Key measurements for future flavor physics

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Where are we?

The BIG question:

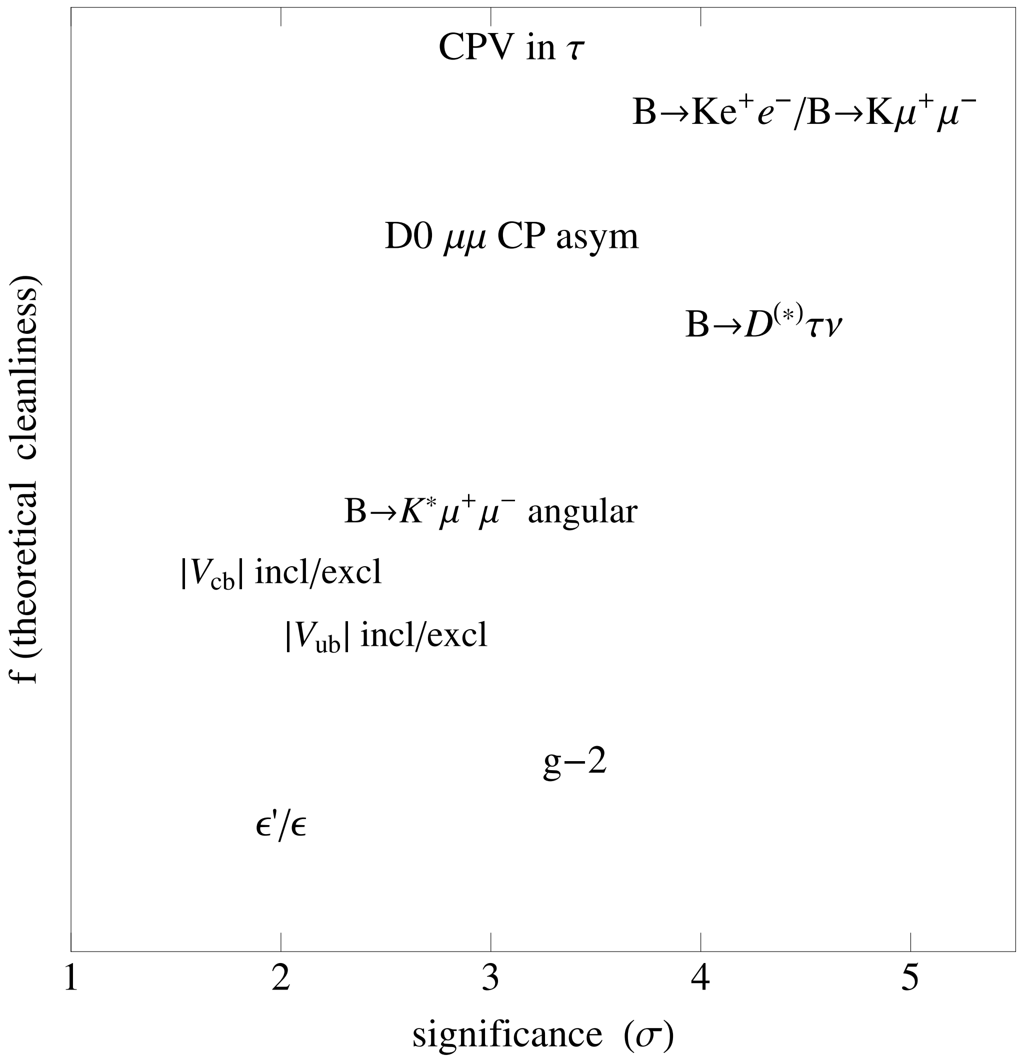
Can we see BSM?

What about QCD?

- Past: Problem. Need to overcome QCD in order to probe the weak interaction
- Future: Learn about QCD using the weak interaction

Are we seeing the tail?

The Zoltan plot



What next?

My personal list. Please let me know the missing items

- Keep going
- CPV in Charm
- Strong phases
- Baryons
- Multi-body decays

Keep going

“Near” future

A lot of things that are “in the making” and we like to make sure we do the best:

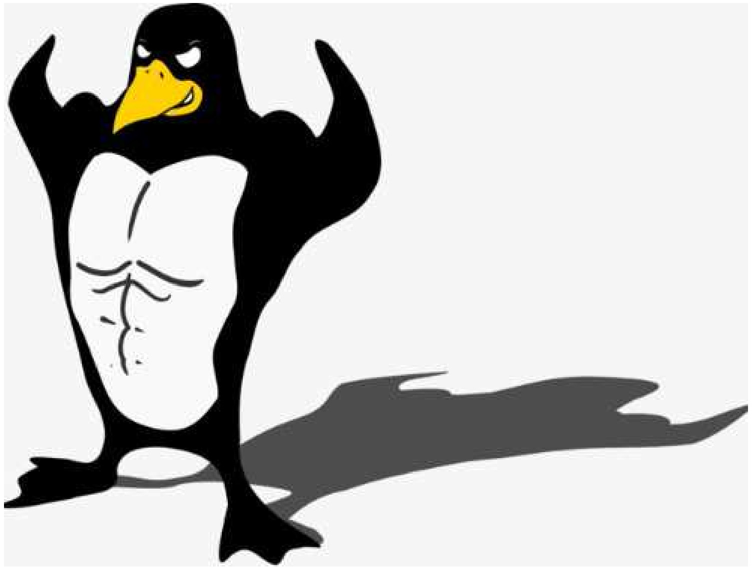
- $B \to DK$. A lot to do (can unbinned do better?)
- Anomalies: R_D, R_K, ...
- “Standard” CPV. We need to think about isospin breaking
- Rare kaon decays, $K \to \pi\nu\bar{\nu}$

CPV in charm

CPV in charm

A big deal...

- Is it SM? Or, better to ask: Is it BSM?
- Assuming it is SM, we learn about QCD
- My best way to summarize the situation is: “It is hard to argue that it is BSM”
- we learn
  - Charm is not heavy
  - Flavor SU(3) is good



How to further test CPV in charm?

We need to keep checking if it is BSM

- Get a_{CP} for each mode
- In the SM it comes from $\Delta U = 0$. Look for CPV in $\Delta U = 1$, like in $D^+ \to \pi^+\pi^0$
- Get more information on strong phases
- Looking for related decays, for example, $D \to KK\pi$

Charm baryons?

Look at

$$\Lambda_c \to pK^+K^- \qquad \Lambda_c \to p\pi^+\pi^-$$

Same diagrams as $D \to K^+K^-$ and $D \to \pi^+\pi^-$

- In the SU(3) limit

$$a_{CP}(D \to KK) = -a_{CP}(D \to \pi\pi)$$

- The spectators are important. In the SU(3) limit

$$a_{CP}(\Lambda_c \to pK^+K^-) \neq a_{CP}(\Lambda_c \to p\pi^+\pi^-)$$

- Measuring the asymmetries in baryons can teach us about QCD

Strong phases

Strong phases

We like to get as many as we can

- Important in many cases: $B \to DK$, CPV in charm
- Getting them out of correlated decays where the decaying state is

$$a|D\rangle + b|\bar{D}\rangle.$$

- So far done at tau-charm factories $\psi(3770) \to D\bar{D}$
- Can we do it at LHCb and/or Belle-II?
  - From $\psi(3770)$
  - From $B \to D\bar{D}$ decays
  - From $B \to D\bar{D}X$ decays

Baryons

Baryons

Baryons open a new set of probes to QCD

- We already have indications for CPV in Λ_b decays
  - We know the weak phase, we can learn about QCD
  - We have more variables to play with
- Polarization: Can help us probe the Dirac structure of operators
  - At high energy, we can use it to get b polarization
  - At Belle-II, get c polarization

Multi-body decays

Multi-body decays

A lot already has been done, and much more to do

- We can use much more data
- CPV "without" strong phases
  - Take advantage of resonances (like in $B \to D^{**}\tau\nu$)
  - CP-odd angular correlations (triple products and more)

Conclusions

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Win-win situation

- Hopefully, we will see BSM
- Even if not, we are learning about QCD