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S-waves and the measurement of β_s in B_s decays

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The CP Violating asymmetry in B_s mixing (β_s) is one of the most promising measurements where physics beyond the Standard Model could be revealed. Currently, such measurements are only a 5% likely to be consistent with SM expectations [1]. While this is not yet a significant deviation it does imply that such measurements should be subject to great scrutiny. The mode $B_s \rightarrow J/\psi \phi$ has been used, and the mode $B_s \rightarrow \phi \phi$ proposed for future measurements. These modes both have two vector particles in the final state and thus angular analyses must be used to disentangle the contributions from CP+ and CP- configurations. All publications of β_s results thus far have not considered the possibility of a substantial S-waves masquerading as low mass K^+K^- pairs. These could well be the result of a final state formed from an s-quark-anti-s-quark pair in a 0^+ spin-parity state, such as the $f_0(980)$ meson. I will show estimates of the S-wave contribution to the $J/\psi \phi$ final state based on D_s decays into $K^+K^-\pi^+\pi^-\pi^+$ [2], and $K^+K^-e^+\nu_e/\pi^+\pi^-e^+\nu_e$ final states [3]. This S-wave contribution needs to be taken into account in determining β_s by including an S-wave amplitude in the fit. This may change the central value of current results and will also increase the statistical uncertainty [2,4]. I will also show estimates of the relative B_s decay rate into $J/\psi f_0(980)$, where $f_0 \rightarrow \pi^+\pi^-$. Comparisons will be made with theoretical models [5,6]. The $J/\psi f_0(980)$ mode has been suggested as a CP eigenstate that could yield an independent value of β_s . I will show an estimate of the sensitivity relative to $J/\psi \phi$ [7]. Specific strategies are proposed for the $B_s \rightarrow \phi \phi$ mode where two S-waves are possible.

[1] CDF and D_0 Combined Working Group, "Combination of D_0 and CDF Results of $\Delta\Gamma_s$ and the CP-Violating Phase β_s " CDF/PHYS/BOTTOM/CDFR/9787, D_0 Note 5928-CONF (2009).

[2] S. Stone and L. Zhang, "S-waves and the Measurement of CP Violating Phases in B_s Decays," Phys. Rev. D79, 074024 (2009) arXiv:0812.2832.

[3] K. M. Ecklund et. al (CLEO), "Study of the semileptonic decay $D_s^+ \rightarrow f_0(980) e^+ \nu_e$ and implications for $B_s \rightarrow J/\psi f_0$," Phys. Rev. D80, 052009 (2009) arXiv:0907.3201.

[4] Y. Xie, P. Clarke, G. Cowan, and F. Muheim, "Determination of $2\beta_s$ in $B_s \rightarrow J/\psi K^+ K^-$ Decays in the Presence of a K^+K^- S-Wave Contribution," JHEP 0909, 074 (2009)

[5] P. Colangelo, F. De Fazio, and W. Wang, " $B_s \rightarrow f_0(980)$ form factors and B_s decays into $f_0(980)$ " arXiv:1002.2880.

[6] O. Leitner, J.-P. Dedonder, B. Loiseau, B. El-Bennich, "Scalar resonance effects on the B_s - anti- B_s mixing angle," arXiv:1003.5980.

[7] S. Stone and L. Zhang, "Measuring the CP Violating Phase in B_s Mixing Using $B_s \rightarrow J/\psi f_0(980)$ ".

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