(11.10) A γ-line at 0.146 MeV is assigned to a +4 to +0 rotational level change in ^{238}Pu. (a) What should the energy of the +2 and +6 rotational levels be? Compare with the measured values of 0.044 and 0.304 MeV. (b) If ^{238}Pu is considered to be a homogenous sphere, what will its apparent radius be? Compare with that obtained using relation (3.7)

$E_{rot}=((h/2*\pi)^2/(2*I_{rot}))*n_r*(n_r+1)$. Hence $I_{rot}=((h/2*\pi)^2/(2*E_{rot}))*n_r*(n_r+1)$

(a).

$MeV := 10^6 \cdot 1.602177 \cdot 10^{-19} \cdot joule$

$h := 6.626076 \cdot 10^{-34} \cdot joule \cdot sec$ $\qquad E_{rot} := 0.146 \cdot MeV$ $\qquad n_r := 4$

$I_{rot} := \dfrac{\left(\dfrac{h}{2 \cdot \pi}\right)^2}{2 \cdot E_{rot}} \cdot n_r \cdot (n_r + 1)$ $\qquad I_{rot} = 4.754 \cdot 10^{-54} \cdot kg \cdot m^2$

$A := 238 \qquad Z := 94 \qquad N := A - Z$

$n := 0, 2 .. 6$

$E_n := \dfrac{\left(\dfrac{h}{2 \cdot \pi}\right)^2}{2 \cdot I_{rot}} \cdot n \cdot (n + 1)$ $\qquad\qquad\qquad E\gamma_n := \dfrac{E_n}{1.602177 \cdot 10^{-19}} \cdot 10^{-6}$

E_n
$0 \cdot kg \cdot m^2 \cdot sec^{-2}$
$7.018 \cdot 10^{-15} \cdot kg \cdot m^2 \cdot sec^{-2}$
$2.339 \cdot 10^{-14} \cdot kg \cdot m^2 \cdot sec^{-2}$
$4.912 \cdot 10^{-14} \cdot kg \cdot m^2 \cdot sec^{-2}$

n
0
2
4
6

$E\gamma_n$
$0 \cdot kg \cdot m^2 \cdot sec^{-2}$
$0.044 \cdot kg \cdot m^2 \cdot sec^{-2}$
$0.146 \cdot kg \cdot m^2 \cdot sec^{-2}$
$0.307 \cdot kg \cdot m^2 \cdot sec^{-2}$

+2 level 0.044 MeV

+4 level 0.146 MeV

+6 level 0.307 MeV

(b) eqn (2.29): $I_{rot}=m*r^2$, hence $r=sqrt(I_{rot}/m)$ $\qquad\qquad u := 1.660540 \cdot 10^{-27} \cdot kg$

$fm := 10^{-15} \cdot m$

$m_{238Pu} := A \cdot u$ $\qquad r_{238Pu} := \sqrt{\dfrac{I_{rot}}{m_{238Pu}}}$ $\qquad r_{238Pu} = 3.47 \cdot fm$

Compare with result from 3.7: $r = r_0 * A^{1/3}$ $\qquad\qquad r_0 := 1.4 \cdot fm$

$$r_A := r_0 \cdot A^{\frac{1}{3}} \qquad r_A = 8.68 \cdot fm$$