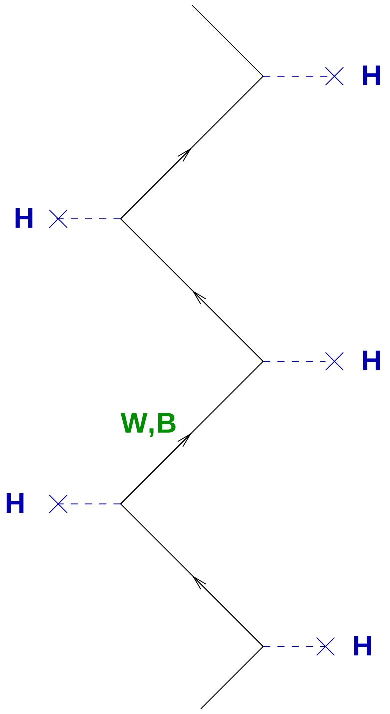
The Higgs mechanism

To interpret the photon γ and the weak vector bosons $(Z, W^{\pm})$ as a mixture of a triplet (W^{+}, W^{0}, W^{-}) and a singlet B might be realistic if the masses of the weak boson would vanish:

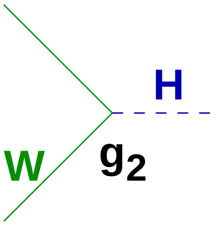
$$m_Z = m_W = 0$$

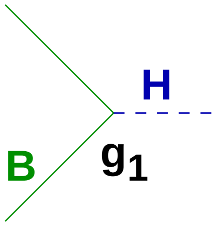
One can have the best of both worlds by making use of the *Higgs effect*:



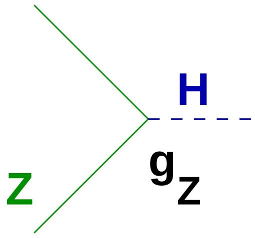
Constant H acts as medium with refraction index n > 1

The Higgs mechanism provides a mass for the Z-boson, but not for the photon γ.





Effectively this gives a coupling to the Z-boson only:



with

$$Z = \cos\theta\, W^0 + \sin\theta\, B$$

provided

$$\cos\theta = \frac{g_2}{\sqrt{g_1^2 + g_2^2}}, \qquad \sin\theta = \frac{g_1}{\sqrt{g_1^2 + g_2^2}},$$

and $\quad g_Z = \sqrt{g_1^2 + g_2^2}.$

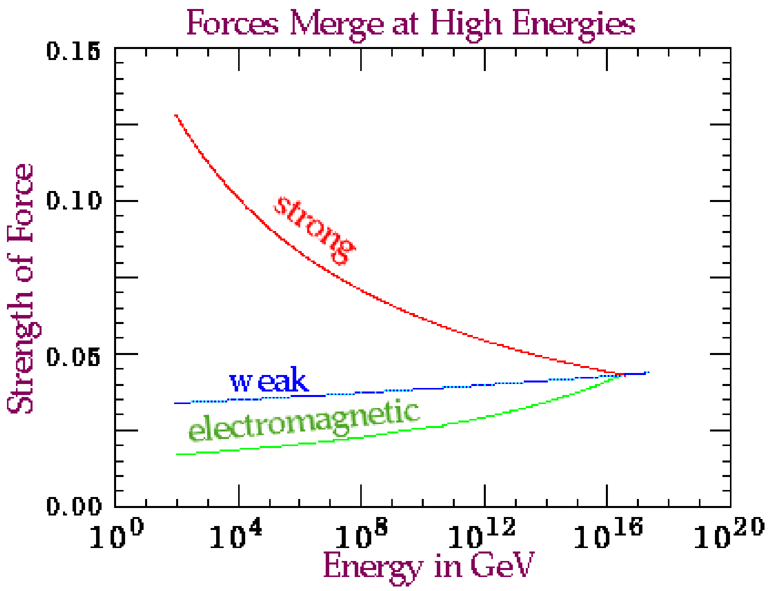
It follows, that

$$\frac{g_1}{g_2} = \tan\theta$$

and

$$\frac{m_W}{m_Z} = \frac{g_2}{g_Z} = \frac{g_2}{\sqrt{g_1^2 + g_2^2}} = \cos\theta = 0.88$$

in excellent agreement with experiments.


Forces Merge at High Energies
0.15
0.10
0.05
0.00
Strength of Force
strong
weak
electromagnetic
10^0
10^4
10^8
10^{12}
10^{16}
10^{20}
Energy in GeV