On The Decay Energy of Fissile Plutonium 239

D.j. Dutta

Abstract

In this note we propose an alternate theoretical equation to compute the decay energy of Pu-239 Radionuclei. The derivation of this formula is not mentioned in this account.

Fissile plutonium 239 is the primary source of “Pit” or fission fuel in modern implosion nuclear weapons, this material is often utilised as a core in nuclear device called “primary” to trigger “secondary” in modern Thermonuclear device. With atomic mass number 294 and half-life of 24,110 years, this isotope is radioactive in nature and can be produced in nuclear laboratory when natural uranium 238 is exposed to neutron radiation, U 238 nuclei captures a neutron to become U 239. The reaction of nuclear transmutation is

$${U_{92}}^{238} + n \rightarrow {U_{92}}^{239} \rightarrow {Np_{93}}^{239} \rightarrow {Pu_{94}}^{239}$$

U 239 converts into Neptunium 239 by β^- decay in approx 23.5 minutes then Np 239 again converts into plutonium 239 via second β^- decay in approx 2.3 days. Adequate fissile plutonium can be produced in nuclear facilities and energy released per fission of Pu 239 is 207.1 MeV bit higher than one fission of U-235. The natural decay however of Pu 239 is to another fissile Uranium U 235 via alpha decay, according to apha decay law mass number of an element (undergoing decay) reduces by four and atomic number decreases by 2 so Pu 239 decay is

$${}^{239}_{94}Pu \rightarrow {}^{4}_{2}He + {}^{235}_{92}U$$

The decay energy of above equation can be obtained from mass-energy relation due to Einstein, but we propose another formula only to find alpha decay energy E_d of fissile plutonium. The equation can be simply presented as

$$E_d = \frac{25\alpha}{\left(5\pi^2 + {A_{He}}^2\right)}(\beta_{Pu} + \beta_{He})$$

α is the fine structure constant from QED taken as 1/ 137.035999084, π=3.14, A_{He}=4 mass number of helium , β_{Pu}=1806.921454 MeV binding energy of plutonium 239, β_{He}=28.30 MeV binding energy of helium 4, The decay energy is 5.1 MeV.