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## Studies of Upsilon Decays at Belle

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- Measurement of Upsilon(5S) decays to B0 and B+ mesons. Decays of the Upsilon(5S) resonance to channels with B+ and B0 mesons are studied using a  $23.6 \text{ fb}^{-1}$  data sample collected with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. Fully reconstructed  $B^+ \rightarrow J/\psi K^+$ ,  $B^0 \rightarrow J/\psi K^0$ ,  $B^+ \rightarrow D\bar{b}^0 \pi^+$  and  $B^0 \rightarrow D^- \pi^+$  decays are used to obtain the charged and neutral B production rates per  $b\bar{b}$  event,  $f(B^+) = (72.1^{+3.9}_{-3.8}) \pm 5.0\%$  and  $f(B^0) = (77.0^{+5.8}_{-5.6}) \pm 6.1\%$ . Assuming equal rates to B+ and B0 mesons in all channels produced at the Upsilon(5S) energy, we measure the fractions for transitions to two-body and three-body channels with B meson pairs,  $f(B\bar{B}) = (5.5^{+1.0}_{-0.9}) \pm 0.4\%$ ,  $f(B\bar{B}^* + B\bar{B}^0) = (13.7 \pm 1.3 \pm 1.1)\%$ ,  $f(B\bar{B}^* + B\bar{B}^0) = (37.5^{+2.1}_{-1.9}) \pm 3.0\%$ ,  $f(B\bar{B}^* \pi) = (0.0 \pm 1.2 \pm 0.3)\%$ ,  $f(B\bar{B}^* \pi + B\bar{B}^0 \pi) = (7.3^{+2.3}_{-2.1}) \pm 0.8\%$ , and  $f(B\bar{B}^* \pi) = (1.0^{+1.4}_{-1.3}) \pm 0.4\%$ . The latter three fractions are obtained assuming isospin conservation.

\*Observation of an enhancement in  $e^+e^- \rightarrow \text{Upsilon}(1S) \pi^+ \pi^-$ ,  $\text{Upsilon}(2S) \pi^+ \pi^-$ , and  $\text{Upsilon}(3S) \pi^+ \pi^-$  production around  $\sqrt{s} = 10.89 \text{ GeV}$  at Belle

We measure the production cross sections for  $e^+e^- \rightarrow \text{Upsilon}(1S) \pi^+ \pi^-$ ,  $\text{Upsilon}(2S) \pi^+ \pi^-$ , and  $\text{Upsilon}(3S) \pi^+ \pi^-$  as a function of  $\sqrt{s}$  between 10.83 GeV and 11.02 GeV. The data consists of  $8.1 \text{ fb}^{-1}$  collected with the Belle detector at the KEKB  $e^+e^-$  collider. We observe enhanced production in all three final states that does not conform well with the conventional Upsilon(10860) lineshape.

- Search for  $\text{Upsilon}(2S) \rightarrow \eta_b \gamma$  and  $\text{Upsilon}(2S) \rightarrow \eta \text{Upsilon}$ . The Belle experiment has integrated a record sample of 160M Upsilon(2S) decays on the resonant peak. First results of searches for rare radiative transitions ( $\text{Upsilon}(2S) \rightarrow \eta_b(1S) \gamma$  and  $\chi_{b0}(1P) \rightarrow \text{Upsilon}(1S) \gamma$ ), and the hadronic transition  $\text{Upsilon}(2S) \rightarrow \eta \text{Upsilon}$  will be presented.

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