Study of high-spin states in ^{44}Ti

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After the systematic studies of superdeformed (SD) states in various mass regions[1], a new 'island' of SD nuclei was found in A$\sim$40 (i.e., ^{36,40}Ar[2, 3], ^{40,42}Ca[4, 5, 6], and ^{44}Ti[7]). Ground states of these isotopes have a spherical shape due to the magic and near magic natures. In the excited states, these nuclei have large deformed strucutres after promoting protons and neutrons across shell gaps between *sd* and *pf* orbitals. Onset of such defomed sturctures in this A$\sim$40 region can be qualitatively understood by the presence of superdeformed shell gaps at N=Z=18, 20, 22, which are caused by the crossing of sigle particle orbitals of *sd* and *pf* shells at large deformation. Among these SD nuclei, quadrupole moments of ^{36,40}Ar[2, 3], ^{40}Ca[4, 5] were measured and the exprimental result shows large quadrupole defomation. In ^{44}Ti, a rotational band built on the 0_2^+ level as a candidate of SD band with 8p-4h configurationis was identified[7], but its quadrupole momenet was not measured. In order to investigate the quadrupole deformation of such collective states in ^{44}Ti, a high-spin gamma-ray spectroscopic experiment was performed.

In order to produce high-spin states of ^{44}Ti, a ^{24}Mg(^{24}Mg,2p2n)^{44}Ti fusion-evaporation reaction was employed. A ^{24}Mg beam with an energy of 104 MeV was used to produce high-spin states. Cross section to produce ^{44}Ti at the ^{24}Mg beam energy of 104 MeV was estimated by the statistical model CASCADE[8] to be $\sim$20 mb. Gamma rays and charged particles emitted from the reaction products were measured by the CAGRA array and a 4π charged-particle array, Si-Ball[9], respectively. The CAGRA array was composed of 14 Clover-type Ge detectors with BGO anti-Compton shield in the experiment. The CAGRA data and the Si-Ball data were taken using the digitizer and trigger modules developed for GRETINA[10] with firmware and DAQ developed for Digital Gammasphere[11]. The data was sorted offline to make $\gamma-\gamma$ coincidence matrix.

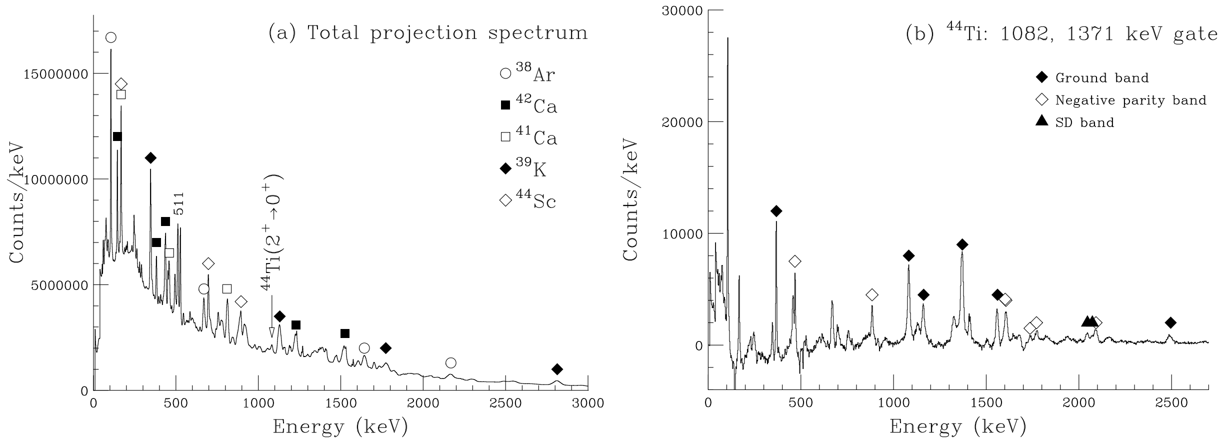

Figure 1: (a) Total projection spectrum of $\gamma-\gamma$ coincidence matrix. γ peaks associated with ^{36}Ar, ^{42}Ca, ^{41}Ca, ^{39}K, and ^{44}Sc are labelled with open circle, filled square, open square, filled diamond, and open diamond, respectively. (b) A sum of γ-gated spectra of 1082 and 1371 keV transitions. γ transitions of ground band, negative parity band, and superdeformed band are labelled with filled diamond, open diamond, and filled triangle, respectively.

In Figure 1, a total projection spectrum of $\gamma-\gamma$ coincidence matrix was plotted (a). Strong γ peaks showing up in the spectrum are associated with the γ-ray transitions in ^{36}Ar, ^{42}Ca, ^{41}Ca, ^{39}K, and ^{44}Sc which are estimated in the CASCADE calculation to be strong channels in the ^{24}Mg+^{24}Mg reaction. Figure 1 (b) is a sum of γ-gated spectra of 1082 and 1371 keV peaks which are the low-lying $2^+ \rightarrow 0^+$ and $4^+ \rightarrow 2^+$ transitions in ^{44}Ti, respectively. As shown in the figure, γ peaks associated with the transtions of high-spin states in ^{44}Ti are clearly seen. By gating on these transitions, further analysis on the high-spin states in ^{44}Ti will be performed.

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