A Proposal to Change How we Handle Branching Fractions Measured from Dalitz-Plot Analyses for D-meson Decays

Pat Burchat

Charles Wohl

November 13, 2004

In a Dalitz-plot analysis of $D \to abc$, the branching ratio for the intermediate submode j, $D \to rc$, $r \to ab$, is given as a "fit fraction" defined as the integral over the Dalitz plot (m^2_{ab} vs. m^2_{bc}) of a single amplitude squared divided by the integral over the Dalitz plot of the square of the coherent sum of all amplitudes:

$$\frac{\mathcal{B}_j(D \to rc,\ r \to ab)}{\mathcal{B}(D \to abc)} = \frac{\int |a_j e^{i\delta_j} \mathcal{M}_j|^2 dm^2_{ab} dm^2_{bc}}{\int |\Sigma_k a_k e^{i\delta_k} \mathcal{M}_k|^2 dm^2_{ab} dm^2_{bc}}.$$

The sum of fit fractions for all components j will, in general, not be unity due to interference.

Example of current practice in D-meson section of RPP:

We use results of Dalitz-plot analyses of both $K^-\pi^+\pi^+$ and $\overline{K}^0\pi^0\pi^+$ to determine $\mathcal{B}(D^+ \to \overline{K}^{*0}\pi^+)$ under the assumption that

$$\frac{\mathcal{B}(D^+ \to \overline{K}^{*0}\pi^+,\ \overline{K}^{*0} \to \overline{K}^0\pi^0)}{\mathcal{B}(\overline{K}^{*0} \to \overline{K}^0\pi^0)} =$$

$$\frac{\mathcal{B}(D^+ \to \overline{K}^{*0}\pi^+,\ \overline{K}^{*0} \to K^-\pi^+)}{\mathcal{B}(\overline{K}^{*0} \to K^-\pi^+)}.$$

This assumption is not valid because the submodes contributing to $\overline{K}^0\pi^+\pi^0$ and to $K^-\pi^+\pi^+$ are very different. (The former is dominated by $K\rho$; the latter is dominated by "nonresonant" $K\pi\pi$ or by $\kappa\pi$.)

Recommendations:

- We recommend that for modes such as $D \to rc,\ r \to ab$ we not correct the D branching fraction for unseen decay modes of the resonance r.

- We recommend listing the D branching fraction for the entire decay chain $D \to rc,\ \ r \to ab$.

- We recommend that all averaging of branching fractions for two-body resonant submodes ($D \to rc$) from different three-body final states be removed for the 2005 web version of the RPP.

- $\approx$ 30 data blocks related to D decays to $K\pi\pi$, $K\overline{K}\pi$ and $\pi\pi\pi$ are affected. If we extend the changes to submodes leading to four-body final states, then the number of affected data blocks more than doubles.

What about B decays?

Interference effects are not as important for B decays.

- Intermediate resonances are often much narrower in B decays than in D decays (*e.g.*, D^* rather than K^* intermediate resonances).

- The width of each resonance is a smaller fraction of the kinematically allowed mass range in B decays, leading to a smaller fractional overlap area of resonances in the Dalitz plot.

Could some charm averaging be done by HFAG?

Examples:

- D_s^+ decay constant (currently handled by "offline averaging" and a Note).
- Form factors for semileptonic charm decays (currently handled as footnotes or not at all; no averaging done).