What is a breakdown of continuous component hidden under 4.4-MeV gamma-ray peak from the AmBe source?

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**Purpose**
- To understand the radiation from AmBe detected by inorganic scintillator.
- To measure the energy spectrum of neutron tagged with 4.4 MeV gamma ray.

**Research background**
- Neutron tagging technique with pure-water is studied in Super-Kamiokande (SK), an underground large water Cherenkov neutrino detector.
- AmBe source was used for evaluating the neutron tagging efficiency.
- AmBe was surrounded by BGO scintillator, to increase the photons from 4.4 MeV gamma-ray.
- Measured tagging efficiencies are relatively 10% smaller than ones of the MC simulation.

**High energy components above 4.4 MeV gamma-ray peak**

**Ratio of 5-10 MeV events to 4.4 MeV peak**
- We measured radiation from AmBe using NaI(Tl) scintillation detector.
- 5-10 MeV high energy components also exist as did in BGO measurement in SK.
- The cause of these components is considered due to n0, but not yet fully understood.
- Part of this components may be misidentified as 4.4 MeV gamma ray in measurement.

**Purpose**
- To investigate the characteristic of 5-10 MeV components, we measured the ratio (defined as below) at different distances between AmBe and the detector (r).

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\frac{5-10 \text{ MeV high energy counts}}{4.4 \text{ MeV peak counts}}
\]

If 5-10 MeV component is made by only n0, the ratio should be constant for any r.

- We suspect if both gamma ray and n1 simultaneously react in NaI, such event makes 5-10 MeV component.

**Set up**
- Measurements were done for several r.

**Result**
- The ratio should have below two components
  1. Constant (due to n0)
  2. Component that decreases by 1/r^2 (due to n1+gamma).

**Summary**
- We studied the components above 4.4 MeV found in the measurement of AmBe neutron source using NaI(Tl) scintillation detector.
  - The ratio has a constant component at ~0.2 and a continuous component that decreases as the distance increases (r<25 cm).
  - This implies that detection of n0 and simultaneous detection of n1 and gamma rays make up part of the 5-10 MeV region.
  - The energy spectrum of neutron tagged with 4.4 MeV gamma-ray calculated by its Time of Flight was roughly in agreement with previous studies.
  - To understand the effect of the surrounding environment by MC simulation and additional experiments.
  - To perform analysis taking detection efficiency into account.