Problem Set #3 Physics 728 Spring 2012 Fun with Glauber

1) Find an expression for the skewness γ_1 of the distribution of number of collisions *n* defined with the probability distribution in eq. (3.42) in Vogt. The skewness is a parameter that characterizes the shape of distribution as explained on Wikipedia ("skewness") where also is given the formula below. E[x] denotes the expectation value of x *i.e.* $< x >$. Assume this is its definition, and for σ and μ use the mean and standard deviation of *n* (e.g. μ = <*n*>). For only slightly less points, you may simply calculate <n^3>.

$$\begin{aligned}\gamma_1 &= \mathrm{E}\left[\left(\frac{X-\mu}{\sigma}\right)^3\right] \\ &= \frac{\mathrm{E}[X^3] - 3\mu\,\mathrm{E}[X^2] + 3\mu^2\,\mathrm{E}[X] - \mu^3}{\sigma^3} \\ &= \frac{\mathrm{E}[X^3] - 3\mu(\mathrm{E}[X^2] - \mu\,\mathrm{E}[X]) - \mu^3}{\sigma^3} \\ &= \frac{\mathrm{E}[X^3] - 3\mu\sigma^2 - \mu^3}{\sigma^3}\ .\end{aligned}$$

2) Using similar logic as for Vogt eq (3.58) show that $P_{hA}(n,b)$ (probability distribution of n collisions in a nucleon-nucleus reaction) itself is approximately a Poisson distribution.

3) If the thickness function $T_{AB}(b)$ has the form $T_{AB}(b) = \exp(-b^2/2\pi\beta^2)/2\pi\beta^2$, show

a) that the total *A+B* inelastic cross section σ_{inel}^{A+B} can be written as the sum

$$-2\pi\beta^2 \sum \binom{AB}{n} (-f)^n/n$$

with the sum over n > 0 to AB and fraction $f = \sigma_{inel}^{N+N} / (2\pi\beta^2)$.

b) therefore, that if the is small, then

$$\sigma_{inel}^{A+B} = AB\ \sigma_{inel}^{N+N}$$

(σ_{inel}^{N+N} is the nucleon+nucleon cross section.)