FYS3520 - Problem set 8

Spring term 2017

Corrections: Problem 2: $E_n = 170$ corrected to 1700 keV

Problem 1 – in class

a) Figure 1 shows the electron spectra meassured on β-particles from decay of ^{210}Bi. What does this spectra tell about the nature of β-decay?

b) Comment on the three decays in Figure 2. What can you say about the half-life of the three different decays?

c) Show in a (semi-)classical calculation that the angular momentum transfer l (in units of $\hbar$) to a electron in β-decay is much smaller then 1. Assume a typical Q-value of 3 MeV and R= 6 fm for the nuclear radius. What do we learn about possible and forbidden β-decays?

d) Frank presents some cool things about his research

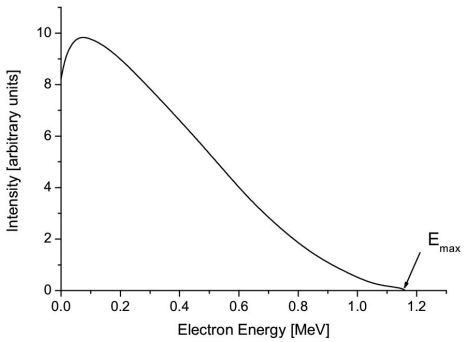

Figure 1: Electron spectra from β-decay of ^{210}Bi.

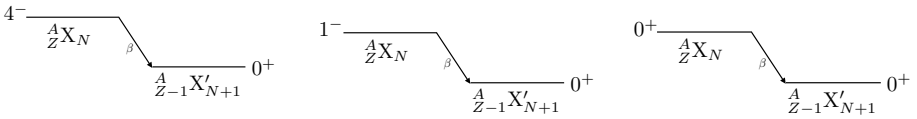

Figure 2: β-decays

Problem 2 β-delayed neutron emission

After β-decay of a excited state it is not only possible to emit γ-rays. Depending on the excitation energy of the daughter nucleus it can also emit particles. The β-delayed neutron emission is essential for the control of nuclear reactors. However, in this example we analyze the β-delayed neutron emission of ^{17}O, which leads to the gs. of ^{16}O. Here ^{17}O has before been populated by β^--decay of ^{17}N. The decay scheme is given in Figure 3

As given in the figure three neutrons are emitted with energies 383, 1171 and 1700 keV, which populate the ground state of ^{16}O.

a) Calculate the Q-value for the β-decay of ^{17}N.

b) Derive a formula that allows you to calculate the excitation energy of ^{17}O as a function of the kinetic energy of the neutron and exicitation energy of ^{16}O. Calculate the excitation energy of ^{17}O.
Hint: You get the correct formula if you take into account energy *and* momentum conservation. You may regard only the ^{17}O-^{16}O system and neglect ^{17}N.

c) Why can the β-delayed neutron emission not populate the first excited state of ^{16}O at 6.05 MeV?

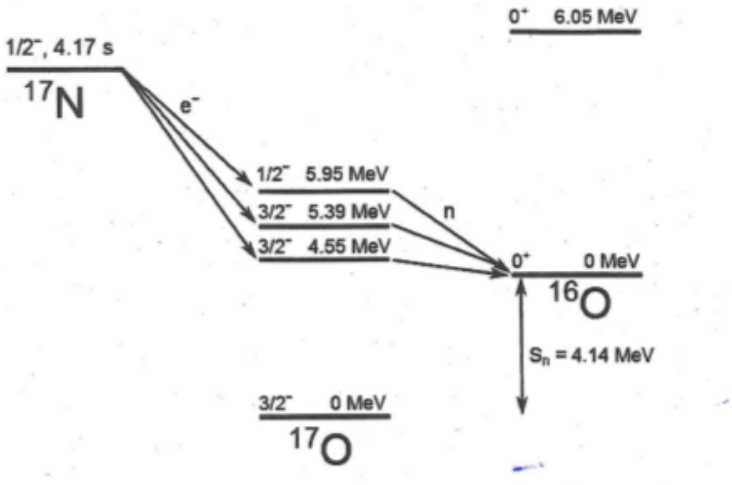

Figure 3: β-delayed neutron emission from ^{17}O