Exam "Gevorderde kernfysica" (G191)

Friday February 1st, 2013 – 14:00 h

1. Given are the following equations for the beta neutrino correlation coefficient *a* and the Fierz interference term *b*. Suppose it is possible to determine both parameters independently from each other.
   Compare the possibilities offered by both observables to search for a possible scalar and a possible tensor component in the weak interaction. Discuss in this comparison e.g. the precision that is needed, the type of beta transition to be used, … .
   For the V and A interactions maximal violation of parity (i.e. $C_V = C_V'$ and $C_A = C_A'$) may be assumed, and time reversal invariance may be assumed for all interactions (i.e. $C_i^* = C_i$ and $C_i'^* = C_i'$ for all i).

$$a\,\xi = M_F^2\left[|C_V|^2 + |C_V'|^2 - |C_S|^2 - |C_S'|^2\right] - \frac{M_{GT}^2}{3}\left[|C_A|^2 + |C_A'|^2 - |C_T|^2 - |C_T'|^2\right]$$

$$b\,\xi = \pm 2\,\mathrm{Re}\left[M_F^2\left(C_S\,C_V^* + C_S'\,C_V'^*\right) + M_{GT}^2\left(C_T\,C_A^* + C_T'\,C_A'^*\right)\right]$$

2. Explain what the magnetic moment of a nucleus is.

3. a) Explain the difference between polarization and alignment. Make also a drawing of an angular distribution pattern for both cases.

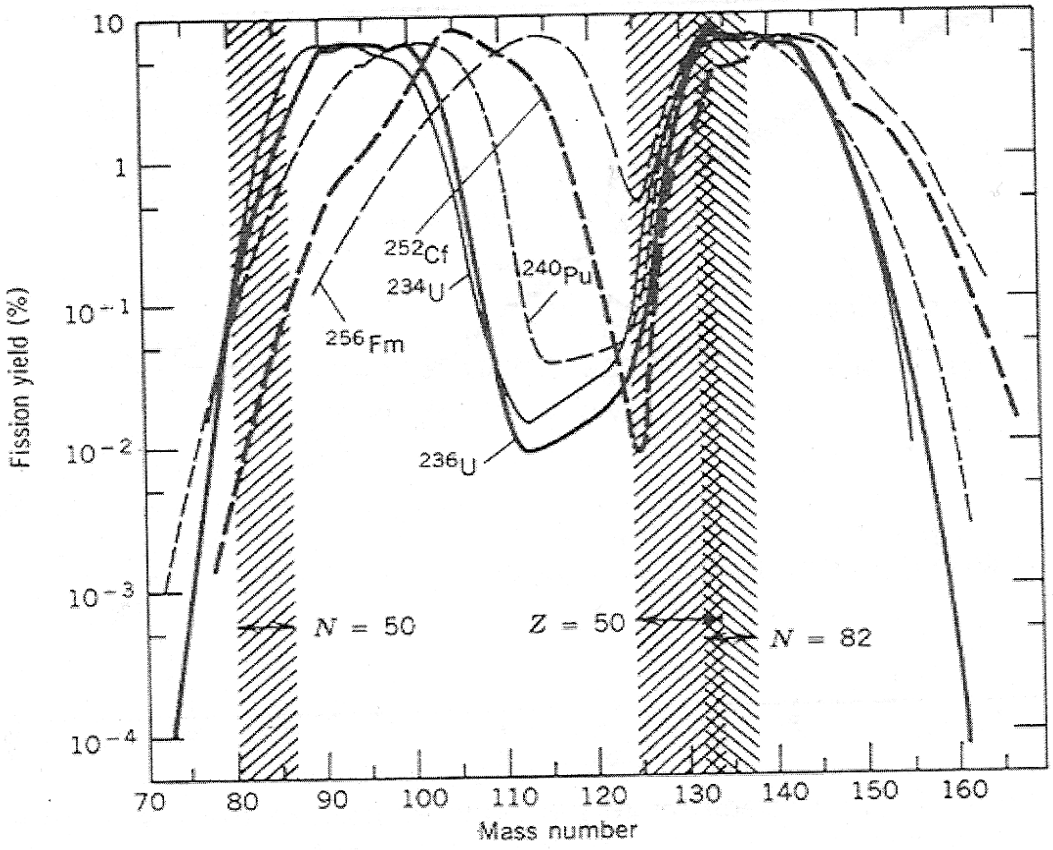
   b) Explain why there can be at most five different types of weak interactions and not more.

   c) Explain what a pseudoscalar weak interaction is.

   d) Which reactions cycle produces the largest amount of energy in a star that is much heavier than our Sun (e.g. with 10 solar masses), the proton-proton cycle or the CNO cycle ? Explain why.

   e) Explain why the nucleus $^{235}_{92}U$ can fission with thermal neutrons and why $^{238}_{92}U$ cannot.

   f) What is shown in the figure below?
   Explain why the curves are all shifted with respect to one another in the region between mass numbers 80 and 120.


10
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
Fission yield (%)
^{252}Cf
^{234}U
^{240}Pu
^{256}Fm
^{236}U
N = 50
Z = 50
N = 82
70
80
90
100
110
120
130
140
150
160
Mass number