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Lifetime of the First Excited State in ^{35}Ar

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It is quite interesting to study the relative importance of the iso-scalar and iso-vector terms in the Ml transition amplitude of the mirror nuclei. In ^{35}Cl the low-lying levels have been extensively investigated by various experimental workers[1,2] while ^{35}Ar nucleus the data is rather meagre. The ^{35}Ar levels studied in the present work were populated using ^{32}S(α, nγ) ^{35}Ar reaction which has Q-value of −8.61 MeV. The incident beams were supplied by the Osaka University 110 cm cyclotron. The alpha particles produced were reduced to (17.9 ± 0.4) MeV by means of an aluminum absorver. Neutrons were detected in a 12.7 cm diam by 12.7 cm long *NE* 213 liquid scintillator. Gamma rays were detected in 47 cm^3 Ge(Li) detector with resolutions of about 3.5 keV for the 1.33 MeV, ^{60}Co line. The *ORTEC* 458 pulse shape analyzer circuits were used to discard the γ-pulses in the neutron detector. In the γ-ray single spectrum, the strong gamma-ray of the energy of 1.18 MeV had the excitation curve like that of (α, n) reaction. And the angular distribution of this γ-ray intensity was unisotropic. Under these experimental facts, the γ ray from the lst excited state ($\frac{1}{2}^+$) to the ground state ($\frac{3}{2}^+$) in ^{35}Ar was considered to be hidden in this strong γ-ray peak. So the energy measurement and doppler shift attenuation measurement were performed by observing the gamma-ray spectra coincident with neutron. The neutron detector was positioned at 0° to the beam direction with its front face 13 cm from the target while the Ge(Li) detector was at 90° and 135° and 12 cm from the target. The sulphur target was prepared by pressing pure natural sulphur powder into 1 mm thick pellets. For the energy of the ^{35}Ar first excited state, $E_x = 1184.4 \pm 0.9$ keV has been obtained. This excitation energy is in good agreement with the values obtained in the reaction experiments.[3] Gamma ray portion spectra observed at two angles, $\theta_\gamma = 90°$ and 135° with respect to the beam direction, are shown in Fig. 1, and observed doppler shifted energy $\Delta E_\gamma = 2.88 \pm 1.7$ keV has been obtained. Since the calculated full shift is $\Delta E_{\text{Full}} = 8.57 \pm 0.20$ keV, the attenuation factor is $F = 0.34 \pm 0.19$; the full shift was calculated under the assumption that the initial

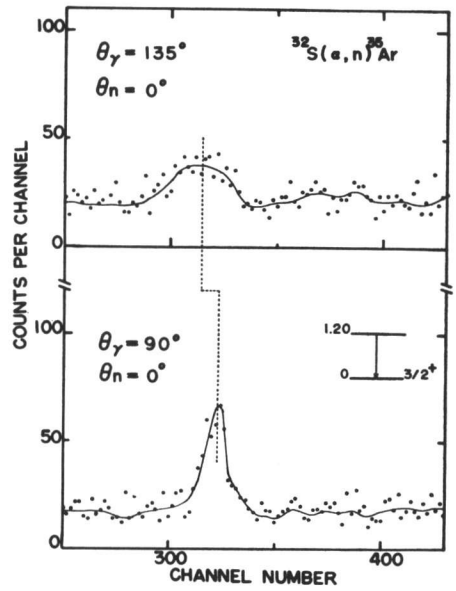

Fig. 1.

recoil velocity is equal to that of the centre of mass motion, and in this calculation, the energy loss of alpha particle in the target was taken into account. Attenuation curve for ^{35}Ar ions slowed down in sulphur was calculated with usual approximations for the stopping process.[4] The density of the target was 2.04 g/cm^3 and the characteristic slowing down time was calculated as 1.19 ps. The resulting mean life $\tau = (11 \pm 9) \times 10^{-13}$ sec for the ^{35}Ar first excited state. The errors do not include the uncertainty of the stopping power estimation. For the first excited state of ^{35}Cl, the mean life averaged over experimental results is $\tau = (1.4 \pm 0.1) \times 10^{-13}$ sec.[2] Since ^{35}Ar and ^{35}Cl are mirror nuclei, the first excited state of ^{35}Ar is assumed to have the same spin as ^{35}Cl, that is, $\frac{1}{2}^+$. The Ml and E2 transition multipolities are to be considered for the transition from the first excited state $\frac{1}{2}^+$ to the ground state $\frac{3}{2}^+$. Although Ml/E2 mixing ratio is not known so far, if these transitions are assumed to be pure Ml, the ratio of the reduced

transition probabilities in two transitions, that is, $B(\mathrm{Ml})\ ^{35}\mathrm{Cl}/B(\mathrm{Ml})\ ^{35}\mathrm{Ar}$, becomes 7. Corresponding $\Delta T = 0$, Ml transitions in mirror pair are expected to be of approximately equal strength or within a factor of two. So, the large difference of this transition should be worth of attention. In order to discuss the cancellation between iso-scalar and iso-vector contributions, the data of the mixing ratio are much desirable.

References

1) D. D. Duncan, K. H. Beurger, R. L. Place and B. D. Kern: Phys. Rev. **185** (1969) 1515.
2) W. J. Wiesehahn: Canad. J. Phys. **49** (1971) 2396.
3) C. A. Whitten, M. C. Mermaz and D. A. Blomley: Phys. Rev. **C1** (1970) 1455.
4) A. E. Blaugrund: Nuclear Phys. **88** (1966) 501.