Aufgabe 1

$$\sigma[e\_] := \frac{2J+1}{16\pi\left(\sqrt{s}\right)^2}\frac{\Gamma i\,\Gamma j}{(e-e0)^2+\frac{\Gamma^2}{4}}$$

Manuell integriert mit Tipp :

$$\left(\frac{(2J+1)\,\Gamma_i\,\Gamma_j}{16\pi\left(\sqrt{s}\right)^2} * \frac{\text{ArcTan}\left[\frac{e0-e}{\frac{\Gamma}{2}}\right]}{\frac{\Gamma}{2}}\right)_{e=0}^{\infty} = \frac{(2J+1)\,\Gamma_i\,\Gamma_j}{16\pi\left(\sqrt{s}\right)^2}\frac{1}{\frac{\Gamma}{2}} * \left(\frac{-\pi}{2} - \text{ArcTan}\left[\frac{e0}{\frac{\Gamma}{2}}\right]\right) =$$

$$\frac{3\,\Gamma_i\,\Gamma_j}{16\pi\left(\sqrt{s}\right)^2}\frac{1}{\frac{2\Gamma_\mu+\Gamma_h}{2}} * \left(\frac{-\pi}{2} - \text{ArcTan}\left[\frac{\sqrt{s}}{\frac{2\Gamma_\mu+\Gamma_h}{2}}\right]\right)$$

$$\text{interg} = \text{Integrate}\left[\sigma[e]\ /.\ \left\{J\to 1,\ e0\to\sqrt{s},\ \Gamma \text{ -> } 2\,\Gamma\mu+\Gamma h\right\},\ \{e,\ 0,\ \infty\},\ \text{Assumptions -> } \Gamma i>0\ \&\&\ \Gamma j>0\ \&\&\ \Gamma\mu>0\ \&\&\ \Gamma h>0\ \&\&\ s>0\right]\ //\ \text{Factor}$$

$$\frac{3\,\Gamma i\,\Gamma j\left(\pi+2\,\text{ArcTan}\left[\frac{2\sqrt{s}}{\Gamma h+2\,\Gamma\mu}\right]\right)}{16\,\pi\,s\,(\Gamma h+2\,\Gamma\mu)}$$

$$e\mu = \text{interg}\ /.\ \{\Gamma i\to\Gamma\mu,\ \Gamma j\to\Gamma\mu\}$$
$$eh = \text{interg}\ /.\ \{\Gamma i\to\Gamma h,\ \Gamma j\to\Gamma\mu\}$$

$$\frac{3\,\Gamma\mu^2\left(\pi+2\,\text{ArcTan}\left[\frac{2\sqrt{s}}{\Gamma h+2\,\Gamma\mu}\right]\right)}{16\,\pi\,s\,(\Gamma h+2\,\Gamma\mu)}$$

$$\frac{3\,\Gamma h\,\Gamma\mu\left(\pi+2\,\text{ArcTan}\left[\frac{2\sqrt{s}}{\Gamma h+2\,\Gamma\mu}\right]\right)}{16\,\pi\,s\,(\Gamma h+2\,\Gamma\mu)}$$

$$s\mu = 8.5 * 10^{-33};$$
$$sh = 3.3 * 10^{-31};$$

$$\frac{e\mu}{eh} == \frac{s\mu}{sh}$$

$$\frac{\Gamma\mu}{\Gamma h} == 0.0257576$$

$$e\mu == s\mu\ /.\ \Gamma h\to\Gamma\mu\Big/\frac{s\mu}{sh}\ /.\ s\to 9500^2$$

$$1.61992\times 10^{-11}\,\Gamma\mu\left(\pi+2\,\text{ArcTan}\left[\frac{465.418}{\Gamma\mu}\right]\right) == 8.5\times 10^{-33}$$

$$\text{erg}\mu = \text{Solve}\left[e\mu == s\mu\ /.\ \Gamma h\to\Gamma\mu\Big/\frac{s\mu}{sh}\ /.\ s\to 9500^2,\ \Gamma\mu,\ \text{Reals}\right][[1,\ 1]]$$

Solve::ratnz : Solve was unable to solve the system with inexact coefficients. The answer was obtained by solving a corresponding exact system and numericizing the result. ≫

$$\Gamma\mu \to 8.35113\times 10^{-23}$$

Hierbei gilt : $\text{ArcTan}\left[\frac{S}{\Gamma}\right] \approx \text{ArcTan}[\infty]$, da die Breite der

Resonanz sehr viel kleiner als die Energie bei der gemessen wird.

$$\Rightarrow e\mu = \frac{3\,\Gamma\mu^2\,(\pi+\pi)}{16\,\pi\,s\,(\Gamma h + 2\,\Gamma\mu)}, \quad eh = \frac{3\,\Gamma h\,\Gamma\mu\,(\pi+\pi)}{16\,\pi\,s\,(\Gamma h + 2\,\Gamma\mu)}$$

$$e\mu = \frac{3\,\Gamma\mu^2\,(\pi+\pi)}{16\,\pi\,s\,(\Gamma h + 2\,\Gamma\mu)}$$

$$eh = \frac{3\,\Gamma h\,\Gamma\mu\,(\pi+\pi)}{16\,\pi\,s\,(\Gamma h + 2\,\Gamma\mu)}$$

$$\frac{3\,\Gamma\mu^2}{8\,s\,(\Gamma h + 2\,\Gamma\mu)}$$

$$\frac{3\,\Gamma h\,\Gamma\mu}{8\,s\,(\Gamma h + 2\,\Gamma\mu)}$$

$$e\mu == s\mu\ /.\ \Gamma h \to \Gamma\mu \Big/ \frac{s\mu}{sh}\ /.\ s \to 9500^2$$

$$1.01783\times 10^{-10}\,\Gamma\mu == 8.5\times 10^{-33}$$

$$erg\mu = \text{Solve}\left[e\mu == s\mu\ /.\ \Gamma h \to \Gamma\mu \Big/ \frac{s\mu}{sh}\ /.\ s \to 9500^2,\ \Gamma\mu,\ \text{Reals}\right][[1,\ 1]]$$

$$\Gamma\mu \to 8.35113\times 10^{-23}$$

$$ergh = \text{Solve}\left[\frac{e\mu}{eh} == \frac{s\mu}{sh}\ /.\ erg\mu,\ \Gamma h,\ \text{Reals}\right][[1,\ 1]]$$

$$\Gamma h \to 3.2422\times 10^{-21}$$

$$e\mu\ /.\ \{s \to 9500^2,\ erg\mu,\ ergh\}$$
$$eh\ /.\ \{s \to 9500^2,\ erg\mu,\ ergh\}$$

$$8.5\times 10^{-33}$$

$$3.3\times 10^{-31}$$

Also richtiges Ergebnis!

Ausgabe 3

$$ds1 = dsd\omega Mott * \left(1 + 2\,\tau\,\text{Tan}\left[\frac{\theta}{2}\right]^2\right);$$

$$ds2 = dsd\omega Mott * \left(W2 + 2\,W1\,\text{Tan}\left[\frac{\theta}{2}\right]^2\right);$$

Koeffizientenvergleich :

$\Rightarrow W2 == 1,\quad W1 == \tau$

Definition :

$$\tau = \frac{Q^2}{4\,m^2\,x^2},\quad \nu = \frac{Q^2}{2\,M\,x}$$

$$F1 = M\,W1,\quad F2 = \nu\,W2$$

M in τ ist abhängig von der Art der Streuung. Bei DIS wird M mit x skaliert, da direkt an Quarks gestreut wird
und nicht an der kompletten Nukleonmasse : $m = Mx$

Einsetzen :

$$F1 = M\, W1 = M\, \tau = \frac{Q^2}{4\, M\, x^2}$$

$$F2 = \nu\, W2 = \nu = \frac{Q^2}{2\, M\, x}$$

Kürzen :

$$\frac{F1}{F2} = \frac{\frac{Q^2}{4\, M\, x^2}}{\frac{Q^2}{2\, M\, x}} = \frac{1}{2\, x}$$

Umstellen :

$2\, x\, F1 = F2 \;\Leftrightarrow$ Callan − Gross !