MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2015A0127 実験課題名 Title of experiment Study of double octupole states in Pb-208 実験責任者名 Name of principal investigator Toshiyuki Shizuma 所属 Affiliation National Institutes for Quantum and Radiological Science and Technology	装置責任者 Name of responsible person Yosuke Toh 装置名 Name of Instrument/(BL No.) BL04 実施日 Date of Experiment 20-26 May, 2016

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。(適宜、図表添付のこと)
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

Following samples were used:

Enriched Pb-207 sample, D=10mm, 160mg

Enriched Pb-208 sample, D=10mm, 159.7 mg

2. 実験方法及び結果 (実験がうまくいかなかった場合、その理由を記述してください。)
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

The first excited state in ^{208}Pb has the spin and parity of 3^- at the excitation energy of 2.614 MeV and interpreted as one-phonon octupole vibrational character. The vibrational nature of this state leads to the expectation of a quartet of double octupole states (DOS) with 0^+, 2^+, 4^+, and 6^+ at roughly twice the energy of the 3^- state, i.e., 5.2 MeV as shown in Fig. 1. In addition, the DOS could decay to the first 3^- state because of its octopole vibrational nature. In this case, the transition between the DOS and the first 3^- state could be observed in γ-ray coincidence measurements. In order to search for the DOS in ^{208}Pb we carried out coincidence measurements of γ-rays emitted from ^{208}Pb produced in the neutron capture reaction on ^{207}Pb.

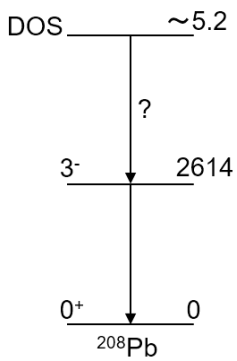

Fig. 1. Level scheme of ^{208}Pb.

The experiment has been performed using the ANNRI instrument at the beam line BL-04. An enriched ^{207}Pb sample was bombarded by the pulsed neutron beam. We measured emitted γ-rays following the

2. 実験方法及び結果（つづき） Experimental method and results (continued)

neutron capture reaction on ^{207}Pb using the ANNRI 4π γ-ray spectrometer which consists of two cluster high-purity Ge detectors surrounding by BGO Compton-suppressed shields. Each of the Ge detectors is composed of seven closely packed hexagonal encapsulated Ge detectors and is vertically placed at angles of ±90° with respect to the neutron beam axis. Coincidence events were recorded with the energy and time information on these γ-rays using the high counting rate and high resolution data acquisition system based on a digital data processing technique. We also measured the time-of-flight (TOF) information of each γ-ray signal relative to the neutron time signal. The measurement time was totally about 96 hours and the total γ-ray coincident events were 4×10^8. We also made a similar measurement on an enriched ^{208}Pb sample for about 12 hour measurement time in order to subtract background components originating from ^{208}Pb in the ^{207}Pb data.

Figure 2 shows a TOF spectrum of neutrons in coincidence with γ-ray signals. Since the states in ^{208}Pb populated in the neutron capture reaction would depend on the incident neutron energy, gating channels of the neutron energy are carefully determined. Figure 3 shows single and coincidence γ-ray spectra. The 7334 keV transition which is a γ-ray transition from the 1^- state at 7334 keV to the ground state can be clearly seen in the left panel of Fig.3. At the lower energy region, single and double escape peaks of this transition, i.e., 6824 and 6314 keV transitions, are observed. In the right panel of Fig.3, the 7334 keV transition is not observed because of no coincident γ-ray. On the other hand, the single and double escape peaks of the 7334 keV transition are observed, because these transitions are in coincidence with the 511 keV annihilation γ-ray. We will further analyze the coincidence data whether transitions in coincidence with the 2614 keV transition exist or not by appropriately gating on the neutron TOF channel.

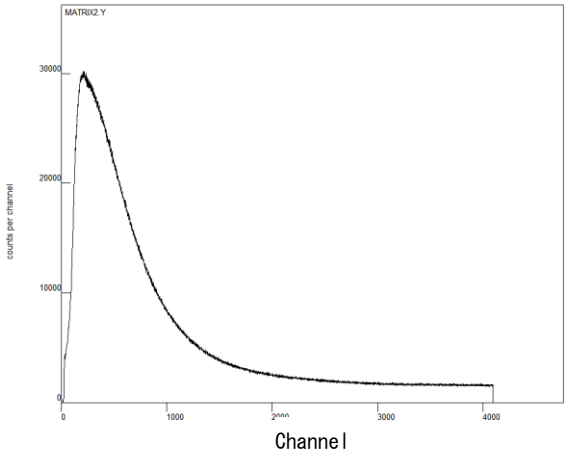

Fig. 2. Neutron TOF spectrum

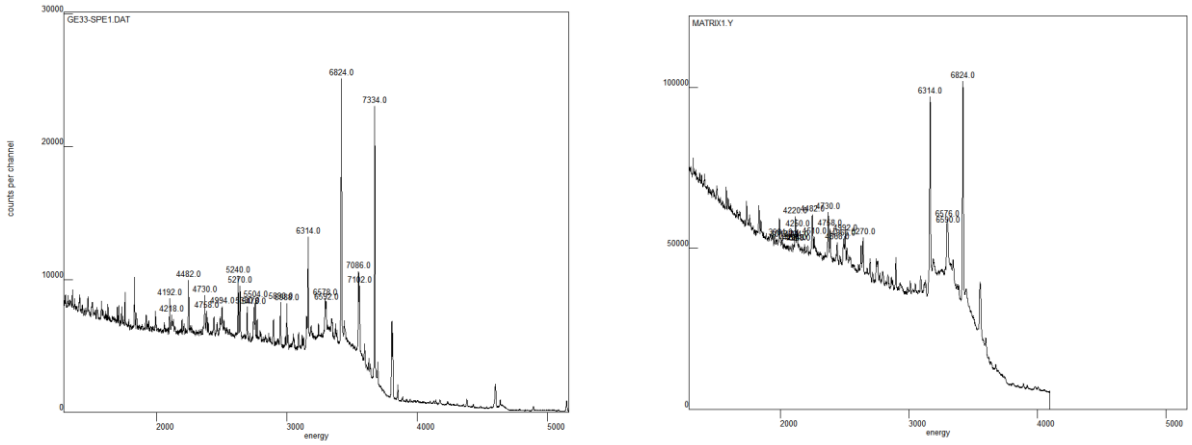

Fig. 3. Single (left) and coincidence (right) γ-ray spectra obtained in the neutron capture reaction on ^{207}Pb.