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Quarkonium (-like) states at BELLE

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Studies of quarkonium and quarkonium-like states have led to several surprises in understanding the strong interaction phenomena. Most notably, exotic resonances that cannot be accommodated with the conventional quarkonium pictures including $X(3872)$, $Z_c(4430)^\pm$, $Z_b(10610)^\pm$ and $Z_b(10650)^\pm$ have been discovered by Belle. In this presentation, we report recent results from Belle on quarkonium and quarkonium-like states at Belle, in B-meson decays, $\Upsilon(nS)$ decays and in ISR processes.

For charmonium(-like) states in B decays, we present new decay modes of $X(3872)$ and $X(3823)$, a new charged state $Z_c(4210)^+ \rightarrow J/\psi\pi^+$, and searches for neutral and charged isospin partners of $D_{s0}(2317)^+$. In the ISR processes, we present a search for Z_{cs} , a partner state of $Z_c(3900)$, in $e^+e^- \rightarrow K^+K^-J/\psi$, improved measurements of $Y(4360)$ and $Y(4660)$ parameters, and search for new resonances in $e^+e^- \rightarrow \gamma\chi_{cJ}$.

For bottomonium(-like) states, we present final results of the 6-dimensional amplitude analysis of the $\Upsilon(5S) \rightarrow \Upsilon(1S, 2S, 3S)\pi^+\pi^-$ decays which determines the spin-parities of $Z_b(10610)$ and $Z_b(10650)$; energy scan of $\sigma[e^+e^- \rightarrow \text{hadrons}]$ and $\sigma[e^+e^- \rightarrow \Upsilon(1S, 2S, 3S)\pi^+\pi^-]$ in the region of the $\Upsilon(5S)$ and $\Upsilon(6S)$ resonances; observation of $\Upsilon(4S) \rightarrow h_b(1P)\eta$ transitions using the $h_b(1P) \rightarrow \eta_b(1S)\gamma$ decays; and the first observation of several new hadronic and radiative transitions, that shed light on the nature of highly excited states. We also present double charmonium production in exclusive bottomonium decays with an evidence for $\Upsilon(1S) \rightarrow J/\psi\chi_{c1}$.

Summary

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