What the ultimate Natural Units of material are?

**Decay Energy**

Since amounts of energy accompanying nuclear decays and nuclear reactions are huge, Einstein's theory suggesting mass being equivalent to energy ($E = mc^2$) is useful and applicable.

The energy involved in decay is often represented by $Q$. The energy released is at the expense of mass. Thus, the total mass of the products is less than the total mass of the reactants.

\[
Q = \text{Total mass of reactants} - \text{Total mass of products}
\]

The energy of decay is mostly carried carried by the light particles, alpha, beta or gamma, but a little bit is carried by the daughter nucleus due to recoil.

- **Energy in Gamma Radiation**
  
  An isomer is a nucleus with excess energy, because one of the nucleons is at an excited energy level. When this nucleon returns to its lowest energy level, the energy is converted into a photon (gamma ray), and the process is also called **isomeric transition** (IT). The frequency of the photon corresponds to the available energy:
  
  \[
  h \nu = E_i - E_f
  \]

  where $E_i$ and $E_f$ stand for the energies of the initial and final levels (or states).

- **Energy in beta decay**
  
  Most beta spectra have some high-intensity peaks at certain energies superimposed on a continuous spectrum. To explain these spectra was difficult initially. The peaks is now known as due to **internal conversion** and **Auger electrons**.

  The parent nuclei have the same mass and so do the daughter nuclei. Yet beta-particle energies range from 0 to a maximum seem to suggest that energy is not conserved in beta decay.

  Based on the principle of conservation of energy, Pauli (1900-1958) suggested that a neutrino with spin $\frac{1}{2}$ is emitted.

- **Energy in alpha decay**
  
  Alpha particles emitted by a nuclide have some distinctive energies. A plot of the number of alpha particles against energy shows a few peaks.

  Typical alpha energies range between 1 and 11 MeV, with most of them within 4 to 8 MeV.

**Contributors**

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