Contribution ID: **834** Type: **Parallel Sessions**

Rare or forbidden B decays at Belle

Friday, 6 July 2012 14:45 (15 minutes)

The quark transition $b \to s\nu\bar{\nu}$ is only possible within the Standard Model (SM) through higher order processes, which are highly suppressed compared to tree-level processes. The theoretical predictions of the decays where this quark process occurs are very precise because there is only one hadron in the final state and no charged lepton. However, in models beyond the Standard Model, these decays can be enhanced by orders of magnitude. The very small SM branching fractions and two undetectable neutrinos in the final state are the main challenges of this analysis. To be able to reconstruct these channels despite the missing neutrinos, the full reconstruction method is used.
We present the results of the search for $B \to h^{(*)}\nu\bar{\nu}$ decays based on the full data set collected at the $\Upsilon(4S)$ resonance with the Belle detector operating at the KEKB asymmetric-energy e^+e^- collider.

We report on a search for heavy neutral leptons in B-meson decays. The results are obtained using a data sample that contains 772×10^6 $B\bar{B}$ pairs collected at the $\Upsilon(4S)$ resonance with the Belle detector at the KEKB asymmetric-energy e^+e^- collider. No signal is observed and upper limits are set on mixing of heavy neutral leptons with left-handed neutrino of the SM in the mass range $0.5 - 5.0\,\mathrm{GeV}/c^2$.

We report a search for B decays into invisible final states using a data sample of 656.7 million $B\overline{B}$ pairs collected at the $\Upsilon(4S)$ resonance with the Belle detector at the KEKB asymmetric-energy e^+e^- collider. The signals of invisible final states are identified by fully reconstructing the accompanying B meson and requiring no other charged particles and no extra energy deposited in the calorimeter. The measured upper limits are reported and the corresponding physics are discussed.

The HyperCP experiment at Fermilab reported the observation of three events for $\Sigma^+ \to p\mu^+\mu^-$ decay. The dimuon masses of the observed events are clustered around $214.3\mathrm{MeV}/c^2$ within the detector resolution of $1\mathrm{MeV}/c^2$. These decays might be interpreted as a two-body decay, $\Sigma^+ \to pX^0(214)$, with $X^0(214) \to \mu^+\mu^-$. Several hypotheses are suggested to interpret $X^0(214)$ including a sgoldstino in SUSY, a light Higgs boson in NMSSM, and a U boson. We report on a search for X^0 in $B^0 \to K^+(\pi^+)\pi^-X^0$ decays using 772 million B meson pairs collected with the Belle detector at the KEKB asymmetric-energy e^+e^- collider. We extend the search to a larger mass region between $212\mathrm{MeV}/c^2$ and $1.8\mathrm{GeV}/c^2$ with different values of the X^0 lifetime.

We study the charmless B^0 decays with final state particles $p\bar{\Lambda}\pi^-\gamma$ using the full data sample collected at the $\Upsilon(4S)$ resonance with the Belle detector at the KEKB asymmetric-energy e^+e^- collider. This decay is believed to proceed via the $b \to s\gamma$ electro-weak penguin process at the quark level. We also search for the intermediate three-body decays using the same final state particles. Observed branching fractions or upper limits are reported.

We present a study of B decays to $K^{(*)}$ and two leptons ($e,\ \mu$) in the full Belle $\Upsilon(4S)$ data set containing 771×10^6 $B\bar{B}$ pairs. The flavor-changing neutral-current process responsible for this decay, $b \to s\ell^+\ell^-$, proceeds via electro-weak penguin diagrams in the Standard Model. However, this process is sensitive to new physics due to contributions from Beyond the Standard Model particles in these diagrams. We report the differential branching fraction, isospin asymmetry, K^* polarization, and forward-backward asymmetry (A_{FB}) as a function of $q^2 = M^2_{\ell\ell}c^2$.

The flavor-changing-neutral-current decays such as $B \to X_s\gamma$ are sensitive to new physics beyond the Standard Model as particles of new physics may enter the loop and affect the decay process. While the branching fraction of the inclusive $B \to X_s\gamma$ decays has been measured by several experiments with good precision,

other quantities such as the CP and isospin asymmetries of the inclusive $B \to X_s\gamma$ are less well determined. To facilitate the precise measurements of such quantities, we study inclusive $B \to X_s\gamma$ decays using a hadronic tagging method, where one of the B mesons in a $B\bar{B}$ event is fully reconstructed in the hadronic final state. In this paper, we show preliminary results of this study using the full Belle data sample of $711\ \mathrm{fb}^{-1}$ integrated luminosity recorded by the Belle detector at the $\Upsilon(4S)$ resonance at the KEKB asymmetric-energy e^+e^- collider.

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Session Classification: Room 217 - Heavy Ion Collisions / B-Physics / CP Violation - TR5/7/9

Track Classification: Track 5 - B-Physics