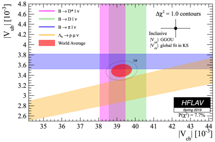
Some research highlights

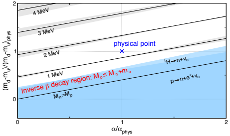
Focus on QCD in its highly nonlinear, low-energy regime, developping and using analytical and massively parallel simulation approaches to study:

- QCD effects in processes measured in experiment, with goal of helping to reveal new physics
- how QCD explains the rich world and structure of hadrons and, in the longer run, of atomic nuclei

CLN (NPB530 '98) and BCL (PRD79 '08) descriptions of semileptonic B decays still used today to measure $|V_{cb}|$ and $|V_{ub}|$



Ab initio calculation of the neutron-proton mass difference (Budapest-Marseille-Wuppertal collaboration, Science 347 '15) helped show just how sensitive the stability of ordinary matter and BBN are to fundamental SM parameters

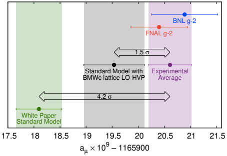


https://www.researchgate.net › publication › 323481543_...
Multiple-channel generalization of Lellouch-Lüscher formula
The **formalism** has since been extended to generic two-particle systems [2][3][4][5][6] [7] [8][9] [10][11], for which, however, the same restrictions apply. At ...

https://www.arxiv-vanity.com › papers
QED-corrected Lellouch-Lüscher formula for $K \rightarrow ππ ...
Here, we report on the progress towards an extension of the **Lellouch-Lüscher formalism** in presence of QED, with the goal of enabling the extraction of physical ...

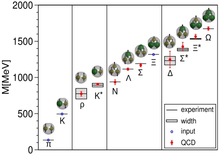
https://link.springer.com › article › JHEP03(2021)152
On the three-particle analog of the Lellouch-Lüscher formula ...
by F Müller · 2021 · Cited by 1 — L. **Lellouch** and M. **Lüscher**, Weak transition matrix elements from ... in a finite volume: 2. general **formalism** and the analysis of data, JHEP 10 ...

Showed how to study important, non-leptonic weak decays such as $K \to \pi\pi$ decays in lattice QCD (CMP219 '01), thought impossible before hand



Leading hadronic contribution to the muon magnetic moment from lattice QCD (Budapest-Marseille-Wuppertal collaboration, Nature 593 '21), suggesting that the measure of the muon $(g-2)$ may be consistent w/ the SM

Ab initio calculation of light hadron mass (Budapest-Marseille-Wuppertal collaboration, Science 322 '08) helped show that QCD describes the strong interaction also at low energy



Also: responsible for quark mass section in PDG; member of the muon $(g-2)$ initiative; chargé de mission at the CNRS' Institut de Physique (INP); ...

WIMP-nucleus spin-independent cross section

In low-E limit

$$\frac{d\sigma^{\rm SI}_{\chi\, {}^A_Z X}}{dq^2} = \frac{1}{\pi v^2}\left[Z f_p + (A-Z) f_n\right]^2 \ |F_X(q^2)|^2$$

w/ $F_X(\vec{q}=0)=1$ nuclear FF and χN couplings $(N=p,n)$

$$\frac{f_N}{M_N} = \sum_{q=[ud],s} f_q^N \frac{\lambda_q}{m_q} + \sum_{Q=c,b,t} f_Q^N \frac{\lambda_Q}{m_Q}$$

such that ($f=u,d,s,c,b,t$ and $\langle N(\vec{p}\,')|N(\vec{p})\rangle = (2\pi)^3\delta^{(3)}(\vec{p}\,'-\vec{p})$)

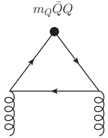
$$f_{ud}^N M_N = \sigma_{\pi N} = m_{ud}\langle N|\bar{u}u+\bar{d}d|N\rangle, \qquad f_f^N M_N = \sigma_{fN} = m_f\langle N|\bar{f}f|N\rangle$$

For f_q^N, $q=u,d,s$, use lattice QCD and Feynman-Hellmann theorem

$$f_q^N M_N = \langle N|m_q\bar{q}q|N\rangle = m_q \left.\frac{\partial M_N}{\partial m_q}\right|_{m_q^{(\phi)}}$$

Heavy quark contributions

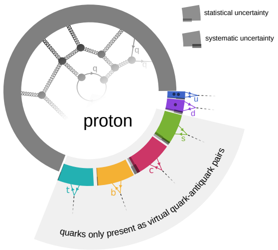
For heavy $Q = c, b, t$ (Shifman et al '78)



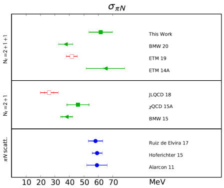
$$\longrightarrow \qquad m_Q\,\bar{Q}Q = -\frac{1}{3}\frac{\alpha_s}{4\pi}G^2 + O\left(\alpha_s, \frac{\mathcal{O}_6}{m_Q^2}\right)$$

Then obtain f_Q^N in terms of f_q^N through to $M_N = \langle N|\theta^\mu{}_\mu|N\rangle$, w/

$$\theta^\mu{}_\mu = (1-2\gamma_m(\alpha_s))\left[\sum_{q=u,d,s} m_q\bar{q}q + \sum_{Q=c,b,t} m_Q\bar{Q}Q\right] + \frac{\beta(\alpha_s)}{2}G^2$$



(BMWc, 2007.03319 [hep-lat])



(Gupta et al, 2105.12095 [hep-lat])

Discrepancy w/ pionic atom result must be understood and resolved