0.1 Theoretical $Z-Z$ Cross Section σ

Define

$$\begin{aligned}
\alpha &= \frac{g^4}{(32\pi)^2 s}\frac{\sqrt{1-4\varepsilon^2}}{(1-\lambda^2)^2+(\frac{\lambda\Gamma_Z}{\sqrt{s}})},\\
\beta &= ((C_V^e)^2+(C_A^e)^2)((C_V^\mu)^2),\\
\Delta &= ((C_V^e)^2+(C_A^e)^2)((C_A^\mu)^2),\\
\Gamma &= 8C_V^e C_A^e C_V^\mu C_A^\mu.
\end{aligned}$$

These definitions produce the differential cross section:

$$\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}^{Z-Z} = \alpha(\beta(1+\cos^2\vartheta+4\varepsilon^2\sin^2\vartheta)+\Delta(1+\cos^2\vartheta)(1-4\varepsilon^2)+\Gamma\sqrt{1-4\varepsilon^2}\cos\vartheta)$$

Under the substitutions

$$\begin{aligned}
\sin^2\vartheta &\to 1-\cos^2\vartheta \quad \text{and}\\
\varepsilon_\pm &= 1\pm 4\varepsilon^2,
\end{aligned}$$

we see that the integral over the solid angle $\mathrm{d}\Omega = \mathrm{d}\phi\,\mathrm{d}x$ (with implicit change of variable $\cos\vartheta \to x$) becomes

$$\begin{aligned}
\sigma &= \alpha\int_0^{2\pi}\mathrm{d}\phi\int_{-1}^{1}\beta\varepsilon_+ + \beta\varepsilon_- x^2 + \Delta\varepsilon_- + \Delta\varepsilon_- x^2 + \Gamma\sqrt{\varepsilon_-}x\ \mathrm{d}x\\
&= 2\pi\alpha\int_{-1}^{1}\beta\varepsilon_+ + \Delta\varepsilon_- + (\beta+\Delta)\varepsilon_- x^2 + \Gamma\sqrt{\varepsilon_-}x\ \mathrm{d}x.
\end{aligned}$$

The Γ term will disappear as it is symmetric in the integration limits. After simplification, the trivial integral is evaluated to

$$\sigma^{Z-Z} = 4\pi\alpha(\beta(\varepsilon_+ + \frac{1}{3}\varepsilon_-)+\frac{4}{3}\Delta\varepsilon_-).$$