

First observation of the $h_b(1P)$ and $h_b(2P)$ bottomonium states and study of $\Upsilon(5S)$ to Bottomonium decays

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We report the observation of the $h_b(1P)$ and $h_b(1P)p$ spin-singlet bottomonium states produced in the reaction $e^+e^- \rightarrow h_b(1P)n\pi^+\pi^-$ with significances of 5.5σ and 11.2σ , respectively. We find that $M[h_b(1P)] = (9898.25 \pm 1.06^{+1.03}_{-1.07}) \text{ MeV}/c^2$ and $M[h_b(1P)p] = (10259.76 \pm 0.64^{+1.43}_{-1.03}) \text{ MeV}/c^2$, which correspond to measurements of the P-wave hyperfine splittings $\Delta M_{mHF} = (1.62 \pm 1.52) \text{ MeV}/c^2$ and $(0.48^{+1.57}_{-1.22}) \text{ MeV}/c^2$, respectively. We also report measurements of the cross sections for $e^+e^- \rightarrow h_b(1P)n\pi^+\pi^-$ relative to the cross section for the $e^+e^- \rightarrow \Upsilon(2S)\pi^+\pi^-$ reaction and examine the Dalitz plots of $\Upsilon(5S) \rightarrow \Upsilon(nS)\pi^+\pi^-$ and $\Upsilon(5S) \rightarrow h_b(mP)\pi^+\pi^-$ decays and search for resonant substructure.

These results are obtained from a 121.4 fb^{-1} data sample collected with the Belle detector near the $\Upsilon(5S)$ resonance at the KEKB asymmetric-energy e^+e^- collider.

Auteur principal: Dr TRABELSI, Karim (KEK)

Orateur: WICHT, Jean

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