

# Indication of New Physics in $B \rightarrow \Phi K_s$ Decays at the BELLE Experiment

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The BELLE experiment at the asymmetric  $e^+e^-$  (3.5 GeV and 8 GeV) accelerator KEK-B at Tsukuba, Japan, has recorded 152 Million  $B\bar{B}$  meson pairs in 4 years of data taking. In the standard model, the size of CP violation in the  $B$  meson system is characterized by a quantity called  $\sin(2\varphi_1)$ , in which  $\varphi_1$  denotes one of the angles in the unitarity triangle. This quantity was determined precisely to be  $\sin(2\varphi_1)=0.733\pm 0.059\pm 0.028$ , based upon  $N=1997$  events with the decay  $B \rightarrow J/\Psi K_s$  and  $N=914$  other  $B \rightarrow$  charmonium+Kaon decays [1] [2] [3]. The measurement is consistent with the measurement of the BABAR detector at SLAC [4]. In the standard model, the decay  $B \rightarrow \Phi K_s$  is expected to show identical CP violation. However, a measurement of  $N=68$  events revealed  $-0.96\pm 0.50+0.09-0.11$  (opposite sign from expectation), which is a  $3.5\sigma$  deviation from the expected standard model value [1] [5]. The probability of obtaining the observed result for  $B \rightarrow \Phi K_s$  as a statistical fluctuation of the  $B \rightarrow J/\Psi K_s$  result is less than 0.1%. In the standard model,  $B \rightarrow \Phi K_s$  is dominated by a penguin diagram with a  $W$  boson and a top quark in a loop. The top quark itself radiates a gluon which creates an  $s\bar{s}$  pair. Two additional decay channels, namely  $B \rightarrow \eta' K_s$  and  $B \rightarrow K^+ K^- K_s$  are dominated by the same diagram. However, their CP violation seems to be consistent (within still large statistical errors) with the  $\sin(2\varphi_1)$  value from  $B \rightarrow J/\Psi K_s$  [6] [7]. The difference between the three different decay channels is given by the spin of the  $\Phi$  meson  $J^P=1^-$  (vector meson), while all Kaons and the  $\eta'$  are  $J=0^-$  (pseudoscalar mesons). In an additional analysis, angular distributions have been investigated. In the case of  $B \rightarrow VV^1$  a helicity analysis can be performed. For this purpose, the  $B \rightarrow J/\Psi K_s^*$  [8] (pseudoscalar meson  $K_s$  replaced by vector meson  $K^*$ ) and  $B \rightarrow \Phi K_s$  [9] were compared. As pointed out recently by Grossman [10], differences between the two decay channels seem visible, and are difficult to be explained within the standard model.

BELLE will resume data taking in 10/2003, with an improved Silicon Vertex Detector (4 layers, larger angular coverage). An update of the analysis results is envisaged for

summer 2004.

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<sup>1</sup> $V$  denotes a vector particle ( $J^P=1^-$ ).

<sup>2</sup>The BELLE and BABAR collaborations differ in nomenclature. The angle  $\beta$  is identical to  $\phi_1$ .