

# Chapter 6

## Discussions

We have reported the first observation of the decay  $B^+ \rightarrow \rho^+ \rho^0$  with 85 M  $B\bar{B}$  collected by the Belle detector at KEKB. The statistical significance is  $5.3\sigma$ . This is the first observation of B meson decays to the charmless vector-vector final states due to the  $b \rightarrow u$  transition. So far, the only observed  $B \rightarrow VV$  mode is  $B \rightarrow \phi K^*$ , which is due to the  $b \rightarrow s$  transition.

We measure a branching fraction of

$$\mathcal{B}(B^+ \rightarrow \rho^+ \rho^0) = (31.7 \pm 7.1(\text{stat.}) \pm 3.9(\text{sys.})_{-2.1}^{+1.0}(\text{pol.})) \times 10^{-6},$$

where the third error is the error associated with the helicity-mix uncertainty. The results are in agreement with the theoretical predictions [15, 16].

An analysis of the helicity-angle distributions gives the longitudinal polarization ratio,

$$\Gamma_L/\Gamma = 94.8 \pm 10.6(\text{stat.}) \pm 2.1(\text{sys.})\%.$$

It confirms the hypothesis that the longitudinal polarization is dominant, and the result is in agreement with the prediction [15].

We measure a  $CP$  asymmetry,

$$\mathcal{A}_{CP}(B^\mp \rightarrow \rho^\mp \rho^0) = (0.1 \pm 22.4(\text{stat.})_{-2.8}^{+2.6}(\text{sys.}))\%.$$

No statistically significant partial rate  $CP$  asymmetry in  $B^\mp \rightarrow \rho^\mp \rho^0$  is observed. Although the statistical error is still large, this is an indication that any factor inducing  $\mathcal{A}_{CP}$  ( the EWP strength, strong phase difference and weak phase difference between the tree and the EWP ) is small as expected from the Standard Model.

Study of  $\rho\rho$  final state may be able to show further interesting features in the future as we accumulate more statistics.  $CP$  violation may be accessed in charmless  $B \rightarrow VV$  decays via azimuthal angular correlations between the two vector particles ( see Appendix A ). The advantage of this method is that  $CP$  violating terms can occur even when there

is no large strong phase difference between the interfering weak amplitudes. This is an important feature of the  $B \rightarrow VV$  decays. Direct  $CP$  violation can also be caused by the  $\rho^0\omega$  interference [16], where the  $CP$  asymmetry appears in the deformation of the Breit-Wigner shape of the  $\rho^0 \rightarrow \pi^+\pi^-$  invariant mass spectrum. In section 3.10, we showed the  $M(\pi^+\pi^-)$  and  $M(\pi^+\pi^0)$  invariant mass spectra for events in the signal region for data. Compared to the  $M(\pi^+\pi^0)$  distribution, the  $\rho^0$  peak in the  $M(\pi^+\pi^-)$  mass distribution is somewhat narrower. This could be due to the possible  $\rho^0\omega$  interference (see Appendix B). A large  $CP$  asymmetry in  $B^+ \rightarrow \rho^0(\omega)\rho^+ \rightarrow \pi^+\pi^-\rho^+$  at the interference region is expected.