Level Structure of ^{32}P

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Introduction

As one moves away from the valley of stability, a narrow region along the N $\approx$ Z line, and approaches the drip lines, the internal structure of the nucleus varies greatly and often suddenly. Within the framework of the spherical shell model, the effective single particle energies and their relative ordering vary as we move away from the valley of stability. This leads to sub-shell gaps that are different from those for stable nuclei resulting in the observation of intriguing phenomena such as the "island of inversion". Our recent investigations of ^{34}P (N =19) nucleus in the vicinity of the island of inversion motivated us to look into ^{32}P (N =17) which has a similar level structure. Both these nuclei have identical proton configuration $\pi(1s^{(1)}_{1/2})$ and odd number of neutrons occupying the $1d_{3/2}$ orbital in their ground state. However the negative parity states in ^{32}P occur at $\sim$1 MeV higher excitation energy than in ^{34}P. The region between the valley of stability and the island of inversion is a highly transient region and not well understood for nuclear structure. Hence a systematic study of nuclei belonging to this region is necessary.

Experiment, Results & Discussion

High spin states of ^{32}P were populated using ^{18}O(^{16}O,1p1n)^{32}P fusion evaporation reaction at an incident beam energy of 34 MeV. The ^{16}O beam was provided by the 15UD Pelletron facility at Inter University Accelerator Centre (**IUAC**), New Delhi. The de-exciting γ rays were detected by the **I**ndian **N**ational **G**amma **A**rray (**INGA**), at IUAC consisting of 18 clover detectors.

The data was analyzed using IUCSORT and RADWARE software packages. The level scheme has been extended due to the observation of several new transitions and is shown in Fig. 1. The linear polarization and angular correlation measurements are being analyzed simultaneously to assign the spin and parity of the levels.

Spherical shell model calculations were carried out using Nushell@MSU [1] within the *sdpf* model space outside a ^{16}O core. The TBME code-named WBMB in Nushell was used. The positive parity states are well reproduced by allowing unrestricted occupation of *sd* shells ($0\hbar\omega$ calculations, Fig. 2(a)). To account for the negative parity states, excitations from *sd* to *fp* shell have to be considered. Fig. 2(b) illustrates the calculations within a truncated model space, wherein the following configurations have been considered ($1d_{5/2}{}^{(9-12)}$ $1d_{3/2}$ $^{(0-8)}$ $2s^{(0-4)}_{1/2}$ $1f^{(0-1)}_{7/2}$).

Recently Bender *et al.* [2] have reported their spherical shell model calculations of ^{32}P, which are compared with our experimental results in Fig. 2(c). Bender *et al.* [2] have lowered the SPE for the $1f_{7/2}$ and

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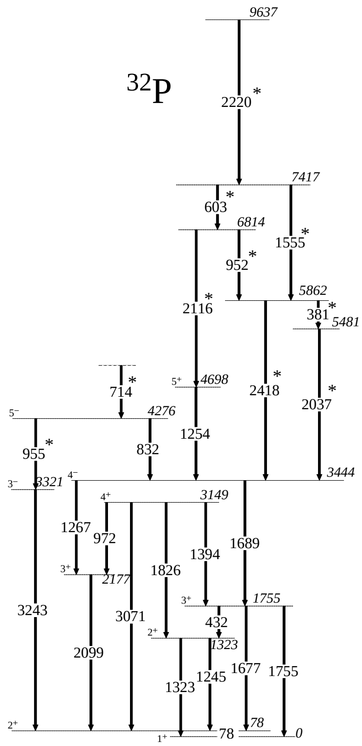

FIG. 1: Preliminary level scheme of ^{32}P. The new assigned γ-rays are marked with an asterisk.

$1p_{3/2}$ orbitals by 1.8 MeV and 0.5 MeV, respectively, thus providing a better fit to the negative parity states. Kangasmaki *et al* [3] had found that the agreement between theory and experiment for the transition probabilities of the negative parity states is poor, an observation similar to ^{34}P. Hence there is a need to employ a larger model space and/or an appropriate Hamiltonian within the *sdpf* model space, which takes into account all possible microscopic intra- as well as intershell interactions.

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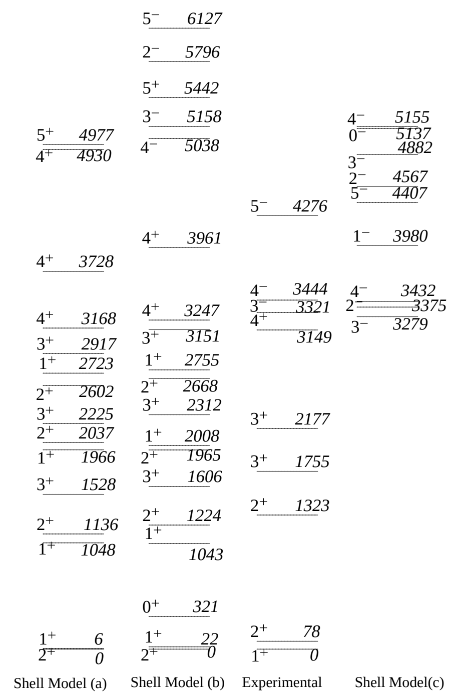

FIG. 2: Comparison between observed and calculated states in ^{32}P.

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