CP Violation Seminar Notes

1 Intro

- Go through first slide, self-explanatory
- Still have lots of unanswered questions; some small, some big
- Sakharov in 1967 gave his criteria
- Yang, Lee, and Wu in 1957 for P, then CP found in 1964 in Kaon mixing
- Don't want infinities in our observables
- No masses before Higgs, SSB mixes with bosons to give mass, then Yukawa
- 2HDM provides a more physical explanation for Yukawa, over convenience
- Three different types, focus on II as it has similarities to SM Yukawa
- Still have sphalerons, then CP violation and phase sorted
- Add Feynman diagrams to amplitudes, can resolve anomalies
- If masses are very heavy, effect is negligible and won't change things

2 Fittings

- Started with obvious decays affected
- Leptonic - B, D, Ds, K-pi ratios
- Mixing, both B and Bs
- $b \to s\gamma$, normalisation constant mention?
- $\tan\beta$ could extend higher and lower as we increase m_{H^+}, so no real constraint
- m_{H^+} has a minimum, but more and more likely as it goes to infinity
- Scanning doesn't tell us much, so we need to fit it
- Wanted to replicate original paper as best as possible using χ^2, whereas they used R-fit
- Scanned to 1.96σ to correspond to 95% CL, fitted there, and then found 1σ region
- Some slight differences due to the methods, but reached same minimum and regions look the same
- Measurements of new observables since 2010, we want to add these
- $B_s \to \mu\mu$ is an interesting one - done so far in large $\tan\beta$ limit so need to do this again
- $\mathcal{R}(D^{(*)})$ historically is difficult to fit both at the same time
- R(D) follows the same shape as the leptonic paths, but R(D*) is out, is there a way to fix this?
- Include R(D) just now and exclude the star, and look for a resolution
- Add these to statistical fit, now have new regions and minima
- $\tan\beta$ must be $\gtrapprox 2$ at 1σ, but at 95% CL we have the same lack of hard constraint as before
- CKM elements will be modified, only really have a big effect on heavier elements though
- Chance to improve unitarity, maybe make space for fourth generation
- Requires more research, but could have significant changes

3 Extension

- Gen 4, extra phases mean extra CPV, more angles just means more params
- Jarlskog, $J = \mathrm{Im}(V_{ud}V_{tb}V_{td}^*V_{ub}) \approx 3 \times 10^{-5}$
- Extran penguins from heavy quarks
- Chiral means SU(2) doublets, i.e. same as before
- Neutrino must be $\gtrapprox 200\,\mathrm{GeV}$ I think

References

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