New Results on Charm Semileptonic Decays and Lifetime

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Representing CLEO Collaboration

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Outline

- measurement of $B(D^+ \to \overline{K^*}^0 l^+ \nu_l)$
- first measurement of $\Gamma(D^{*+})$
- form factor ratio measurement in $\Lambda_c \to \Lambda e^+ \nu$
- evidence for $\Omega_c \to \Omega e^+ \nu$
- measurement of Ξ_c^+ lifetime

Measurement of $B(D^+ \to \overline{K^*}^0 l^+ \nu_l)$

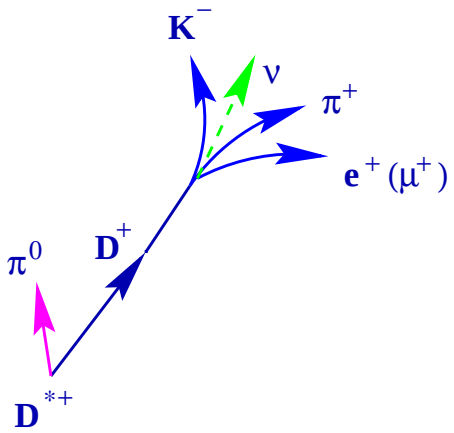
Motivation:

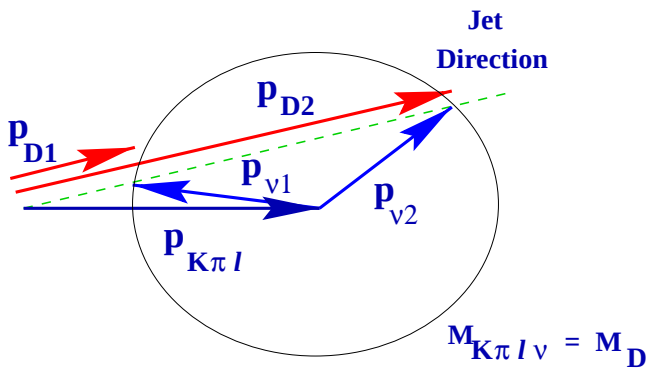
- no reliable calculation of form factors in $D^+ \to \overline{K^*}^0 l^+ \nu_l$
  - ☆ measurement of form factors helps to guide theory
- HQET and chiral symmetry:
  - ☆ form factors in $D^+ \to \overline{K^*}^0 l^+ \nu_l$ is related

    to those in $b \to u l \nu$ and $b \to s l l$
    - ⇨ measurement of $B(D^+ \to \overline{K^*}^0 l^+ \nu_l)$

      helps to reduce uncertainty in V_{ub} extraction

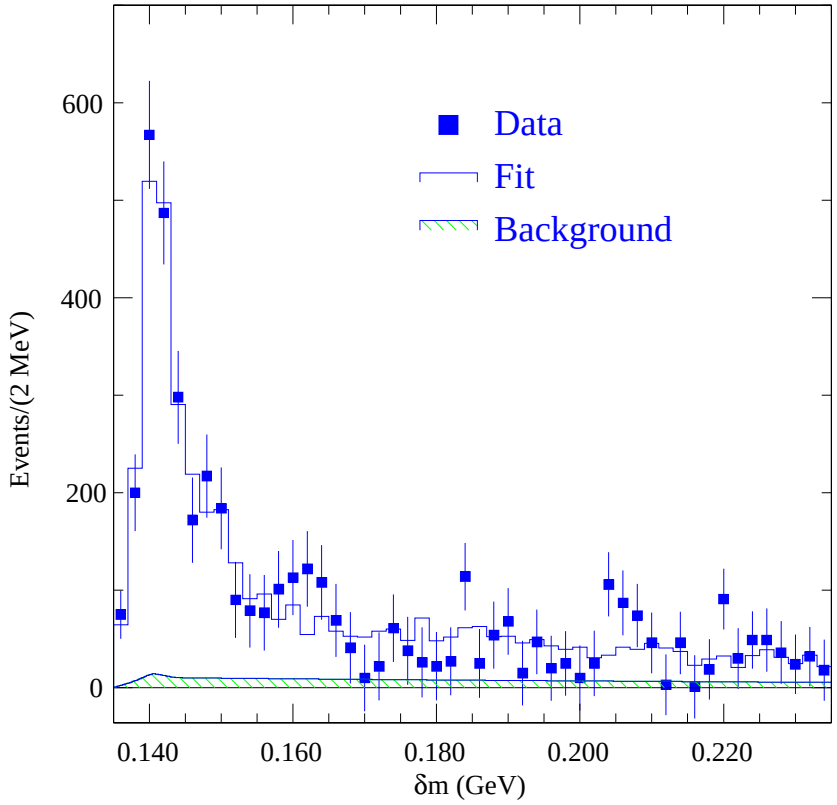
Analysis procedure:





- choose δm closest to 0.1406 GeV:
  - P_{D1} or P_{D2} or event missing momentum
- fit for K^* resonance in each δm bin
- fit δm to extract signal yield

Fit of δm Distribution



- clear excess of events over low background

Preliminary Results on $B(D^+ \to \overline{K^*}^0 l^+ \nu_l)$

- $R_l = \dfrac{B(D^+ \to \overline{K^*}^0 l^+ \nu_l)}{B(D^+ \to K^- \pi^+ \pi^+)}$:

$$R_e = 0.74 \pm 0.04 \pm 0.06$$

$$R_\mu = 0.72 \pm 0.10 \pm 0.06$$

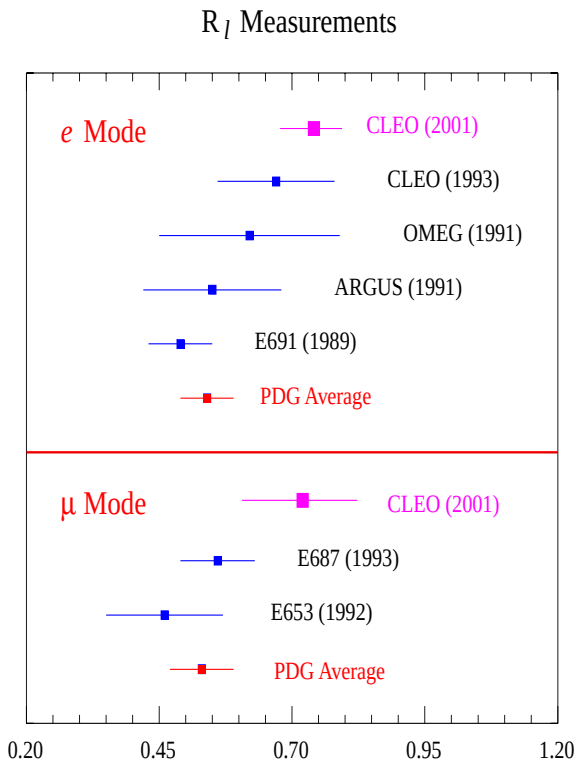
$$R_l = 0.73 \pm 0.04 \pm 0.05$$

- PDG : $B(D^+ \to K^- \pi^+ \pi^+) = (9.0 \pm 0.6)\%$:

$$B_e = (6.7 \pm 0.4 \pm 0.5 \pm 0.4)\%$$

$$B_\mu = (6.5 \pm 0.9 \pm 0.5 \pm 0.4)\%$$

$$B_l = (6.6 \pm 0.4 \pm 0.5 \pm 0.4)\%$$



- CLEO results are consistent with other experiments

First Measurement of $\Gamma(D^{*+})$

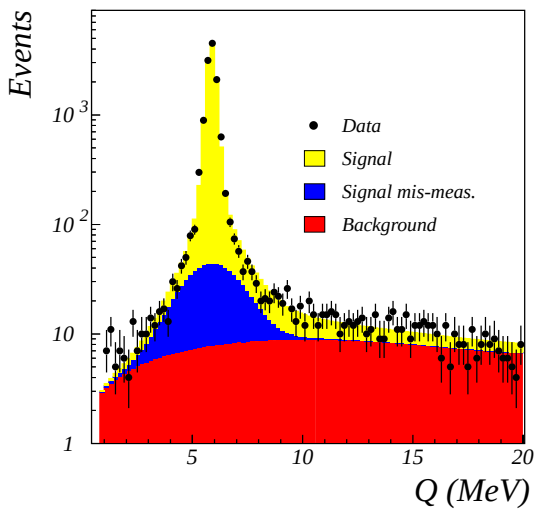
- use $D^{*+} \to D^0\pi^+$ with $D^0 \to K^-\pi^+$
- measure energy release:

  $Q = m(K^-\pi^+\pi^+) - m(K^-\pi^+) - m_{\pi^+}$

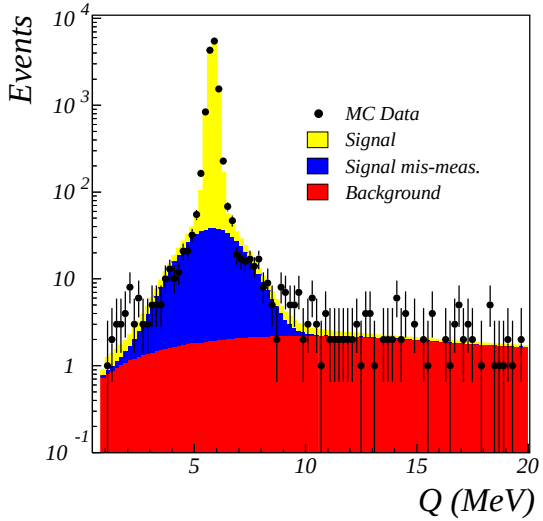
  - ☆ width of Q distribution is dominated by $\Gamma(D^{*+})$ and detector resolution
  - ☆ use unbinned maximum likelihood fit with Breit Wigner shape for $\Gamma(D^{*+})$

Typical Fits of Data and MC

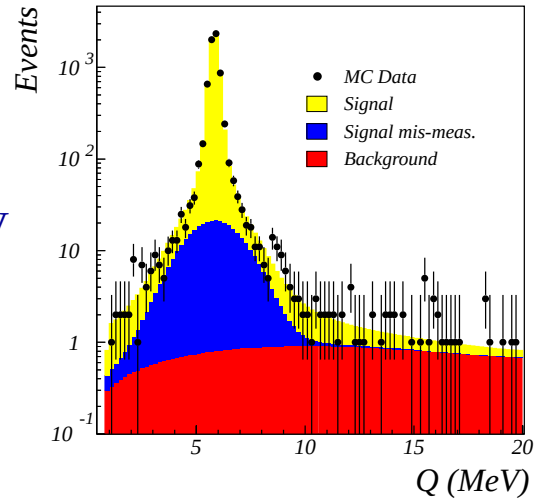
Data



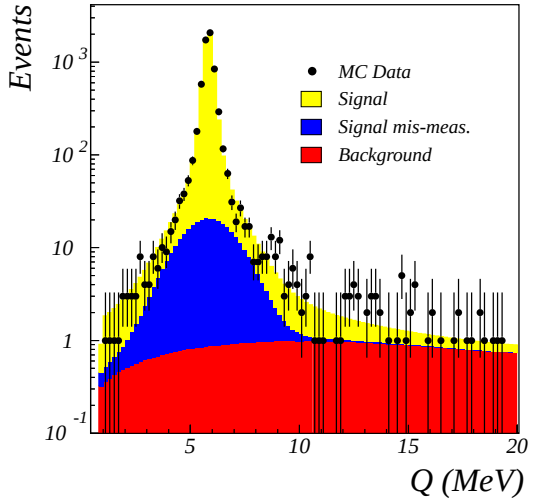
Γ_{MC} = 0 KeV



Γ_{MC} = 100 KeV



Γ_{MC} = 130 KeV



Results

- $\Gamma(D^{*+}) = 96 \pm 4 \pm 22$ KeV
  - first measurement of $\Gamma(D^{*+})$
- $m(D^{*+}) - m(D^0) = 145.412 \pm 0.002 \pm 0.012$ MeV
- $$\Gamma(D^{*+}) = \frac{g^2_{D^{*+}D^0\pi^+}}{24\pi m^2_{D^{*+}}} p^3_{\pi^+} + \frac{g^2_{D^{*+}D^+\pi^0}}{24\pi m^2_{D^{*+}}} p^3_{\pi^0} + \frac{\alpha g^2_{D^{*+}D^+\gamma}}{3} p^3_{\gamma}$$

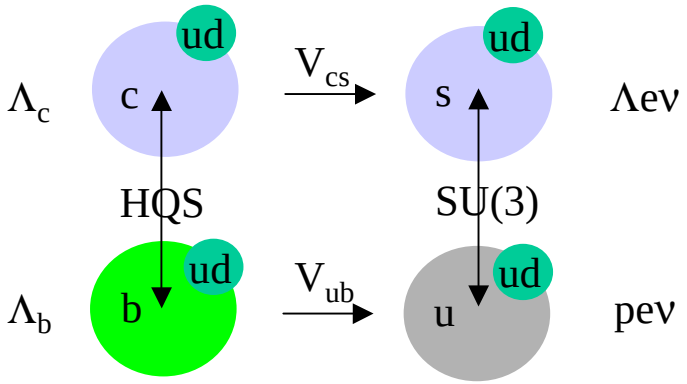
$$g_{D^*D\pi} \equiv g_{D^{*+}D^0\pi^+} = -\sqrt{2} g_{D^{*+}D^+\pi^0} = \frac{2m_{D^{*+}}}{f_\pi} g$$

  - ☆ $g_{D^*D\pi} = 17.9 \pm 0.4 \pm 2.0$
  - ☆ $g = 0.59 \pm 0.01 \pm 0.07$
  - consistent with RQM, HQET, Chiral Bag Model, HMχL
  - contradicts QCD sum rules: g = 0.2 - 0.3

Form Factor Ratio Measurement in $\Lambda_c \to \Lambda e^+ \nu$

Motivation:

- alternative methods for extracting $|V_{ub}|$ and $|V_{cb}|$:



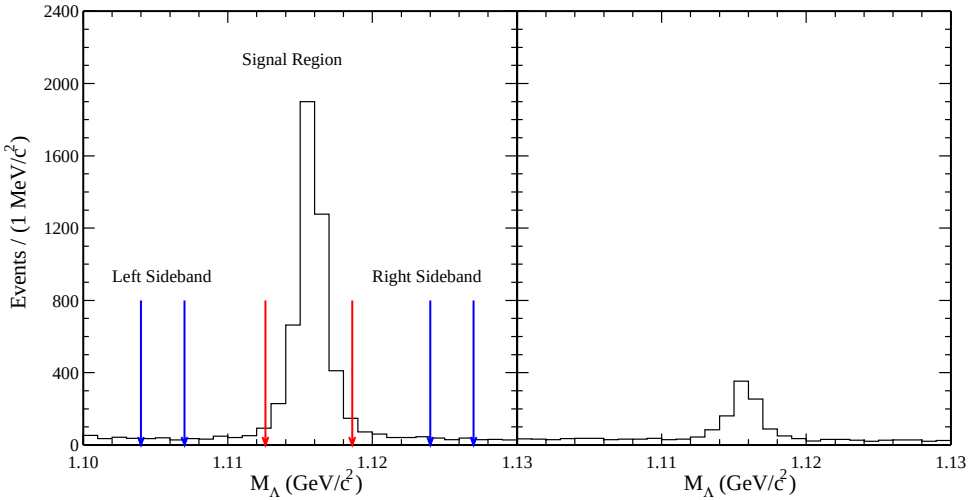
- ☆ same set of form factors in both decays
- ☆ Korner-Kramer:

$$R = \frac{f_2(q^2)}{f_1(q^2)} = -0.25$$

Analysis procedure:

- extract form factor ratio from fits
  to decay rate distributions of three kinematic variables
  - $t = \dfrac{q^2}{q^2_{\max}}$
  - $\cos\theta_W$: angle between e and W in center of mass of W
  - $\cos\theta_\Lambda$: angle between p and Λ in center of mass of Λ

right sign
(Λe^+ and $\bar{\Lambda} e^-$)



wrong sign
(Λe^- and $\bar{\Lambda} e^+$)

- clear excess of right sign over wrong sign events

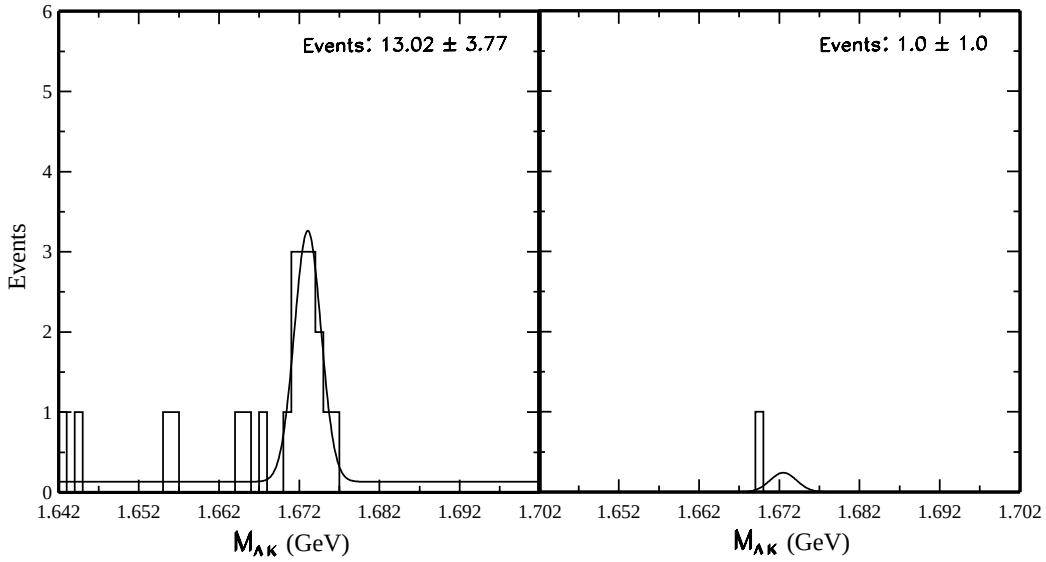
Preliminary Results

- $R = -0.31 \pm 0.06 \pm 0.06$
  - ☆ CLEO(1995): $R = -0.25 \pm 0.14 \pm 0.08$
  - ⇨ significant improvement over previous measurement
  - ☆ Korner-Kramer: $R = -0.25$
  - ⇨ consistent with Korner-Kramer

Search for $\Omega_c \to \Omega e^+ \nu$

- measurements of semileptonic decays of charm mesons and baryons provides test of Heavy Quark Expansions theory
- search for Ω_c by comparing right sign (Ωe^+) and wrong sign (Ωe^-) event yields:

right sign



wrong sign

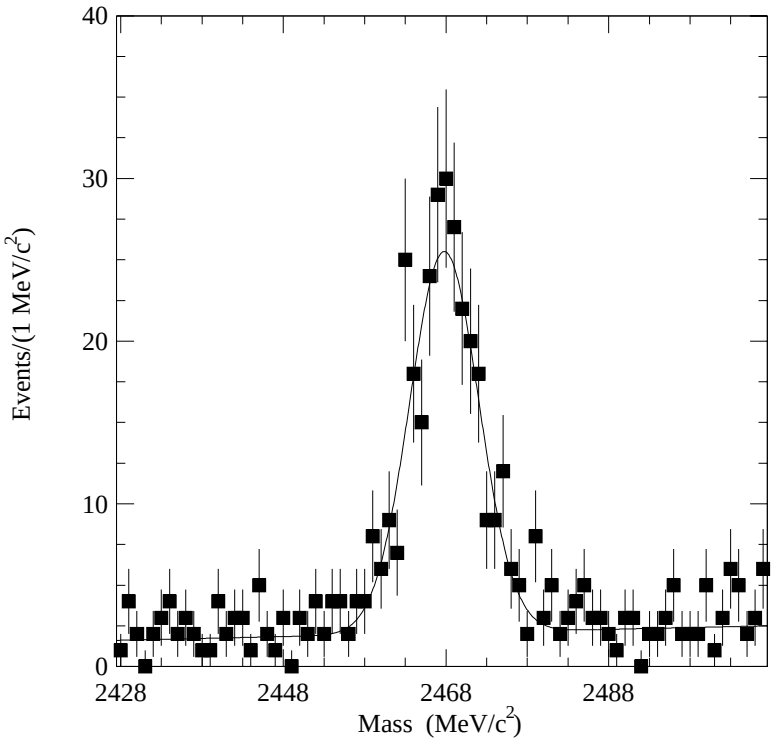
Preliminary Results

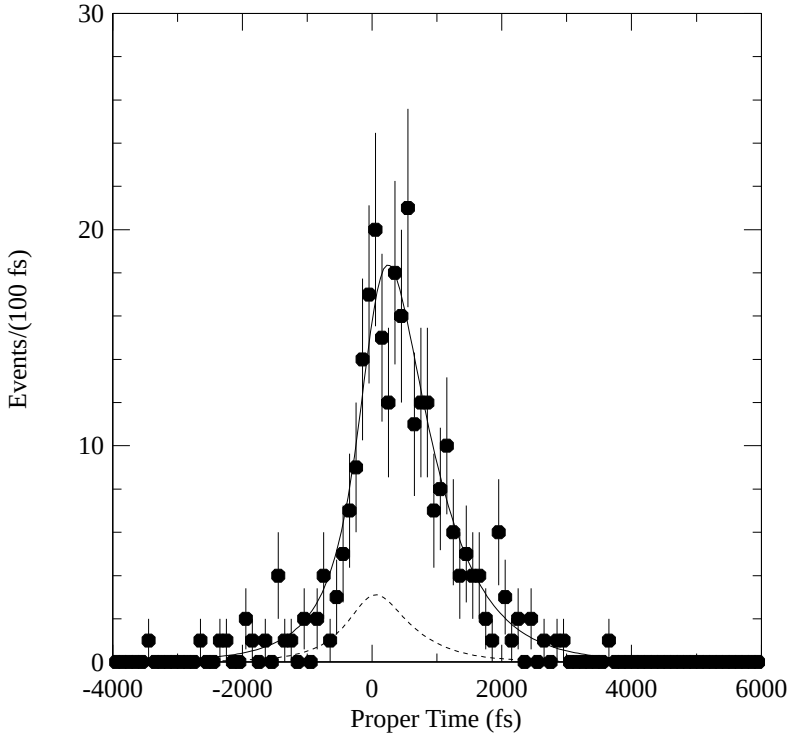
- $B(\Omega_c \to \Omega e^+ \nu) \cdot \sigma(e^+e^- \to \Omega_c X) = 42.2 \pm 14.1 \pm 11.9$ fb
  - ☆ first observation of baryon β decay with no u or d in parent particle
  - ☆ background fluctuation probability < 9×10^{-4}

Measurement of Ξ_c^+ Lifetime

- theoretical motivation:
  - understanding of contribution of *W*-exchange mechanisms to weak decays which are different for charm mesons and baryons
- experimental motivation:
  - charm mesons (D^0, D^+, D_s) and baryon (Λ_c^+) lifetimes are measured to 1-4%
  - Ξ_c^+ lifetime measured to 20%
  - e^+e^- experiments provides measurements with different systematic from fixed target experiments

Ξ_c^+ Mass and Lifetime Distributions





- clear excess of events with positive lifetime

Results

- CLEO: $\tau_{\Xi_c^+} = 503 \pm 47 \pm 18$ fs
- CLEO result is consistent with other experiments