

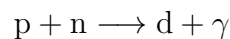
Kjarna- og öreindafræði

Dæmablað 1

Skilafrestur 14. September 2016 kl. 15:00

1. Neutron – proton capture (10)

A neutron and a proton can undergo radioactive capture at rest



Find the energy of the photon emitted in this capture. Is the recoil of the deuteron important ?

2. A gold foil (10)

A gold foil 0.02 cm thick is irradiated by a beam of thermal neutrons with a flux of 10^{12} neutrons/cm²/s. The nuclide ^{198}Au with a half-life of 2.7 days is produced by the reaction $^{197}\text{Au}(n, \gamma)^{198}\text{Au}$. The density of gold is 19.3 g/cm³ and the cross section for the above reaction is 97.8×10^{-24} cm². ^{197}Au is 100 % naturally abundant.

(a) If the foil is irradiated for 5 minutes, what is the ^{198}Au activity of the foil in decays/cm²/s?

(b) What is the maximum amount of ^{198}Au /cm² that can be produced in the foil?

(c) How long must the foil be irradiated if it is to have 2/3 of its maximum activity?

3. Decay chain (20)

A parent isotope has a half-life $T_{1/2} = 10^4$ yr = 3.15×10^{11} s. It decays through a series of radioactive daughters to a final stable isotope. Among the daughters the

greatest half-life is 20 yr. Others are less than a year. At $t = 0$ one has 10^{20} parent nuclei but no daughters.

- (a) At $t = 0$ what is the activity (decays/sec) of the parent isotope ?
- (b) How long does it take for the population of the 20 yr isotope to reach approximately 97 % of its equilibrium value ?
- (c) At $t = 104$ yr how many nuclei of the 20 yr isotope are present ? Assume that none of the decays leading to the 20 yr isotope is branched.
- (d) The 20 yr isotope has two competing decay modes: α , 99.5 %; β , 0.5 %. At $t = 104$ yr, what is the activity of the isotope which results from the β -decay ?
- (e) Among the radioactive daughters, could any reach their equilibrium populations much more quickly (or much more slowly) than the 20 yr isotope ?