Charmonium and X, Y, Z at Belle

We report results of a study of charmonium and X, Y, Z states
using the world-largest data sample accumulated with the Belle detector
at the KEKB asymmetric-energy e+e- collider. :
We present results from a study of $X(3872) \to J/\psi \pi^+ \pi^-$
decays produced in exclusive $B \to K\pi^+\pi^- J/\psi$ decays
using the full Belle data set. We present new measurements of the
$X(3872)$ mass and width and the
$BF(B \to KX(3872)) \times BF(X(3872) \to \pi^+\pi^- J/\psi)$
product branching fractions for both charged and neutral B mesons.
A new measurement of the difference in mass between
$X(3872) \to \pi^+\pi^- J/\psi$ signals in B^+ and B^0 decays
and results of a search for a charged partner of the $X(3872)$
in the decay $B \to KX^+, X^+ \to \pi^+\pi^0 J/\psi$ are reported.
In addition, we examine possible J^{PC} quantum number assignments
for the $X(3872)$ based on comparisons of angular correlations
among final state particles in $X(3872) \to \pi^+\pi^- J/\psi$ decays
with simulated data for J^{PC} values of 1^{++} and 2^{-+}.
We examine the influence of $\rho - \omega$ interference in the
$M(\pi^+\pi^-)$ spectrum. The analysis
is based on a 711 fb^{-1} data sample that contains
772 million $B\bar{B}$ meson pairs collected at the $\Upsilon(4S)$
resonance in the Belle detector at the KEKB collider.

We report a study of $B \to (J/\psi\gamma)K$ and $B \to (\psi'\gamma)K$
decay modes using 772×10^6 $B\bar{B}$ events collected
at the $\Upsilon(4S)$ resonance.
We observe $X(3872) \to J/\psi\gamma$ and report the first evidence
for $\chi_{c2} \to J/\psi\gamma$ in $B \to (X_{c\bar{c}}\gamma)K$
decays, while in a search for $X(3872) \to \psi'\gamma$
no significant signal is found.

We measure the cross section for $e^+e^- \to \pi^0\pi^0 J/\psi$
from threshold up to 6 GeV using initial state radiation events
from e^+e^- annihilation at $\sqrt{s} = 10.58$ GeV. We reconstruct
the J/ψ in its di-muon decay mode. Using this data we search for
evidence of $Y(4260)$ decaying to $\pi^0\pi^0 J/\psi$. This analysis
is based on a data sample with an integrated luminosity of 791 fb^{-1}
collected with the Belle detector.

We present the results of an amplitude analysis of the
$\bar{B}^0 \to J/\psi K^- \pi^+$ decays.
A search for charged charmonium-like states
in the $J/\psi\pi^+$ system has been performed. We have measured
the helicity amplitudes of the resonances in the $K^-\pi^+$ system.
The analysis is based on 711 fb^{-1} data sample collected
by the Belle detector.

We report the results of a study of
$B^\pm \to K^\pm \eta_c$ and $B^\pm \to K^\pm \eta_c(2S)$ decays
followed by η_c and $\eta_c(2S)$ decays to $(K_S K\pi)^0$.
The results are obtained from a data sample containing 535 million
$B\bar{B}$-meson pairs collected in the Belle experiment.
We measure the products of the branching fractions
$\mathcal{B}(B^\pm \to K^\pm \eta_c)\mathcal{B}(\eta_c \to K_S K^\pm \pi^\mp)$ and
$\mathcal{B}(B^\pm \to K^\pm \eta_c(2S))\mathcal{B}(\eta_c(2S) \to K_S K^\pm \pi^\mp)$.
Interference with the non-resonant component leads to significant
model uncertainty in the measurement of these product branching fractions.

Our analysis accounts for this interference and allows the model
uncertainty to be reduced. We also obtain the masses and widths of the
above mentioned charmonia. In the $\eta_c(2S)$ case the results are
significantly affected by the interference and also include
a model uncertainty.

The subject of this analysis is the $Y(3940)$ enhancement
at about 3940 MeV. The mass and
decay width have been determined by the Belle collaboration upon discovery
and were later confirmed by BaBar. Additional quantum numbers, however
have not been measured yet. The decay channels, used in this analysis
are $B^0 \to J/\psi \omega K_S^0$ and $B^+ \to J/\psi \omega K^+$
(and charge conjugate). J^{PC} shall be determined
through an angular distribution analysis of Belle data equivalent
to 711 fb^{-1}, as well as improvements made in mass and decay width
measurements. With a better understanding of the resonances quantum numbers,
hopefully statements regarding its theoretical interpretation can be made.

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Classification de Session: Flavour Physics and Fundamental Symmetries

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