CFT HADRONIC MULTI-BODY II

April 27, 2026 | Christoph Hanhart | IAS Forschungszentrum Jülich

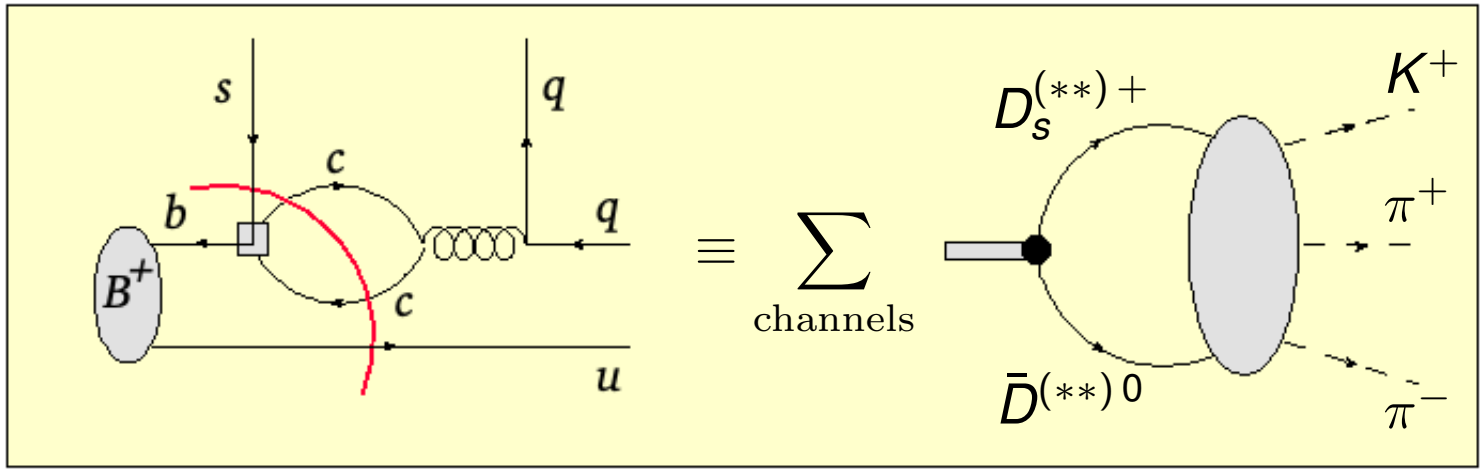
color meets flavor

JÜLICH Forschungszentrum

From our recent study for $B^{\pm} \to K^{\pm}\pi^{+}\pi^{-}$...

Currently $\bar{c}c$ loops as imaginary, partial wave dependent numbers

We want to make contact to what is known from hadron phenomenology



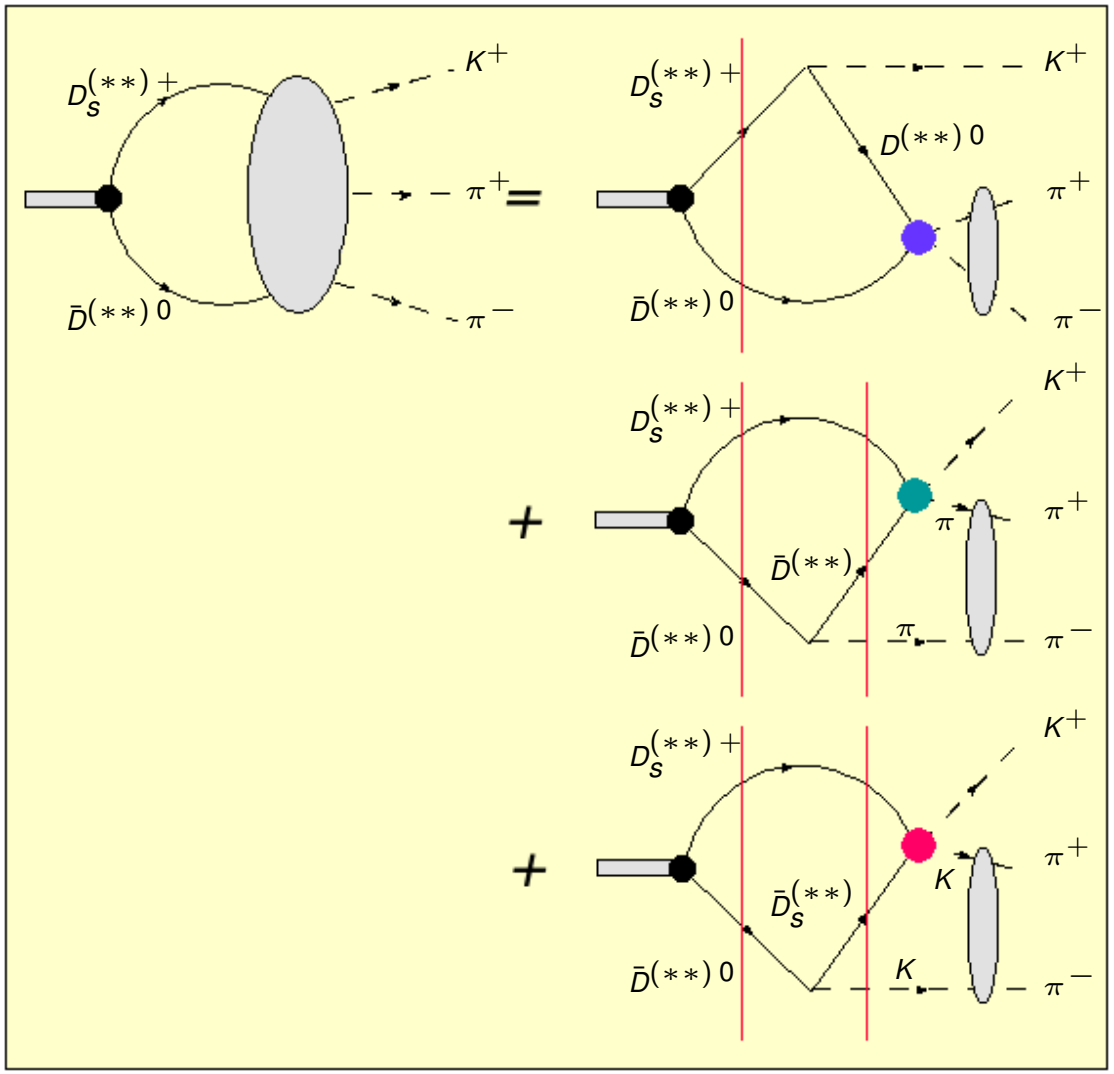
Note: $$\boxed{|(c\bar{c})_8(q\bar{q})_8\rangle_1 = \left(\sqrt{8}|(c\bar{q})_1(\bar{c}q)_1\rangle - |(c\bar{q})_8(\bar{c}q)_8\rangle\right)/3}$$

with $\mathrm{Br}(B \to D_s^{(**)}\bar{D}^{(**)}) \sim \mathcal{O}(1-3\%)$ vs. $\mathrm{Br}(B \to K\pi\pi) \sim \mathcal{O}(10^{-4})$

Can we unterstand charm loops exclusively and
control the $m_{\pi\pi}$ dependence (role of quarkonium-like states)?

An even closer look

We still restrict ourselves to $m_{\pi\pi} < 1$ GeV and omit 3-body rescatterings



second cut not operative

$\Longrightarrow$ contribution provides

constant Im-part

Both cuts operative

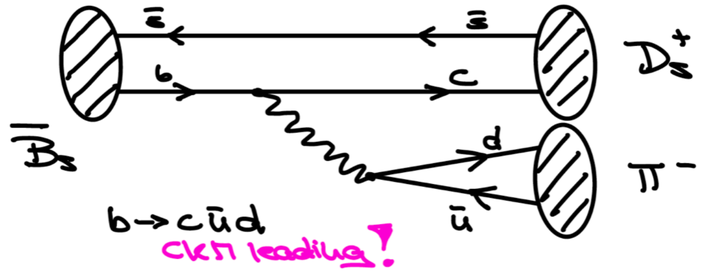
$\Longrightarrow$ additional $m_{\pi\pi}$ or $m_{\pi K}$

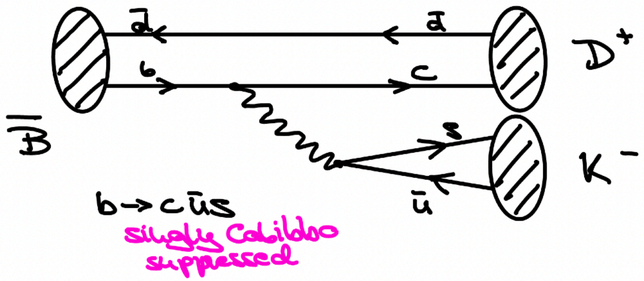
dependence possible

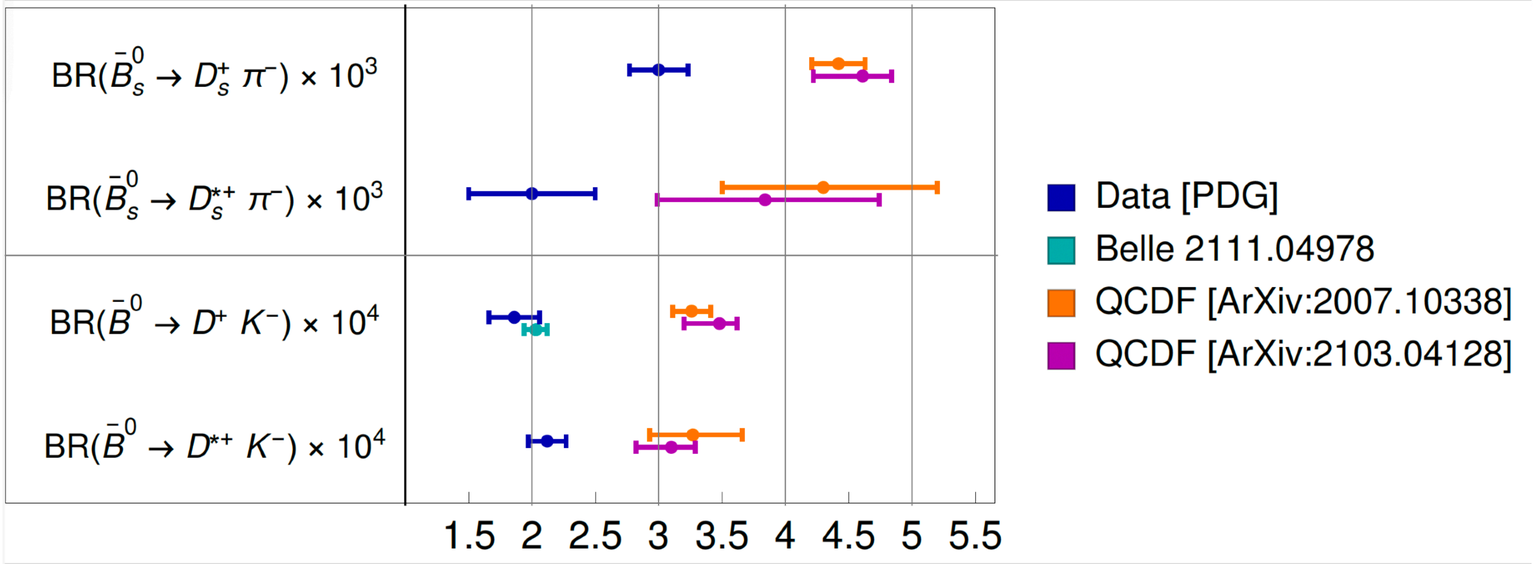
Role of Exotics? $\Longrightarrow$ RA1

QCD factorisation seems to disagree with Exp. for the “simplest” decays

e.g. Color-allowed, flavour-specific tree-level decay







QCD factorisation

QCD factorization for B ---> pi pi decays: Strong phases and CP violation in the heavy quark limit #1
M. Beneke (CERN), G. Buchalla (CERN), M. Neubert (SLAC), Christopher T. Sachrajda (Southampton U.) (May, 1999)
Published in: *Phys.Rev.Lett.* 83 (1999) 1914-1917 • e-Print: hep-ph/9905312 [hep-ph]
pdf links DOI cite claim reference search 1,517 citations

QCD factorization for exclusive, nonleptonic B meson decays: General arguments and the case of heavy light final states #2
M. Beneke (Aachen, Tech. Hochsch.), G. Buchalla (CERN), M. Neubert (Cornell U., LNS), Christopher T. Sachrajda (Southampton U.) (Jun, 2000)
Published in: *Nucl.Phys.B* 591 (2000) 313-418 • e-Print: hep-ph/0006124 [hep-ph]
pdf links DOI cite claim reference search 1,499 citations

QCD factorization for B ---> pi K decays #3
M. Beneke (Aachen, Tech. Hochsch.), G. Buchalla (CERN), M. Neubert (Cornell U., LNS), Christopher T. Sachrajda (Southampton U.) (Jul, 2000)
Contribution to: ICHEP 2000, 882-885 • e-Print: hep-ph/0007256 [hep-ph]
pdf cite claim reference search 59 citations

QCD factorization in B ---> pi K, pi pi decays and extraction of Wolfenstein parameters #4
M. Beneke (Aachen, Tech. Hochsch.), G. Buchalla (CERN), M. Neubert (Cornell U., LNS), Christopher T. Sachrajda (Southampton U.) (Apr, 2001)
Published in: *Nucl.Phys.B* 606 (2001) 245-321 • e-Print: hep-ph/0104110 [hep-ph]
pdf links DOI cite claim reference search 1,262 citations

Discrepancy of experiment with NNLO-QCD corrections to the leading power term in QCDf

- **Huber, Kränkl** 1606.02888
- **Bordone, Gubernari, Huber, Jung, vanDyk** 2007.10338
- **Iguro, Kitahara** 2008.01086
- **Cai, Deng, Li, Yang** 2103.04138
- **Bordone, Greljo,Maryocca** 2103.10332
- **Beneke, Böer, Finauro, Vos** 2107.03819

How to shed light into that?

1. **Study factorisation in more detail**
2. **Use alternative methods like LCSR**
3. **Can this be new physics?**
4. **Experimental cross-checks**

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How large can power corrections be?
e.g. CRC-studies by Bell and Feldmann

Other approaches

First steps (will be extended):

Non-factorisable effects in the decays $\overline{B}_s^0 \to D_s^+\pi^-$ and $\overline{B}^0 \to D^+K^-$ from LCSR #6

Maria Laura Piscopo (Siegen U.), Aleksey V. Rusov (Siegen U.) (Jul 14, 2023)

Published in: *JHEP* 10 (2023) 180 • e-Print: 2307.07594 [hep-ph]

pdf DOI cite claim reference search 32 citations

Other approaches

BSM in tree-level b-decays is constrained

Model-independent bounds on new physics effects in non-leptonic tree-level decays of B-mesons #27

Alexander Lenz (Durham U., IPPP), Gilberto Tetlalmatzi-Xolocotzi (Siegen U. and Nikhef, Amsterdam) (Dec 16, 2019)

Published in: *JHEP* 07 (2020) 177 • e-Print: 1912.07621 [hep-ph]

pdf DOI cite claim reference search 124 citations

Update and further investigate these constraints

and has many interesting consequences:

New physics effects in tree-level decays and the precision in the determination of the quark mixing angle γ #32

Joachim Brod (Mainz U. and U. Mainz, PRISMA), Alexander Lenz (Durham U. and Durham U., IPPP), Gilberto Tetlalmatzi-Xolocotzi (Durham U. and Durham U., IPPP), Martin Wiebusch (Durham U. and Durham U., IPPP) (Dec 3, 2014)

Published in: *Phys.Rev.D* 92 (2015) 3, 033002 • e-Print: 1412.1446 [hep-ph]

pdf DOI cite claim reference search 97 citations

Also model-dependent studies, e.g. 2HDM

Testing the Standard Model with CP asymmetries in flavor-specific nonleptonic decays #1

Tim Gershon (Warwick U.), Alexander Lenz (Siegen U.), Aleksey V. Rusov (Siegen U.), Nicola Skidmore (Manchester U.) (Nov 8, 2021)

Published in: *Phys.Rev.D* 105 (2022) 11, 115023 • e-Print: 2111.04478 [hep-ph]

If the new physics is CP violating, Then there is a Null-test in the SM

Tested in Dortmund:

First measurement of the decay-time-integrated CP asymmetry in $B_s^0 \to D_s^-\pi^+$ decays #1

LHCb Collaboration • Roel Aaij (Nikhef, Amsterdam) et al. (Mar 11, 2026)

e-Print: 2603.10860 [hep-ex]

pdf cite claim reference search 1 citation

Further tests, also Belle II

Work out consequences of current Bounds