_Q^3. *Phys. Rev. D*, 100(9):093001, 2019.

[9] **Thomas Mannel, Muslem Rahimi,** and **K. Keri Vos.** Impact of background effects on the inclusive V_{cb} determination. *JHEP*, 09:051, 2021.

[10] Mikołaj Misiak, **Abdur Rehman,** and **Matthias Steinhauser.** Towards $\overline{B} \to X_s \gamma$ at the NNLO in QCD without interpolation in m_c. *JHEP*, 06:175, 2020.

Good luck for your next step!

Thanks

But the biggest thanks today goes to