B_d mixing and prospects for B_s mixing at DØ

Tulika Bose (Columbia University)

Constraining the CKM matrix

\[
\begin{pmatrix}
1 & x & y \\
x & A & t \\
y & t & 1
\end{pmatrix}
\]

Neutral B meson transition from particle to anti-particle state, and vice-versa

Weak eigenstates \to mass eigenstates

Caused by higher order flavor changing weak interactions:

\[\Delta m_q = m(B_{q\rightarrow\bar{q}}) - m(B_{q\rightarrow \bar{q}})\]

\[\Delta m_q = |V_{tq}V_{td}|^2\]

Mixing parameters \[\chi_q = \Delta m_q/\Gamma_q\]

First oscillations observed at ARGUS ('87) in the B_d system

⇒ signaled a large top quark mass (later verified by CDF and DØ)

\[\Delta m_q \approx |F(QCD)|\]

but large QCD effects dominate the extraction of \[V_{td}\]

- consider ratio

\[\frac{\Delta m_q}{\Delta m_d} = \frac{M_{21}^{2} + M_{23}^{2}}{M_{12}^{2}}\]

from Lattice QCD

Theoretical error on the ratio expected to drop faster than that on \[F(QCD)\]

\[\Delta m_q\] has been precisely measured: the world average is

\[\Delta m_d = 0.502 \pm 0.007 \text{ ps}^{-1}\]

\[\Delta m_q\] a direct measurement of \[\Delta m + \Delta m_q\] (current value) + \[V_{td}\] (relatively well known) ⇒ \[V_{td}\]

Current limits say that \[B_s\] oscillates at least 30 times faster than \[B^0\]!

Though experimentally challenging, a \[B_s\] mixing measurement will be precise.

The Tevatron B-factory and the new DØ

Rich B Physics program at DØ

benefits from:

- Large muon acceptance: \(|\eta| < 2\)
- Forward tracking coverage: \(|\eta| < 1.7\) (tracking), \(|\eta| < 3\) (silicon)
- Robust muon trigger

\[\Delta m_q\] mixing crucial for understanding initial-state flavor tagging

\[B_s\] oscillations measured at DØ in semileptonic mode - Hadronic - \[B_s\] decay modes) are being studied.

B_s oscillations at DØ:

- Selection of final states suitable for the study
- Tagging the meson flavor at decay time (final state)
- Tagging the meson flavor at production time (initial state)
- Proper time reconstruction for each meson candidate

Average statistical significance

Average statistical significance

Oscillations with soft muon tagging

Identify the flavor of the other B in the event using sign of the muon it decayed to:

- same sign: one B hadron oscillated
- opposite sign: both or neither oscillated

\[\Delta m_q = 0.506 \pm 0.055\text{(stat)} \pm 0.049\text{(syst)} \text{ pb}^{-1}\]

Future prospects

Large signal yields!

Pushing for limit on \[\Delta m_q\] by end of summer

Other decay modes (hadronic \[B_s\] decay modes) are being studied.

We think we understand the mixing of \(B_s\)…

A deviation from this simple diagram is a deviation from the Standard Model (New Physics)