

# Abstract

Recently, many unexpected new particles were discovered with masses around 4 GeV/ $c^2$ . They are collectively called  $XYZ$  mesons and while some of them have been identified as charmonium states, many others have properties that don't fit into the quark-antiquark classification, and so far remain unclassified. The  $X(3872)$  meson was the first to be discovered and is the most studied of these states, and there is a variety of hypotheses on its nature. Other new states include the  $X(3940)$  and  $Y(3940)$  mesons, which have the same mass and similar widths; it is not clear if they are the same state or not. More experimental evidence is required to understand these particles.

We report a search for  $B \rightarrow X(3872)K$  with  $X(3872)$  decaying to  $D^{*0}\bar{D}^0$  using a sample of 657 million  $B\bar{B}$  pairs recorded at the  $\Upsilon(4S)$  resonance with the Belle detector at the KEKB asymmetric-energy  $e^+e^-$  collider. The study is performed for both  $D^{*0} \rightarrow D^0\gamma$  and  $D^{*0} \rightarrow D^0\pi^0$  decay modes.

We find a total signal of  $50.1_{-11.1}^{+14.8}$  events with a mass of  $3872.9_{-0.4}^{+0.6}{}_{-0.5}^{+0.4}$  MeV/ $c^2$ , a width of  $3.9_{-1.4}^{+2.8}{}_{-1.1}^{+0.4}$  MeV/ $c^2$  and a product branching fraction

$$\mathcal{B}(B \rightarrow X(3872)K) \times \mathcal{B}(X(3872) \rightarrow D^{*0}\bar{D}^0) = (0.80 \pm 0.20 \pm 0.11) \times 10^{-4}.$$

The statistical significance of the signal is  $7.9\sigma$ .

Furthermore, from the same study we also set an upper limit at 90% confidence level on the product branching fraction

$$\mathcal{B}(B \rightarrow Y(3940)K) \times \mathcal{B}(Y(3940) \rightarrow D^{*0}\bar{D}^0) < 0.67 \times 10^{-4},$$

which suggests that the  $X(3940)$  and  $Y(3940)$  mesons are different states.

**Keywords:** high energy physics, Belle,  $B$  physics, charmonium, new particles.