Introduction

In Nuclear Science, the decay series refers to the radioactive decay of different discrete radioactive decay products as a chained series of transformations. They are also known as "radioactive cascades". Most radioisotopes do not decay directly to a stable state, but rather undergo a series of decays until eventually a stable isotope is reached. Stable isotopes have ratios of neutrons to protons in their nucleus that start out at 1 in stable helium-4 and smoothly rise to ~1.5 for lead. All nuclides having atomic number Z greater than 83 are unstable and disintegrate with the emission of either an alpha (α), which reduces the mass number of a nucleus by 4, or a beta (β) particle, which does not change the mass number.

Most of the radioactive nuclides found in nature are members of four radioactive series. The first member of the series is called the parent, the intermediate members are called daughters and the final stable member is called the end-product. These series are Thorium series, Neptunium series, Uranium (or Radium) series and Actinium series. The mass number of every isotope in these series can be represented as A= 4n, A= 4n+1, 4n+2 and 4n+3, respectively.

In this paper, the characteristics of naturally occurring Thorium and Uranium series in nuclear emulsion of KEK-PS E373 experiment will be presented.

Nuclear Emulsion

Nuclear emulsion plates are fabricated by drying after pouring emulsion on both sides of polystyrene film (base). The main component of emulsion is gelatin. It contains silver halide microcrystals (AgX) with their size of 0.2μm. The base film is used for support to avoid separation of the emulsion during photographic development.

Nuclear Emulsion is the best three-dimension detector. It is used to detect charged particles, and measures the energies of particles more accurately than other detecting devices. The masses of several elementary particles have been measured in emulsion immediately after their discovery. It is also possible to measure the true rectified range of the particle and to determine the magnitude and direction of its velocity, the product of its velocity and momentum. On the other hand, the ranges and lifetime of short lived particles such as hyper-fragments are easily measured. Moreover, it can be used in radiation monitoring for the protection of people who work with radioactive material, X ray generators, and high-energy accelerators.

Thorium and Uranium series

The decay chain of Thorium and Uranium series are shown in Fig. 1 and Fig.2, respectively. In those figures, τ represents the life time, the value with % indicates the percent branching and the value in keV unit express the kinetic energy of emitted alpha particles for corresponding nucleus.