

## Muon pair production 3

The following formula from electroweak theory<sup>1</sup> is a better predictor for SLAC PEP data.

$$\frac{d\sigma}{d\Omega} = F(s)(1 + \cos^2 \theta) + G(s) \cos \theta$$

where

$$F(s) = \frac{\alpha^2}{4s} \left[ 1 + \frac{g_V^2}{\sqrt{2}\pi} \left( \frac{m_Z^2}{s - m_Z^2} \right) \left( \frac{sG}{\alpha} \right) + \frac{(g_A^2 + g_V^2)^2}{8\pi^2} \left( \frac{m_Z^2}{s - m_Z^2} \right)^2 \left( \frac{sG}{\alpha} \right)^2 \right]$$

$$G(s) = \frac{\alpha^2}{4s} \left[ \frac{\sqrt{2}g_A^2}{\pi} \left( \frac{m_Z^2}{s - m_Z^2} \right) \left( \frac{sG}{\alpha} \right) + \frac{g_A^2 g_V^2}{\pi^2} \left( \frac{m_Z^2}{s - m_Z^2} \right)^2 \left( \frac{sG}{\alpha} \right)^2 \right]$$

and

$$g_A = -0.5$$

$$g_V = -0.0348$$

$$m_Z = 91.17 \text{ GeV}$$

$$G = 1.166 \times 10^{-5} \text{ GeV}^{-2}$$

The corresponding formula for  $\hat{y}$  is

$$\hat{y} = 2\pi [F(s)(1 + x^2) + G(s)x] \times (\hbar c)^2 \times 10^{37}$$

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

$x$	$y$	$\hat{y}$
-0.925	67.08	65.59
-0.85	58.67	60.84
-0.75	54.66	55.07
-0.65	51.72	49.96
-0.55	43.70	45.49
-0.45	41.12	41.69
-0.35	39.71	38.53
-0.25	35.34	36.02
-0.15	33.35	34.17
-0.05	34.69	32.97
0.05	34.05	32.42
0.15	34.48	32.53
0.25	34.66	33.28
0.35	35.23	34.69
0.45	35.60	36.75
0.55	40.13	39.47
0.65	42.56	42.83
0.75	46.37	46.85
0.85	49.28	51.52
0.925	55.70	55.45

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<sup>1</sup>See "Quantum Field Theory Revised Edition" by Mandl and Shaw, p. 316.

The coefficient of determination  $R^2$  is

$$R^2 = 1 - \frac{\sum(y - \hat{y})^2}{\sum(y - \bar{y})^2} = 0.98$$

The result indicates that electroweak theory explains 98% of the variance in the data.