

D_s cross section revisited

Errors found in previous calculation of the D_s production cross-section in proton-nucleon interactions decrease the value from 5.2mbarns/nucleon to 3.5mb/nucleon. This is a reduction of ~30%.

The D_s cross section used in E872 has been calculated from :

$$\sigma(D_s) = \sigma(D) \cdot \frac{\sigma(D_s)}{\sigma(D)}$$

where $\sigma(D)$ is either D^+ or D^0 . The ratios $\sigma(D_s)/\sigma(D^0)$ and $\sigma(D_s)/\sigma(D^+)$ are measured by many experiments using both pions and protons over a range of energies. They are consistent throughout and the averages are $.18 \pm .05$ and $.40 \pm .06$ respectively. In reviewing the publications it has been found that the values used for the D_s cross section are incorrect: the values calculated by R.S. are $\sigma(D^+) = 11.3 \pm 2.2 \mu\text{barn/nucleon}$ and $\sigma(D^0) = 27.4 \pm 2.6 \mu\text{barn/nucleon}$.

There are three experiments which have measured the D cross-section in 800 GeV proton-nucleon interactions: E653^[1], E743^[2], E789^{[3],[4]}.

Table 1 shows published values, the values used previously and corrected values.

Exp. [# events]	Published value	Previous used value	Correct value
$\sigma(D^0)$ $\mu\text{barn/nucleon}$			
E789[4000]	17.7 ± 3.5	20.9 ± 3.5	16.9 ± 3.3
E743 [10]	22 ± 10	22 ± 10	12.7 ± 6
E653 [128]	38 ± 13	38 ± 13	38 ± 13 *
$\sigma(D^+)$ $\mu\text{barn/nucleon}$			
E743 [46]	26 ± 9	26 ± 9	17.7 ± 3.5
E653 [18]	38 ± 17	38 ± 17	31 ± 11

Table 1

E743

E743 calculated cross-section by counting number of charm decays found in bubble chamber data. It ID charm decays by identifying either C3 vertices for D^+ or V2 for D^0 for It used branching ratios of D^+ to C3 = .43 and D^0 to V4 = .17. Mark III data from 1991 increases these branching ratios to .54 and .293 respectively.

Since the number of observed charm $\propto [\text{Br} * \sigma]$ an increase of the BR by $.54/.43 = 1.26$ decreases the cross-section of D^+ to $20.1 \mu\text{barn/nucleon}$ and an increase of the BR by $.29/.17 = 1.71$ decreases the cross-section of D^0 to $12.7 \mu\text{barn/nucleon}$ and

E653

E653 calculated cross-section by counting number of charm decays found in emulsion data. It ID charm decays by identifying semi-muonic C3 vertices for D^+ or semi-muonic V2 vertices for D^0 . It calculated it's result with only those decays consistent with $D^+ \rightarrow K^*(892)^0 \mu \nu$ which were identified by $K^* \rightarrow \pi^- K^+$. E653 found 18 of these events.

It cites the PDG for branching ratios used in the calculation.

The value $\text{BR}(D^+ \rightarrow K^*(892)^0 \mu \nu) * \text{BR}(K^* \rightarrow \pi^- K^+)$ used was .025, and has since been updated to $.029 \pm .004$. This decreases the D^+ cross-section measurement from 38 to $31 \mu\text{barn/nucleon}$. It is not possible to update D^0 cross-section in the same manner since only limits on semi-muonic branching ratios are given in the old PDG and which values were used are not explicitly stated in the paper (or by BR, VP, BL).

E789

E789 measured only D^0 production, only at $X_F \sim 0$ and extrapolated the data to all X_F . The X_F and Pt used in the extrapolation are from E653 and E743 and are not the cause of discrepancy.

RS uses the value of 20.9 while the published value is 17.7. This is probably due to the line in ref. [3] ...

“Averaging with previous measurements using 800 GeV proton beams ^[references to E743 and E653] gives $\sigma(pN \rightarrow D^0 X) = 20.9 \pm 3.5 \mu\text{barn/nucleon}$.”

The slight correction in the table is again due to an updated branching ratio BR ($D^0 \rightarrow K \pi$) which was .0365 in 1994 and is now .0383.

References

- [1] K.Kodama et al., Phys. Lett. **B 263**: 573-578 (1991)
- [2] R. Ammar et al., Phys. Re. Lett . **61**,19: 2185-2188 (1988)
- [3] D. M. Kaplan et al., Int. J. Mod. Phys. **A12**: 3827-3863 (1997)
- [4] M. J. Leitch et al., Phys. Rev. Lett. **72**: 2542-2545 (1994)