

Muon pair production 2

Muon pair production data from www.hepdata.net/record/ins216031, Table 1, $\sqrt{s} = 29 \text{ GeV}$.

x	y
-0.925	67.08
-0.85	58.67
-0.75	54.66
-0.65	51.72
-0.55	43.70
-0.45	41.12
-0.35	39.71
-0.25	35.34
-0.15	33.35
-0.05	34.69
0.05	34.05
0.15	34.48
0.25	34.66
0.35	35.23
0.45	35.60
0.55	40.13
0.65	42.56
0.75	46.37
0.85	49.28
0.925	55.70

For x and y we have

$$x = \cos \theta, \quad y = s \frac{d\sigma}{d \cos \theta} = 2\pi s \frac{d\sigma}{d\Omega}$$

The cross section formula is

$$\frac{d\sigma}{d\Omega} = \frac{(\alpha\hbar c)^2}{4s} (1 + \cos^2 \theta)$$

To compute predicted values \hat{y} , multiply by 10^{37} to convert square meters to nanobarns.

$$\hat{y} = 2\pi s \frac{d\sigma}{d\Omega} = \frac{\pi(\alpha\hbar c)^2}{2} (1 + x^2) \times 10^{37}$$

The following table shows predicted values \hat{y} .

x	y	\hat{y}
-0.925	67.08	60.44
-0.85	58.67	56.10
-0.75	54.66	50.89
-0.65	51.72	46.33
-0.55	43.70	42.42
-0.45	41.12	39.17
-0.35	39.71	36.56
-0.25	35.34	34.61
-0.15	33.35	33.30
-0.05	34.69	32.65
0.05	34.05	32.65
0.15	34.48	33.30
0.25	34.66	34.61
0.35	35.23	36.56
0.45	35.60	39.17
0.55	40.13	42.42
0.65	42.56	46.33
0.75	46.37	50.89
0.85	49.28	56.10
0.925	55.70	60.44

The coefficient of determination is

$$R^2 = 1 - \frac{\sum(y - \hat{y})^2}{\sum(y - \bar{y})^2} = 0.87$$

Hence $d\sigma$ explains 87% of the variance in the data.