Electromagnetic Transition Strengths in ^{33}S

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INTRODUCTION

The shell-model calculations provide a good description of the level energies and transition probabilities in the nuclei around ^{33}S. For low spin states, sd-interactions are applicable but for higher spin states the fp shell has to be taken into account [1-4]. As a part of the spectroscopy of high-spin states in ^{33}S lifetimes were investigated using the Doppler-shift attenuation method (DSAM). These data provide absolute transition strengths which are crucial for testing the predictions of nuclear models. The data were analyzed using gates from above, set on shifted component of directly feeding transition [5]. In this way, the longstanding problem of unknown feeding inherent to singles measurements is eliminated and much more reliable lifetimes are obtained [6].

The aim of the present work is to extract precise lifetime values of excited states in ^{33}S and to measure electromagnetic transition strengths in this nucleus.

EXPERIMENT

High-spin states in ^{33}S have been populated via a fusion-evaporation reaction at 40 MeV bombarding energy. A ^{14}N beam, delivered by the LNL XTU-Tandem accelerator impinged on a 99.7% enriched ^{24}Mg target with an average beam current of 5 pnA. The 1 mg/cm^2 thick target was evaporated on a 8 mg/cm^2 gold layer.

The γ rays emitted in the reaction were detected by the 4π GASP array composed of 40 Compton-suppressed large-volume, high-purity Ge detectors arranged in seven rings at different angles with respect to the beam axis. Events were collected when at least two germanium detectors are firing in coincidence. Energy and efficiency calibrations were performed with standard γ-ray sources of ^{56}Co and ^{152}Eu.

After performing gain-matching and shift corrections, the data were sorted into 49 γ-γ matrices, corresponding to all possible combinations of detector pairs, which are positioned in seven rings around the beam axis, respectively at the polar angles of 34°, 60°, 72°, 90°, 108°, 120°, 146°.

DATA ANALYSIS AND RESULTS

The investigated level scheme is shown on Fig. 1. More information can be found in [6].

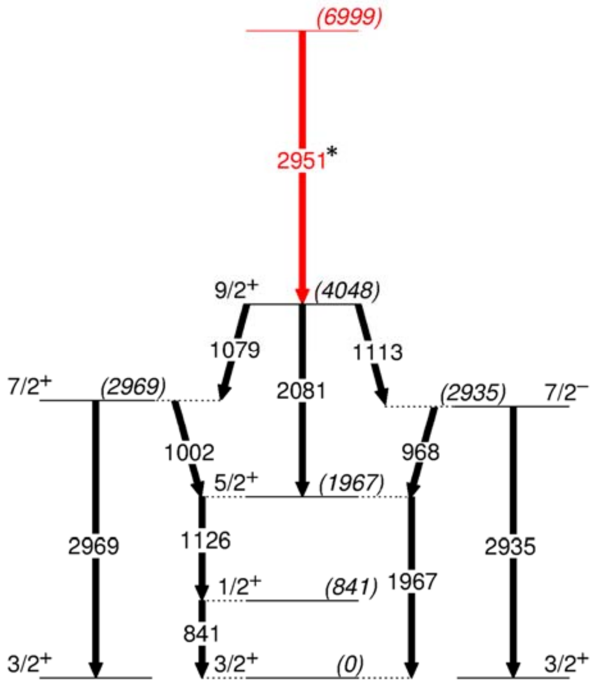

Fig. 2. Section of ^{33}S level scheme with the used new transition marked with a star.

In order to obtain lifetime information the data have been analyzed by applying a modern version of the Doppler-shift attenuation method. Gates are set only on the shifted component of a transition directly feeding the level of interest [5]. This component corresponds the emission during the slowing down of the recoiling nucleus in the target or the stopper and thus contains useful timing information. The resulting line-shape of the γ-transition depopulating the level of interest is then decomposed into shifted and unshifted component associated with emission during the slowing down (SS) and emission at rest (U) respectively. The lifetime of the level of interest can be derived from the areas $\{B_{SS}, A_{SS}\}$ and $\{B_{SS}, A_U\}$ of these components [3] through the equation:

$$\tau_a = \frac{\{B_{SS,} A_U\}}{(d\{B_{SS,} A_{SS}\}/dt_S)} \;; \qquad (1)$$

Here t_s is the time at which the recoil comes to rest.

The analysis was carried within the framework of the Differential decay curve method (DDCM) [2] according to the procedure outlined in [7].

In order to increase the statistics, equivalent gates were set at all rings where an appreciable Doppler Shift was present and the resulting spectra were summed. Thus, it was possible to derive an independent lifetime value for four of the seven rings and the final value τ was derived by averaging the results.

In Fig. 2. and in Fig. 3. examples are shown of line shape analysis of the 2081 keV transition at two different angles. The gate is set on the newly discovered 2951 keV transition which feeds directly the 4048 keV energy level. The analysis confirms the previously known lifetime. More details and results will be given in a forthcoming paper.

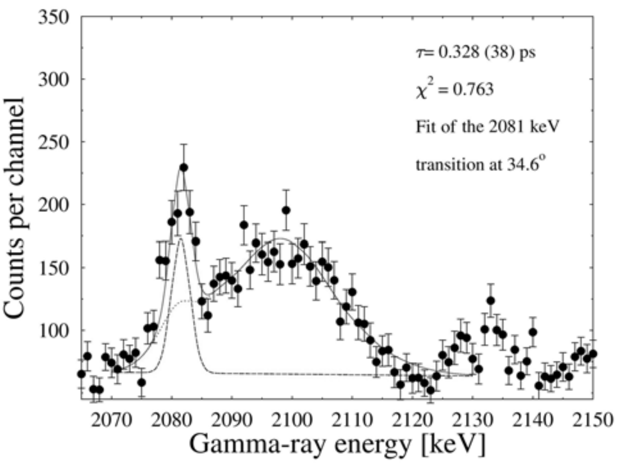

Fig. 2. Example of the line-shape of the 2081 keV transition at 34.6° generated by the sum of gates set on the shifted component of 2951 keV and determination of the lifetime.

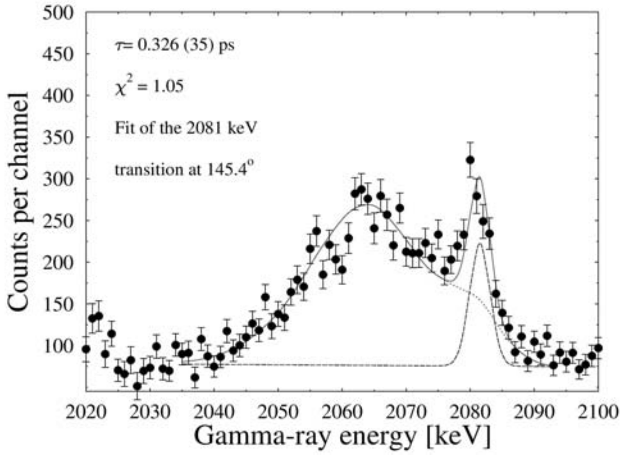

Fig. 3. Example of the line-shape of the 2081 keV transition at 145.4° generated by the sum of gates set on the shifted component of 2951 keV and determination of the lifetime.

SUMMARY AND CONCLUSIONS

In order to investigate the level scheme of ^{33}S we have performed a DSAM experiment at the Laboratori Nazionali di Legnaro, Italy the GASP array. The DDCM method was used in the data analysis of coincident events, where a gate was set on the shifted component of the directly feeding transition. Further work on the lifetime measurement is in progress.

AKNOWLEDGMENTS

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