Measurement of Partial Branching fraction for B → X lν decays and determination of |Vub|
[PRL 100, 171802 (2008)]

V_{u}\text{ is the smallest element of the CKM-matrix, yet, for the }\text{ Standard Model to describe CP violation, it has to be nonzero.}

Our group studies semileptonic decays of the B going to a hadronic system X_q containing the light u quark.

We have determined partial branching fractions in 3 limited regions of phase space: M_\pi < 1.7 GeV/c^2, P_\ell < 0.66 GeV/c, and P_\ell > 0.66 GeV/c.

Corresponding values of |V_{ub}| are extracted using several theoretical calculations.

**Why study V_{u}\text{ and V}_{c}?**

Answer: redundant and precise measurements of the Unitary Triangle are needed.

The dimensions of the triangle are in fact tightly connected to CP violation research.

**Measurement of Partial Branching Fractions**

- Inclusive measurement
- Heavy Quark Expansion gives $f(B \rightarrow X_l\nu) = G_{max}1102 \pm 397 (1\mbox{ std.})$

Unfortunately:
- Kinematic cuts needed to select the dominant $b\rightarrow u$ background.
- Smaller acceptance increases theory uncertainties.
- Phase space "shape" function to resum non-perturbative physics.

Measure partial Branching Fraction $\lambda_{B} = V_{ub}^2 |V_{cb}^2|^2$ in a region where the signal background is good and the partial rate $V_{ub}$, is reliably calculated.

To reduce systematic uncertainties, we measure first a ratio of partial BR

Get partial rate prediction (2008) from theory

- $V_{ub}\times |V_{cb}|^2 = 6.33 \times 10^{-3}$
- $\lambda_B = \frac{\lambda_{B}^\text{max}}{\lambda_{B}^\text{min}}[1.15 - 0.27]$
- $\lambda_B > 0.8(\text{non SF region})$

**Recent Analysis technique**

1. B decays to an exclusive final state
2. Selection:
   - \text{B} \rightarrow \ell \nu + m^* \pi^-
   - $P_{\nu} > 1 \text{ GeV}$
   - $Q > 1 \text{ GeV}$
   - $M_{\pi^0} > 1 \text{ GeV}$
   - $Q_{\text{recoil}} \sim 0$

The semileptonic decay of the second B meson $\bar{B}_{\ell+} \rightarrow \ell^- \nu + \pi^-$ is identified.

This technique results in a low event selection efficiency but allows the determination of the momentum, charge, and flavor of the B mesons.

**Exclusive vs Inclusive measurements**

- Exclusive:
  - Inclusive $\rightarrow$ Exclusive
  - Measurement is the one most used in experimental studies.

- Inclusive:
  - Inclusive $\rightarrow$ Exclusive
  - Measurement has very large systematic uncertainties.

**Possible answers:**
- It is used only in the most difficult $B$-meson analyses.
- It is used for $B^0 \rightarrow \ell^\pm \nu$ transitions.
- It is used for $B^0 (\rightarrow \ell^\pm \nu) \rightarrow \ell^- \nu + \pi^-$ transitions.
- It is used for $B^0 (\rightarrow \ell^\pm \nu) \rightarrow \ell^- \nu + \pi^- + \pi^0$ transitions.

**Our Babar result, based on hadronic mass spectrum**

$V_{ub} \rightarrow 1.15 \pm 0.27$ (BABAR)

$V_{ub} \rightarrow 1.15 \pm 0.27$ (HFAG)

- Our Babar result: $V_{ub} \rightarrow 1.15 \pm 0.27$ (BABAR)
- This result is the one most precise to date.
- The hadronic mass spectrum is very clean.
- There is also a good compatibility between the 2 results.

**CKM consistency**

- Indirect determination from global UT fit (jpl) $V_{ub}$ from exclusive decay $\pi^0 \rightarrow \ell^\pm \nu$, single hadronic inclusive measurements

Recently a lot of work in the inclusive decays has been done but still there is some tension, some distance between the central values.

**Open questions:**
- Is it due to New Physics? It is an open question.
- Are we possibly just doing something wrong?

Possible answers:
- We are possibly just doing something wrong.
- It is due to a systematic error.
- It is due to New Physics.
- It is due to the measurement.

**in 5 min:**

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