Study of Single Particle Excitations in ^{153}Sm via One Neutron Pickup ◇

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1. Introduction

The investigation of the resolved distribution of single particle strength in a deformed nucleus like ^{153}Sm is of interest for a detailed comparison with modern nuclear structure calculations like Interacting Boson Fermion Model (IBFM).

In the limit of one step processes the observed strength of one neutron pickup determines the Nilsson expansion coefficients and, thus, allows to study directly the wave function of Nilsson orbitals. For the inclusion of further degrees of freedom like vibrations in model calculations our high quality data should provide a test case.

2. Experimental results and analysis

The one neutron pickup reactions ^{154}Sm($\vec{\mathrm{d}}$,t), (d,t), (p,d), and (^{3}He,^{4}He) ^{153}Sm have been measured with three different beams and at beam energies ranging from 23 to 32 MeV [1]. The reaction products from ^{154}Sm-targets of 99.2% enrichment and area densities from 20 to 200 μg/cm^2 were analysed in the Munich Q3D-magnetic spectrograph equipped with a high resolution focal plane detector [2]. The high resolution of up to 4keV FWHM obtained in (p,d) is required to separate the dense spectra and to achieve a reliable energy calibration. With (^{3}He,^{4}He) we are measuring selictivly the L-transfers higher than three. The analysing power of the ($\vec{\mathrm{d}}$,t) is essential for reliable determination of I^π. In fig. 1 the three lowest band members of the 3/2[532] Nilsson band at 127keV with I^π=3/2$^-$, at 183keV with I^π=5/2$^-$, and at 263keV with I^π=7/2$^-$ are shown. The theoretical calculations performed with the code CHUCK [3] using only one step processes, reproduce both the angular distribution and the analysing power (asymmetry) in a reasonable way.

With the exception of about six states populated with very weak cross sections, all observed states below 1 MeV could be identified with respect to the I^π quantum number. Many of these assignments are new compared to [4].

Fourteen negative parity states are seen up to 1 MeV. Two of them cannot be assigned to a known Nilsson band. One of them, a I^π=3/2$^-$ state at E$_x$=979keV is suggested as a new bandhead. Between 1 MeV and 2 MeV about 40 negative parity states are observed.

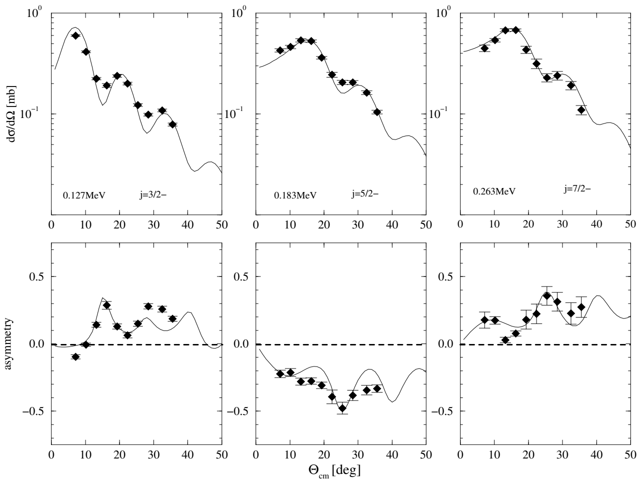

Fig. 1: Three lowest band members of the 3/2[532] Nilsson band

For the positive parity states, the situation is even more complicated: Twenty-one positive parity states are observed up to 1 MeV and only twelve can be assigned to Nilsson bands, at least four new bandheads are identified. Theoretical Nilsson calculations based on single particle energies [5–7] predict seven I^π=1/2$^+$, four I^π=3/2$^+$, and nine I^π=5/2$^+$ states in a large energy range in comparison to three I^π=1/2$^+$, six I^π=3/2$^+$, and five I^π=5/2$^+$ states seen below E_x=1MeV.

Between 1 and 2 MeV at least five new I^π=1/2$^+$ and about thirty I^π=3/2$^+$ are identified.

3. Conclusion

Even from this preliminary analysis it is obvious, that the Nilsson model does not account for the many states in ^{153}Sm. Other degrees of freedom like vibrations [8] of the deformed core have to be taken into account.

References

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