Calculation of Energy Release in D-T Nuclear Fusion Reaction

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Abstract

This note can be very essential in studying the detailed properties of nuclear fusion reaction which is proposed to be our ultimate source of energy in near future. However we don't know about future but here we will derive the alternate theoretical relation to compute the amount of energy release in deuterium- tritium fusion. The derivation may be kept confidential for security purpose

Keywords: Nuclear Fusion, Thermonuclear Bomb, Columbic Barrier

Nuclear fusion is the reaction which powers the stars including our sun; Mr. Hans Bethe proposed that proton- proton fusion cycle is responsible for sun to survive. The outward pressure generated due to intense heat courtesy to nuclear fusion balances the violent inward gravitational collapse thus preventing explosion, means the hydrostatic equilibrium is necessary for the existence of star. The advancement in understanding nuclear fusion is quite phenomenal but achieving it artificially is still a colossal task which is yet to do. Furthermore the thermonuclear bomb based on Teller-Ulam design was successfully tested with yield approximately thousand times more than that of Hiroshima bomb. The detailed design of hydrogen or thermonuclear bomb is highly confidential but the basic idea is the primary section (contains implosion method plutonium fission bomb) and secondary section contains the fusion fuel lithium deuteride. The fission bomb explodes and generates huge temperature and pressure in the form of highly penetrating gamma rays which in the process called radiation pressure compresses and crushes the fusion fuel in which tritium and deuterium begins to form and as the pressure and density is extremely high the nuclear fusion reaction begins, means the primary stage is the trigger to initiate the fusion in secondary and thus fireball begins to form. For achieving nuclear fusion very high temperature (density and kinetic energy) is required in order to break the columbic barrier of the protons in nucleus due to their repulsive electric tendency. The D-T fusion is

$$ {}^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + neutron + energy $$

This reaction releases overall energy of 17.6 MeV. Traditionally knowing the mass of each nucleus and calculating mass defects and using $\Delta E = \Delta mc^2$ one can compute the yield of the above reaction which is 17.6 MeV. In this note an alternate new equation is highly derived in a thorough manner to estimate the yield of D-T reaction. The derivation and assumptions required for the derivation is classified but the derived equation is intensely simple, which reads

$$ E_{(D-T)} A_T A_D = \pi^2 (E'_T + E'_D) $$

Such that it shows that

$$ E_{(D-T)} = \frac{\pi^2 (E'_T + E'_D)}{A_T A_D} $$

The equation approximately yields 17.6 MeV. E' is the binding energy of the participating nucleus (i.e. deuterium and tritium), A is the atomic mass number of tritium and deuterium respectively. The values are as follows: binding energy of tritium is 8.48182 MeV, binding energy of deuterium is 2.22452 MeV. The equation seems very useful in interpreting nuclear fusion.