PROCEEDINGS OF SCIENCE

Hadronic decays of $D^{0(+)}$ and D_s^+ at BESIII

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In this talk, we present a selection of recent results on hadronic decays of $D^{0(+)}$ and D_s^+ from BESIII collaboration, including the amplitude analyses of $D^0 \to K^-\pi^+\pi^+\pi^-$, $D^+ \to K_S^0\pi^+\pi^+\pi^-$, $D^0 \to K^-\pi^+\pi^0\pi^0$ and $D_s^+ \to \pi^+\pi^0\eta$, as well as the measurements of absolute branching fractions for $D_s^+ \to p\bar{n}$, $D_s^+ \to \omega\pi^+$ and $D_s^+ \to \omega K^+$, and D mesons decays into two pseudoscalar mesons. These results are based on the data samples collected with the BESIII detector at the energies of $\psi(3770)$ and $\psi(4160)$.

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1. Introduction

Hadronic decays of $D^{0(+)}$ and D_s^+ mesons are an important tool for understanding the dynamics of the strong interaction in the low energy regime. BESIII experiment has collected the world's largest samples at $\psi(3770)$ and $\psi(4160)$ resonances. Based on these samples, BESIII has performed the amplitude analyses of $D^0 \to K^-\pi^+\pi^+\pi^-$ [1] and $D^+ \to K_S^0\pi^+\pi^+\pi^-$ [2], as well as the measurements of absolute branching fractions (BFs) for $D_s^+ \to p\bar{n}$ [3], $D_s^+ \to \omega\pi^+$ and $D_s^+ \to \omega K^+$ [4], and D mesons decays into two pseudoscalar mesons [5]. In this proceeding, we present the preliminary results of amplitude analyses of $D_s^+ \to \pi^+\pi^0\eta$ and $D^0 \to K^-\pi^+\pi^0\pi^0$ (the inclusion of charge conjugate reactions is implied).

2. Amplitude analysis of $D_s^+ \to \pi^+\pi^0\eta$ (preliminary)

We perform the first amplitude analysis of $D_s^+ \to \pi^+\pi^0\eta$ with a data sample of 3.19 fb^{-1} collected with the BESIII detector at a center-of-mass energy of 4.178 GeV. The double tag (DT) method is used to reconstruct the D_s mesons. Seven single tag (ST) modes are used: $D_s^- \to K_S^0K^-$, $D_s^- \to K^+K^-\pi^-$, $D_s^- \to K_S^0K^-\pi^0$, $D_s^- \to K^+K^-\pi^-\pi^0$, $D_s^- \to K_S^0K^+\pi^-\pi^-$, $D_s^- \to \pi^-\eta$, and $D_s^- \to \pi^-\eta'$. In which, K_S^0, η, and $\eta^{(\prime)}$ are reconstructed with $\pi^+\pi^-$, $\gamma\gamma$ and $\pi^+\pi^-\eta$, respectively. The DT events are reconstructed $D_s^+D_s^-$ pairs with D_s^- in a tag mode combined with $D_s^+ \to \pi^+\pi^0\eta$, where π^0 and η are reconstructed with $\gamma\gamma$. A multi-variable analysis is performed to suppress the background from fake η. A sample of 1239 events with a purity of $(97.7 \pm 0.5)\%$ is obtained to perform the amplitude analysis. The magnitudes, phases and fit fractions (FFs) of the intermediate processes obtained from the amplitude analysis are listed in Table 1. The Dalitz plot of $M^2_{\pi^+\eta}$ versus $M^2_{\pi^0\eta}$ for data is shown in Fig. 1(a). The projections for the data, total fit, and the contributions from individual components of the full sample and the sub-sample with $M_{\pi^+\pi^0}$ larger than 1.0 GeV$/c^2$ are shown in Figs. 1(b-d) and Figs. 1(e,f), respectively. Obvious $a_0(980)$ peaks are observable in Fig. 1(e) and Fig. 1(f).

Table 1: The magnitudes, phases, and FFs for intermediate processes obtained from the amplitude analysis. The first and second uncertainties are statistical and systematic, respectively.

Amplitude	Magnitude	Phase	FF
$D_s^+ \to \rho^+\eta$	1.0 (fixed)	0.0 (fixed)	$0.783 \pm 0.050 \pm 0.021$
$D_s^+ \to (\pi^+\pi^0)_V\eta$	$1.234 \pm 0.272 \pm 0.329$	$0.612 \pm 0.172 \pm 0.342$	$0.054 \pm 0.021 \pm 0.026$
$D_s^+ \to a_0(980)\pi$	$0.788 \pm 0.058 \pm 0.046$	$2.794 \pm 0.087 \pm 0.041$	$0.232 \pm 0.023 \pm 0.034$

The DT yield is determined by the fit to the $M_{\pi^+\pi^0\eta}$ distribution, which is shown in Fig. 2. We obtain the total BF of $D_s^+ \to \pi^+\pi^0\eta$ to be $(9.50 \pm 0.28_{\text{stat.}} \pm 0.41_{\text{sys.}})\%$. With the FFs listed in Table 1, the BFs for $D_s^+ \to \rho^+\eta$, and $D_s^+ \to a_0(980)^{+/0}\pi^{0/+}$ are calculated to be $(7.44 \pm 0.48_{\text{stat.}} \pm 0.44_{\text{sys.}})\%$, and $(1.46 \pm 0.15_{\text{stat.}} \pm 0.23_{\text{sys.}})\%$, respectively. The measured BF of $D_s^+ \to a_0(980)^{+/0}\pi^{0/+}$ is larger than other measured pure W-annihilation decays [3, 4] by one order. This provides theoretical challenge to understand such a large W-annihilation contribution.

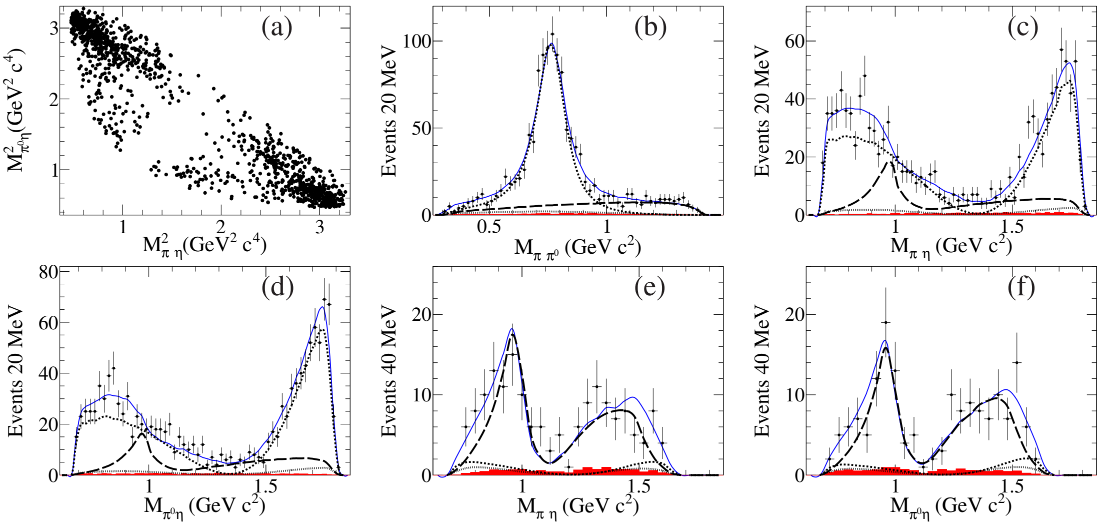

Figure 1: Figure (a) shows the Dalitz plot of $M^2_{\pi^+\eta}$ versus $M^2_{\pi^0\eta}$. Figures (b), (c), and (d) are the projections plotted with full data sample. Figures (e) and (f) are the projections after requiring $M_{\pi^+\pi^0} > 1.0$ GeV$/c^2$. In the projections, the dots with error bars are the data. The solid, dashed, dotted, and long dashed lines are the total fit, the contributions from $D_s^+ \to \rho^+\eta$, $D_s^+ \to (\pi^+\pi^0)_V\eta$, and $D_s^+ \to a_0(980)\pi$, respectively. The hatched histograms are the simulated background.

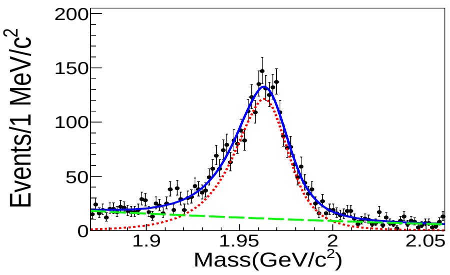

Figure 2: The fit to $M_{\pi^+\pi^0\eta}$ distribution. The dots with error bars are the data. The solid lines are the total fit. The dashed and the long dashed lines are the signal and the background, respectively.

3. Amplitude analysis of $D^0 \to K^-\pi^+\pi^0\pi^0$ (preliminary)

We perform the first amplitude analysis of $D^0 \to K^-\pi^+\pi^0\pi^0$ with a data sample of 2.93 fb^{-1} collected with the BESIII detector at $\psi(3770)$ resonance. The DT candidates are required to have $D^0 \to K^-\pi^+\pi^0\pi^0$ as the signal and the $\bar{D}^0 \to K^+\pi^-$ as the tag. A sample of 5950 events with a purity of 98.9% is obtained to perform the amplitude analysis. We find that 26 amplitudes are needed to describe the substructures of the final states. The projections of data sample and the fit on the invariant masses squared and the cosines of helicity angles for the $K^-\pi^+$, $K^-\pi^0$, $\pi^+\pi^0$ and $\pi^0\pi^0$ systems are shown in Fig. 3.

The DT yield is determined by the fit to the $M_{\rm BC}$ distributions of the DT of data, which are shown in Figs. 4(a) and (b). The ST yield is determined by the fit to the $M_{\rm BC}$ distribution of the ST of data, which is shown in Fig. 4(c), The ST and DT data yields are determined to be

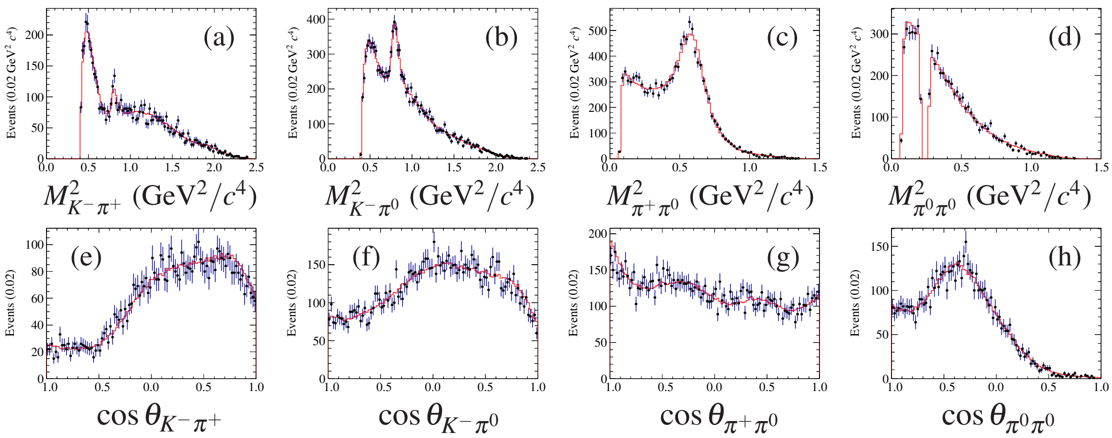

Figure 3: Projections of data and the fit on the (a)-(d) invariant masses squared and the (e)-(h) cosines of helicity angles. The solid lines indicates the fit results, while the dots with error bars indicate data.

534581 ± 769 and 6101 ± 83, respectively. We obtain the total BF of $D^0 \to K^-\pi^+\pi^0\pi^0$ to be $(8.98 \pm 0.13(\text{stat}) \pm 0.40(\text{syst}))\%$.

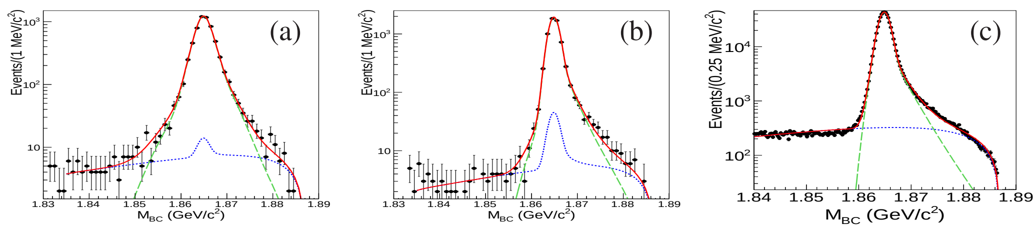

Figure 4: Fits to the $M_{\rm BC}$ distributions of the DT of the data sample projected to the (a) signal side and the (b) tag side, and fit to (c) the $M_{\rm BC}$ distributions of the ST of the data sample. The dots with error bars are data, the solid lines are the total fit, the (green) dashed lines are the signal, and dotted lines are the background.

4. Summary and Outlook

BESIII has produced a large amount of results on hadronic decays of $D^{0(+)}$ and D_s^+ based on the world's largest samples at $\psi(3770)$and $\psi(4160)$ resonances. Many new and precision measurements are expected to be coming soon.

References

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