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**PRELIMINARY RESULTS ON CHARMED MESON
SPECTROSCOPY**

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Abstract

We report the preliminary measurement by the FOCUS Collaboration (E831 at Fermilab) of masses and widths of the $L=1$ charm mesons D_2^{*0} and D_2^{*+} . The fit of the invariant mass distribution requires an additional term to account for a broad structure over background.

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We present preliminary results from the FOCUS experiment (E831 at Fermilab) on the spectroscopy of bound states of a charm quark and a light quark with orbital angular momentum $L = 1$, called $D_2^*(c\bar{u}, c\bar{d})$. A theoretical framework for the spectrum of heavy-light mesons is given by Heavy Quark Symmetry (HQS), which predicts both narrow and broad states. While the narrow states are well established, the evidence for the broad states (both in the c -quark and in the b -quark sector) is much less stringent [2].

The data for this paper were collected in the Wideband photoproduction experiment FOCUS during the Fermilab 1996–1997 fixed-target run. FOCUS is a considerably upgraded version of a previous experiment, E687 [1]. In FOCUS, a forward multi-particle spectrometer is used to measure the interactions of high-energy photons on a segmented BeO target. We obtained a sample of over 1 million fully reconstructed charm particles in the three major decay modes: $D \rightarrow K\pi, K2\pi, K3\pi$.

The decays $D^0 \rightarrow K^-\pi^+, D^+ \rightarrow K^-\pi^+\pi^+, D^0 \rightarrow K^-\pi^+\pi^-\pi^+, D^{*+} \rightarrow D^0\pi^+$ were selected[3]. The D^+ or D^0 candidates were combined with the pion tracks in the primary vertex to form $L=1$ D -meson candidates in channels $D^+\pi^-$ and $D^0\pi^+$. Figure 1a,b) shows the distribution in the invariant mass difference $\Delta M_0 \equiv M(D^+\pi^-) - M(D^+) + M_{PDG}(D^+)$. The plot shows a pronounced peak, consistent with being due to a D_2^{*0} of mass $M \approx 2460 \text{ MeV}/c^2$. Because of the narrow width, this state has traditionally been identified as the $J = 2^+$ state. The additional enhancement at $M \approx 2300 \text{ MeV}/c^2$ is

Table 1: Preliminary measurements of masses and widths for narrow structures in $D^+\pi^-$ and $D^0\pi^+$ invariant mass spectra.

	Mass MeV/ c^2	Width MeV/ c^2
D_2^{*0}	$2463.5 \pm 1.5 \pm 1.5$	$30.5 \pm 1.9 \pm 3.8$
PDG2000	2458.9 ± 2.0	23 ± 5
D_2^{*+}	$2468.2 \pm 1.5 \pm 1.4$	$28.6 \pm 1.3 \pm 3.8$
PDG2000	2459 ± 4	25^{+8}_{-7}

consistent, as verified from Monte Carlo simulations, with arising from the feed-down of the states D_1^0 and D_2^{*0} decaying to $D^{*+}\pi^-$, with the D^{*+} subsequently decaying to D^+ and undetected neutral pion. The D_2^{*0} signal was fitted with a relativistic D -wave Breit-Wigner function, convoluted with a gaussian resolution function ($\sigma = 7$ MeV). The background was fitted with the sum of an exponential, and two gaussians for the feed-downs described above, whose peaks and widths were fixed at the Monte Carlo values. The slope of the exponential was fixed to the value determined by a fit to the wrong-side events mass distribution, which is very well described by a single-slope exponential in the entire fitting interval $2250 - 3000$ MeV/ c^2 . For this fit we get a $\chi^2/\text{dof} = 2$, and a $\Gamma = 55 \pm 3$ MeV/ c^2 D_2^{*0} width non compatible with the PDG2000 world average of $\Gamma = 23 \pm 5$ MeV/ c^2 . We then add an S -wave relativistic Breit-Wigner function to the fit, which improves the fit quality $\chi^2/\text{dof} = 0.9$, and provides a width $\Gamma = 30 \pm 2$ MeV/ c^2 compatible to the PDG2000 value. The mass difference $\Delta M_+ \equiv M(D^0\pi^+) - M(D^0) + M_{PDG}(D^0)$ spectrum (Fig. 1d,e) shows structures similar to those in the ΔM_0 spectrum, and the fitting procedure follows the same guidelines.

Several systematics checks have been performed to verify the stability of our measurements of masses and widths[3]. As one example we show (Fig.1c,f) how a $P > 10$ GeV/ c cut on the momentum of the soft pion provides peak and width statistically compatible. Table 1 summarizes the preliminary results on the measurements of masses and widths.

In conclusion, the study of the $D\pi$ mass spectrum provides new preliminary values of the masses and widths for the D_2^* meson (Tab. 1). The $D\pi$ mass spectrum (once subtracted the background, the D_2^* signal, and the expected feed-downs) shows an excess of events centered around 2420 MeV/ c^2 and about 185 MeV/ c^2 wide. The observed excess could be reminiscent of the broad D_0^* predicted by HQS, or of a feed-down from another broad state such as the $D_1(j_q = 1/2)$, possibly interfering. Work is in progress to verify such hypothesis.

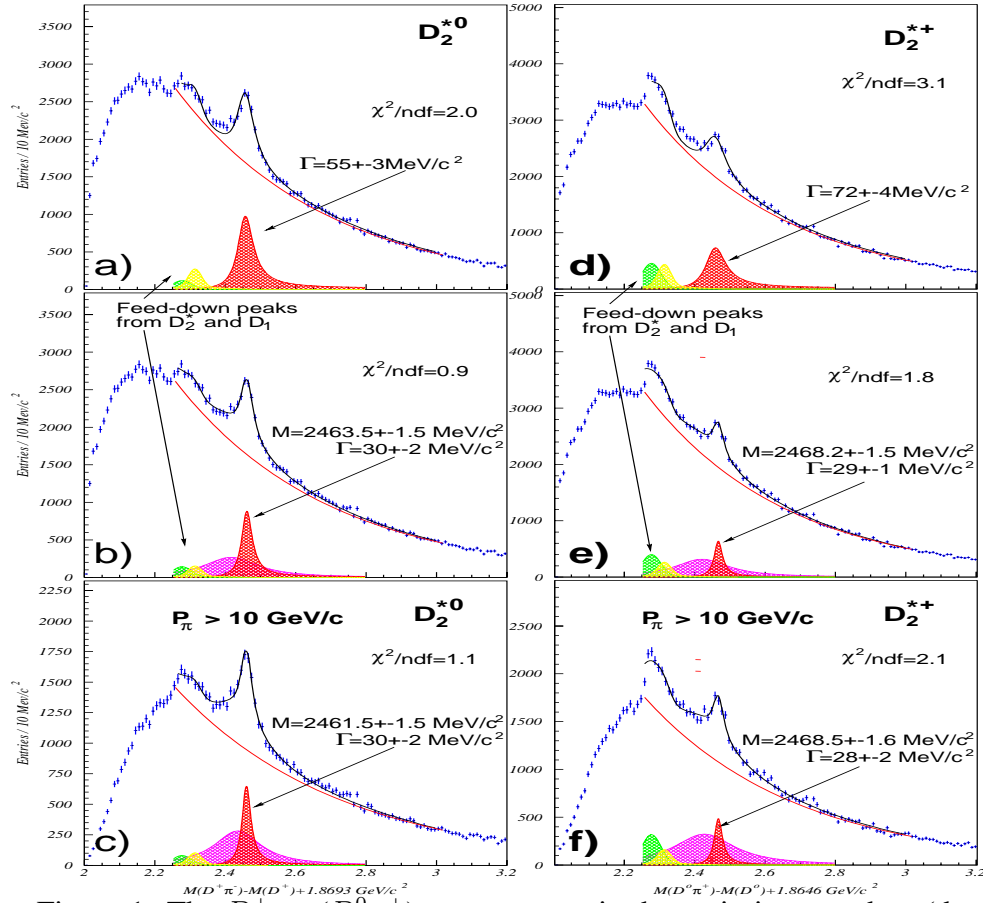


Figure 1: The $D^+\pi^-$ ($D^0\pi^+$) mass spectra is shown in insets a, b, c (d, e, f). Insets c, f show the effect of a soft pion momentum cut.

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