Yield Estimation Formula of Plutonium 239 Nuclear Fission

Deep Jyoti Dutta, *Division of Nuclear Physics (DNP), American Physical Society, College Park, Maryland

Abstract

The necessity of this note is to propose a theoretical formula to calculate the energy release in fissile plutonium 239 radioisotope or radionuclide in a nuclear fission reaction. This equation can approximately predict the yield of the fission energy of pu-239. The derivation may be kept classified.

The unexpected discovery of radioactivity by Professor Becquerel in 1896 ushered a new possibility towards understanding the nuclear properties of an atom. Rutherford's nuclear model is highly priceless because for his new interpretation of his alpha scattering experiments by assuming a small dense core overall positive charge which he coined as nucleus. Otto Hahn and Fritz strassmann claimed that a nuclear fission reaction was discovered in Berlin on 17th December 1938 during the ruling period of great dictator Adolf Hitler, that discovery was a milestone in the history of science. Then in 1942 a team led by brilliant Professor Enrico Fermi discovered the first man-made self sustaining nuclear chain reaction in the world's first nuclear reactor named Chicago Pile-1 or CP-1 in University of Chicago. CP-1 was actually assembled for research in nuclear fission which consequently led to the development of the most terrifying weapons in human history the atom bomb in a project called Manhattan Project with Julius Robert Oppenheimer as a director. The present note derives a very sensitive formula to compute the energy release in nuclear fission in one atom of fissile radioisotope plutonium 239, thus evading the traditional way to compute the energy release as because this formula is derived from some highly classified special consequence. The natural alpha decay of pu-239 is

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

Using radioactive displacement law one can observe that in alpha decay, mass number (A_P) decreases by 4 and atomic number(p_N) decreases by 2. The formula to approximate the energy release in pu fission E_{Pf} is given by

$$ \frac{7E_{Pf}}{5} \cong \pi^2 \left(\frac{E'_P + M_n}{P_N}\right) $$

Therefore one can easily observe that

$$ E_{Pf} \cong \frac{5}{7}\pi^2 \left(\frac{E'_P + M_n}{P_N}\right) $$

Such a formula will show an approximate value of 205.9 MeV. E'_P is the binding energy of pu-239 which is 1806.921454 MeV, $M_n = 939.56\, MeV$ mass of neutron and $P_N = (A_P - N_n) = (239 - 145) = 94\, protons$.