Spectroscopy Studies in A $\sim$ 35 Region: Recent Results

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Introduction

There has been a growing interest to understand the structure of *sd*-shell nuclei in recent years. The use of heavy-ion beams in conjunction with advanced detector arrays allowed to extend the experimental information, which were limited previously mainly to low- and medium-spin states [1], in the range of high spins [2–4]. In these nuclei, the low spin structure of positive parity states at not too high energy can be well reproduced by shell model calculations in the *sd* main shell with the USD residual interaction [5]. At high spin and energy, the excitation of particles from the *sd* shell to the *fp* shell have to be taken into account, and the experimental data serve as testing ground of recently proposed effective interactions [6, 7].

Excited states of ^{35}S and ^{36}Cl have been studied previously via stripping and/or pick up reactins [8, 9]. However, only low and medium spin states were investigated due to the use of light projectiles and of the limited sensibility of the detection systems. The availability of large high resolution γ-ray spectrometers has recently renewed the interest in studying medium and high spin states of light nuclei in A=30-40 mass region [2, 3]. The present work is devoted to the investigation of the high-spin states in ^{35}S and ^{36}Cl by in-beam γ-ray spectroscopy.

Experimental Details

High spin states of ^{35}S and ^{36}Cl have been populated via the fusion-evaporation reaction. The beam was ^{14}N and it delivered by the LNL XTU-Tandem accelerator impinged on ^{24}Mg target with an average beam current of 5 pnA. Two energies, 40 MeV and 31 MeV, were used in the experiment with the same experimental conditions to populate ^{35}S and ^{36}Cl, respectively. The γ-rays emitted in the reaction were detected using the 4π-GASP array composed of 40 Compton-suppressed large volume high-purity Ge detectors.

Detailed experimental conditions, analysis and data reduction methodology are given in [10].

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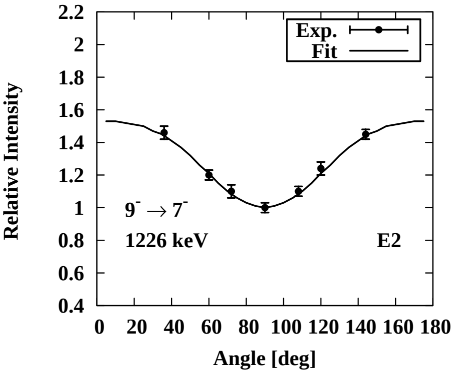

FIG. 1: Angular distribution results for the 1226 keV transitions in ^{36}Cl.

Results and Discussion

In case of ^{35}S; the level scheme has been extended up to $J^\pi = 17/2^+$ at 8023 keV and $J^\pi = 13/2^-$ at 6352 keV. The multipolarity of several γ-rays have been assigned on the basis of transition multipolarities deduced from measured angular distribution ratio R_{ADO} [11] values (ex. Fig. 1) and/or lifetime considerations. Nine new states, seven of positive parity and two of negative parity, and 28 new γ-ray transitions, have been added. Moreover, firm spin-parity was assigned to four previously known levels. Lifetimes have been determined for six states by applying DSAM.

In case of ^{36}Cl; a total of twenty new excited states de-exciting through 62 new γ-rays have been observed and are placed in the previously known level scheme of ^{36}Cl nucleus with proposed spins and parities. The spins and parities of the newly identified states have been adopted on the basis of angular distributions information of de-exciting transitions and measured lifetimes. This work establishes the high spin structure of ^{36}Cl up to the 10^+ state at 10707 keV for positive parity, and up to the 11^- state at 10296 keV for negative parity. From lineshape analysis, lifetimes have been derived for 14 new levels in ^{36}Cl.

All experimental results have been interpreted in the framework of shell-model predictions using different model spaces and interactions, that allow to deduce the configurations of the observed states. The calculations have been done with the shell model code ANTOINE [12]. Three different interactions (USD [5], PSDPF [7] and *sdfp* [6]) have been used for calculations. We note a very good agreement between experimental and calculated positive parity states for low spins with both USD and PSDPF interactions. But the higher spin states are predicted at much higher energies than those observed experimentally. By using *sdfp* interaction we obtained better result for higher positive parity states. On the other hand a remarkable good description is provided with PSDPF and *sdfp* for all observed negative-parity states [10]. Details of our findings will be presented durging the symposium.

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