11. 12. 2009

Übungen "Physik am LHC" Blatt IV

Statistics

1. Suppose you do an experiment that gives 1 with a probability p and 0 with probability $1-p$ (like flipping a coin or seeing a Higgs or not seeing a Higgs). Show that the probability for k times getting 1 in N experiments is given by
$$P_p(k) = \left(\begin{array}{c} N \\ k \end{array} \right) p^k \left(1-p\right)^{N-k}.$$

2. Show that for $p \to 0,\ N \to \infty$ keeping $pN = \bar{n}$ the probability is given by (Poisson distribution)
$$P_{\bar{n}}(k) = \frac{\bar{n}^k}{k!} e^{-\bar{n}}$$
with variance $\sqrt{\bar{n}}$.

3. Suppose you have two Poisson distributions with mean $\bar{n}_1$ and $\bar{n}_2$. Show that the probability to observe $k = k_1 + k_2$ events is given by $P_{\bar{n}_1+\bar{n}_2}(k)$.

4. In the lecture it was shown that for signal discovery the quantity $S/\sqrt{B}$ should be maximised where S is the expected signal and B the expected background. Which quantity must be maximised for an optimal cross section measurement?

Higgs decay

Consider the WW fusion channel of the Higgs with the Higgs decaying to τs:

$$pp \to qqH + X \to qq\tau^+\tau^- + X$$

For the high τ momenta involved one can assume that the visible decay products of the τ as well as the neutrino follow exactly the τ direction.

1. Show that under this assumption the Higgs mass can be reconstructed from the visible τ decay-products and from the missing transverse momentum.

2. Why does the same procedure have problems for gluon-gluon fusion?