Anomalies in Flavour Physics

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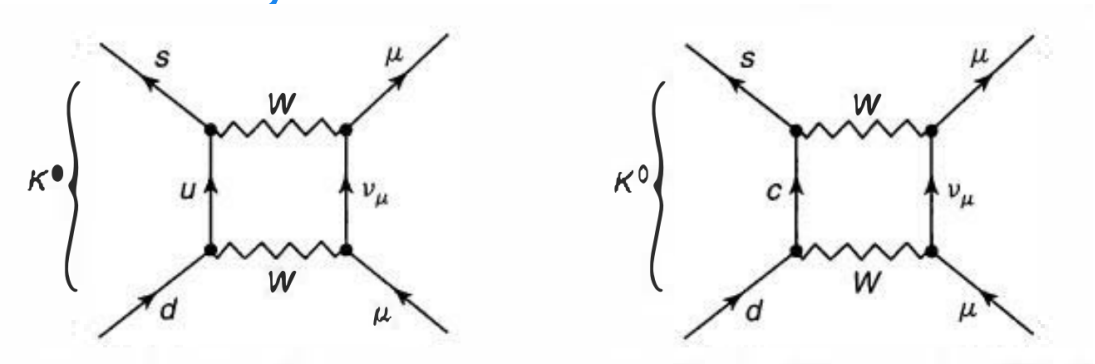
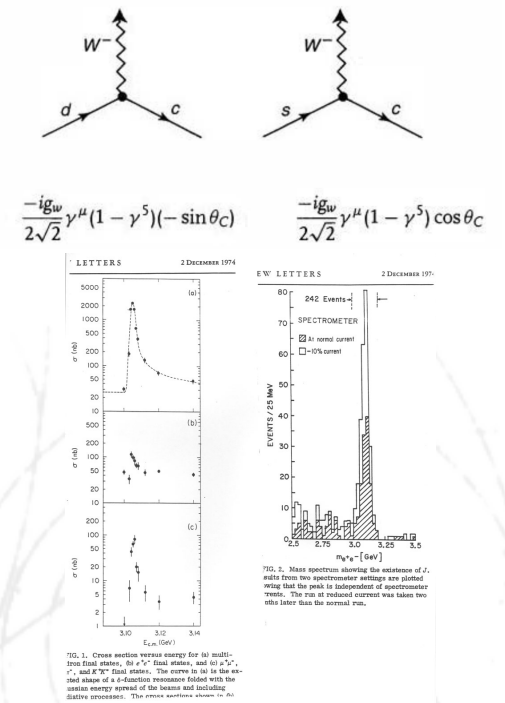
Outline

1. History of Flavour Physics discoveries.
2.
3.

A lesson from history - GIM mechanism



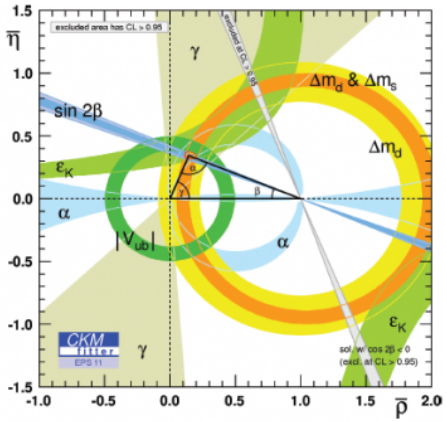
- Cabibbo angle was successful at explaining dozens of decay rates in the 1960s.
- There was one how ever that was not observed by experiments: $K^0 \to \mu^- \mu^+$.
- Glashow, Iliopoulos, Maiani (GIM) mechanism was proposed in the 1970 to fix this problem. The mechanism required the existence of the 4^{th} quark.
- At that point most of the people were skeptic about that. Fortunately in 1974 the discovery of the J/ψ meson silenced the skeptics.



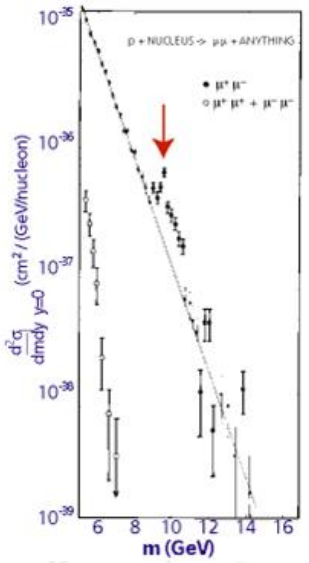
A lesson from history - CKM matrix

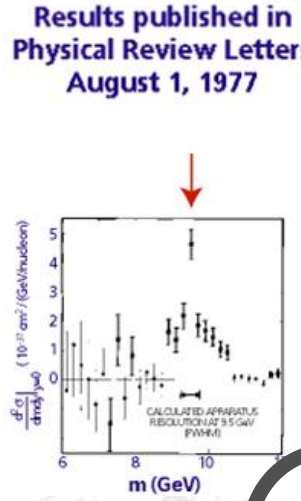
$$V \approx \begin{pmatrix} 1 & \lambda & \lambda^3 \\ -\lambda & 1 & \lambda^2 \\ -\lambda^3 & -\lambda^2 & 1 \end{pmatrix} \begin{matrix} u \\ c \\ t \end{matrix}$$

$\lambda \approx 0.22$: Cabibbo angle

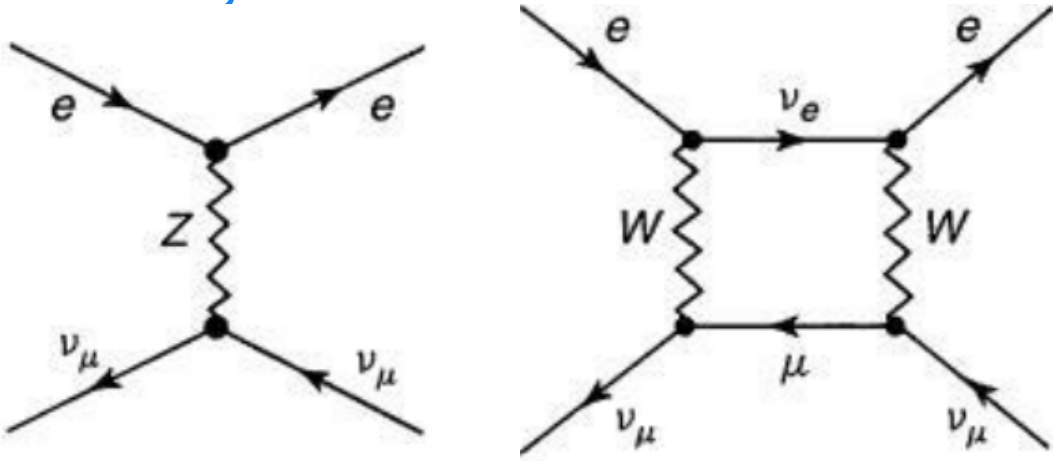


- Similarly CP violation was discovered in 1960s in the neutral kaons decays.
- 2×2 Cabbibo matrix could not allow for any CP violation.
- For the CP violation to be possible one needs atleast 3×3 unitary matrix
  ↬ Cabibbo-Kobayashi-Maskawa matrix (1973).
- It predicts existence of b (1977) and t (1995) quarks.

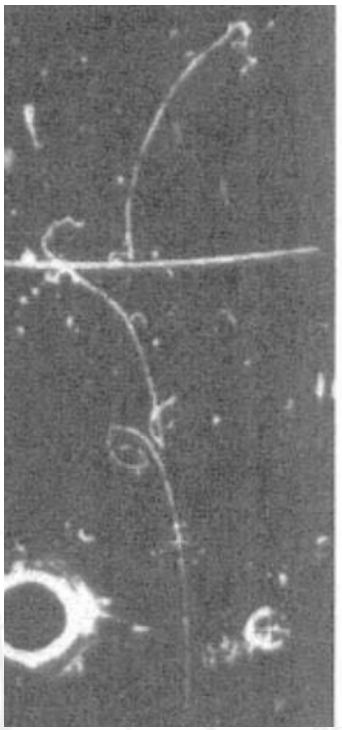


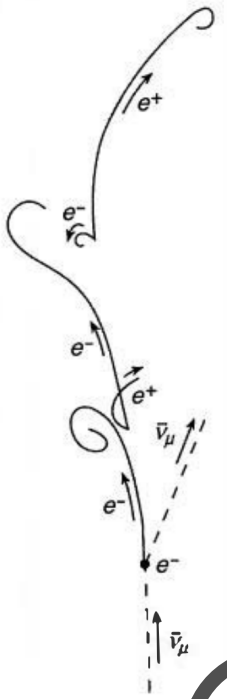


A lesson from history - Weak neutral current



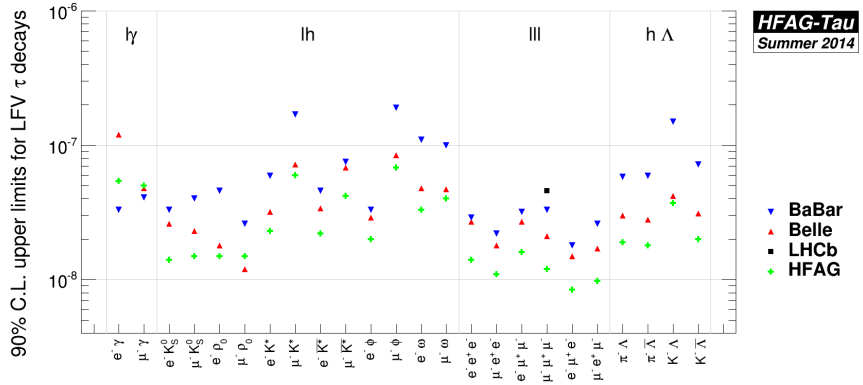
- First the weak neutral currents were introduced in 1958 by Buldman.
- Later on they were naturally build in unification of weak and electromagnetic interactions.
- 't Hooft proved that the GWS models was renormalizable.
- Everything was there in theory side, only missing piece was the experiment, till 1973.

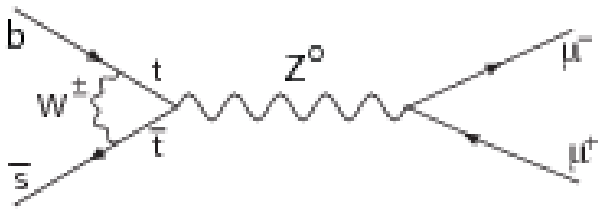


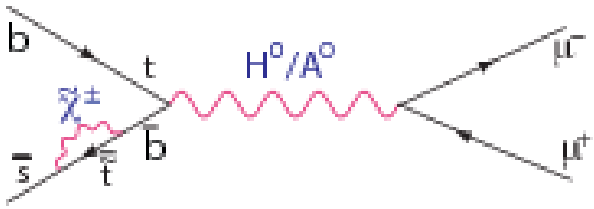


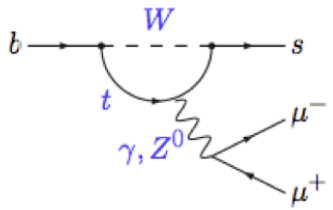
Modern challenges: loops come in to the game

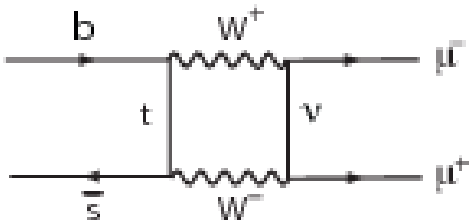
- Standard Model contributions suppressed or absent:
  - Flavour Changing Neutral Currents.
  - CP violation
  - Lepton Flavour/Number or Lepton Universality violation.
- In general can probe physics beyond GPD reach.

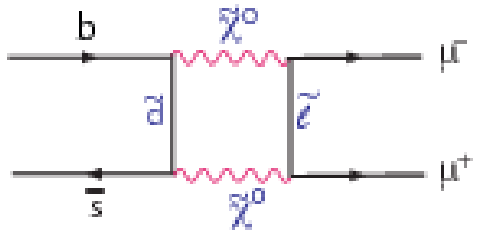


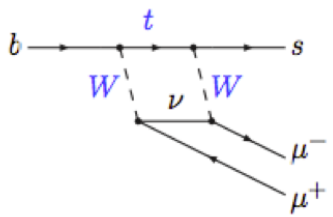












Backup