



## Hadronic spectroscopy at Belle\*

M. Bračko<sup>a,b</sup> and T. Živko<sup>b</sup>, representing the Belle Collaboration

<sup>a</sup> University of Maribor, Smetanova ulica 17, SI-2000 Maribor, Slovenia

<sup>b</sup> Jožef Stefan Institute, Jamova cesta 39, SI-1000 Ljubljana, Slovenia

**Abstract.** The Belle experiment continues with study of  $D_{sJ}$  particles, as well as charmonium and charmonium-like states. Recent results on these topics are briefly mentioned.

Belle is an experiment at the  $e^+e^-$  collider KEKB [1]. The main goal of the experiment is a precision measurement of CP violation in the system of B mesons. The asymmetric KEKB collider operates around the center-of-mass energy of the  $Y(4S)$  resonance; the total collected integrated luminosity is about  $945 \text{ fb}^{-1}$  in July 2009. The large amount of data and excellent detector performances enable successful study of other topics besides properties of B mesons. In what follows, news from Belle about charmed strange mesons, charmonium and charmonium-like states will be briefly mentioned. Details of the reported analyses can be found in quoted references.

New charmed strange meson,  $D_{sJ}(2700)^+$ , was observed in the decay channel  $D^0K^+$  [2]. Angular analysis favours spin-parity assignment  $1^-$ . It is possible that this particle is  $X(2690)$ , which was previously observed by *BABAR* [3].

Partial wave analysis of another charmed strange meson,  $D_{s1}(2536)^+$ , in decay channel  $D^{*+}K_S^0$  revealed domination of the S wave [4], at variance with HQET prediction.

Properties of charmonium-like state,  $X(3872)$ , were further studied. Positive charge parity is established [5], while favoured  $J^P$  is  $1^+$  or  $2^-$ . Belle updated the analysis of the  $X(3872)$  in the  $D^0\bar{D}^{*0}$  decay channel [6]. The measured mass value is compatible with the new *BABAR* measurement [7]. According to all measurements, the favoured interpretation is that the  $X(3872)$  is a mixture of the  $D^0\bar{D}^{*0}$  molecule and a  $c\bar{c}$  state.

A new state, named  $Z^+(4430)$  and decaying to  $\psi(2S)\pi^+$ , is observed in the B meson decays to  $K\pi^\pm\psi(2S)$  final state [8]. An updated measurement, based on a full Dalitz plot analysis of the  $K\pi^\pm\psi(2S)$  final state, was performed recently [9]. Results of this analysis confirm the original discovery of the  $Z^+(4430)$ .

Two new states,  $Z^+(4050)$  and  $Z^+(4250)$ , decaying to  $\chi_{c1}\pi^+$ , were observed in  $K^-\chi_{c1}\pi^+$  decays of  $\bar{B}^0$  [10]. All three observed charged charmonium-like states –  $Z^+(4430)$ ,  $Z^+(4050)$  and  $Z^+(4250)$  – are serious tetraquark candidates.

\* Talk delivered by T. Živko

New particles,  $X(3940)$  and  $X(4160)$ , decaying to  $D^*\bar{D}$  and  $D^*\bar{D}^*$  were observed in events with double  $c\bar{c}$  production [11]. The established experimental technique was used to measure the cross section for  $e^+e^- \rightarrow J/\psi c\bar{c}$  in a model independent way [12].

Several new  $Y$  states and peaks in mass plots were observed in initial state radiation events [13]. These states are regarded as serious charmonium - gluon hybrid candidates [14].

As new experimental data are still accumulated and many studies are ongoing, more interesting results on these and similar topics are to be expected from Belle in the near future.

## References

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