Heavy Quark Fragmentation in e^+e^- Annihilation

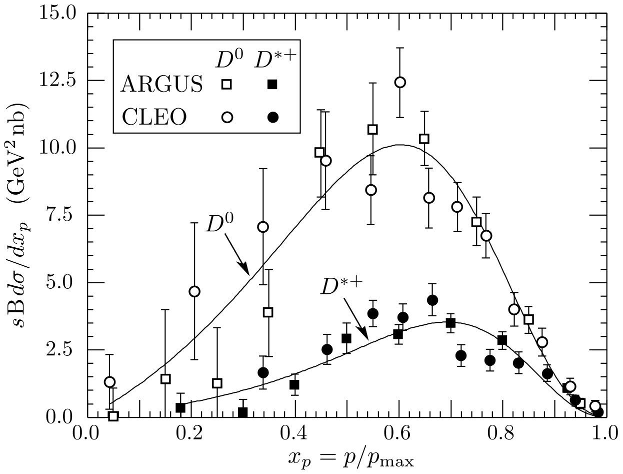

Figure 36.13: Heavy quark fragmentation: Shown are the **CLEO**—D. Bortoletto *et al.*, Phys. Rev. **D37**, 1719 (1988) and **ARGUS**—H. Albrecht *et al.*, Z. Phys. **C52**, 353 (1991) inclusive cross sections ($s\,\mathrm{B}\,d\sigma/dx_p$, with $x_p = p/p_{\mathrm{max}}$) for the production of pseudoscalar D^0 and vector D^{*+} in e^+e^- annihilations at $\sqrt{s}$ ~10 GeV. For the D^0, B is the branching ratio for $D^0 \to K^-\pi^+$, while in the D^{*+} case B is the product branching ratio for $D^{*+} \to D^0\pi^+$ followed by $D^0 \to K^-\pi^+$. These inclusive spectra have not been corrected for cascades from higher states, nor for radiative effects. Many functional forms have been suggested to describe these "hard" spectra, characteristic of charmed particles produced in e^+e^- annihilations. The parameterization given by Peterson *et al.*, (Phys. Rev. **D27**, 105, (1983)) in terms of just one variable ϵ_p has found the most use:

$$\frac{dN}{dx_p} = \frac{1}{x_p[1-(1/x_p)-\epsilon_p/(1-x_p)]^2} \, .$$

Fits to the combined CLEO and ARGUS D^0 and D^{*+} data give $\epsilon_p(D^0) = 0.135 \pm 0.010$ and $\epsilon_p(D^*) = 0.078 \pm 0.008$; these are indicated by the solid curves.

Spin-dependent effects have been observed in, *e.g.*, the polarization of D^{*+} mesons as a function of x_p. Recent measurements of ϵ_p for D^{**} and D_{sJ} mesons by **CLEO**—J. Alexander *et al.*, Phys. Lett. **B303**, 377 (1993) and **ARGUS**—H. Albrecht *et al.*, Phys. Lett. **B221**, 422 (1989) and Phys. Lett. **B232**, 398, (1989) also indicate that the fragmentation functions of such orbitally excited charmed mesons are distinctly harder than for D or D^* mesons. How much of this is a mass effect and how much is truly a spin effect has not yet been fully determined. (Courtesy of D. Besson, Univ. of Kansas, 1994.)

Average e^+e^-, pp, and $\overline{p}p$ Multiplicity

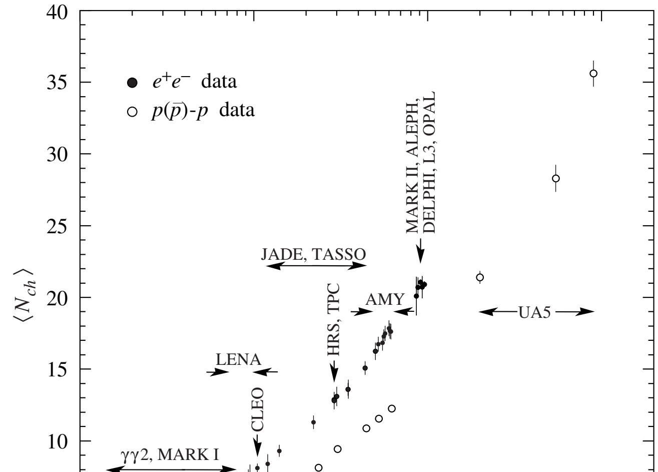

Figure 36.14: Average multiplicity as a a function of $\sqrt{s}$ for e^+e^- and $p\overline{p}$ annihilations and and pp collisions. The indicated errors are statistical and systematic errors added in quadrature, except when no systematic errors are given.

e^+e^-: All measurements include contributions from K^0_S and Λ decays. The $\gamma\gamma2$ and MARK I measurements contain a systematic 5% error. The five points at the Z resonance have been spread horizontally for clarity: **OPAL**—P.D. Acton *et al.*, Z. Phys. **C53**, 539 (1992) and references therein, R. Akers *et al.*, Z. Phys. **C68**, 203 (1995); **ALEPH**—D. Buskulic *et al.*, Z. Phys. **C**, CERN PPE/95-82.

$p^{(\overline{p})}$: The values measured by UA5 exclude single diffractive dissociation: J. Benecke *et al.* (bubble chamber), Nucl. Phys. **B76**, 29 (1976), W.M. Morse *et al.* (bubble chamber), Phys. Rev. **D15**, 66 (1977); **ISR**—A. Breakstone *et al.*, Phys. Rev. **D30**, 528 (1984); **UA5**—G.J. Alner *et al.*, Phys. Lett. **167B**, 476 (1986), Ansorge *et al.*, Z. Phys. **C43**, 357 (1989). (Courtesy of O. Biebel, S. Bethke, and D. Lanske, RWTH, Aachen, 1994.)

Annihilation Cross Section Near M_Z

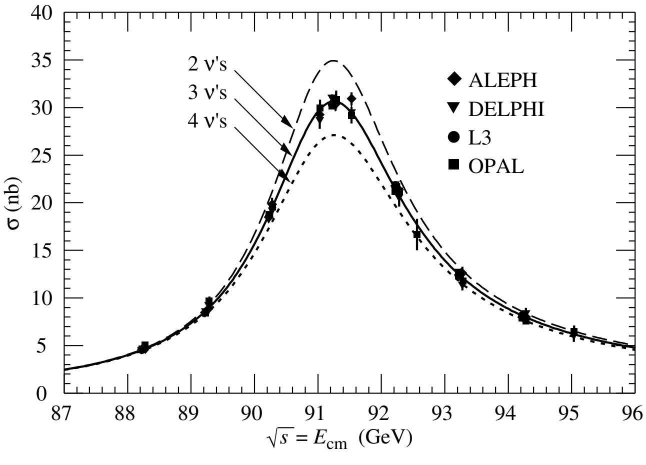

Figure 36.15: Data from the ALEPH, DELPHI, L3, and OPAL Collaborations for the cross section in e^+e^- annihilation into hadronic final states as a function of c.m. energy near the Z. LEP detectors obtained data at the same energies; some of the points are obscured by overlap. The curves show the predictions of the Standard Model with three species (solid curve) and four species (dashed curve) of light neutrinos. The asymmetry of the curves is produced by initial-state radiation. References:

ALEPH: D. Decamp *et al.*, Z. Phys. **C53**, 1 (1992).
DEPHI: P. Abreu *et al.*, Nucl. Phys. **B367**, 511 (1992).
L3: B. Adeva *et al.*, Z. Phys. **C51**, 179 (1991).
OPAL: G. Alexander *et al.*, Z. Phys. **C52**, 175 (1991).