Shell Model Calculation for Te isotopes

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Introduction

The even-even $^{116-130}$Te consists of two protons outside the Z = 50 proton shell-closure and spans the region with 64 - 78 neutrons. Observed excited states and transition probabilities establish the vibrational collective behavior at low spin in these isotopes [1]. Shell model calculations have been used to explain the observed properties of Sn nuclei situated either just outside ^{100}Sn [2] core or above ^{132}Sn closed-shell [3]. The motivation of the present work is to explain the observed shell structure and collectivity in 116 ≤ A ≤ 130 in shell model framework.

Shell Model Calculation and Results

The present calculations have been done above the closed-core of ^{100}Sn using the Windows version of NuShellX@MSU [4]. Valence space consists of $0g_{7/2}$, $1d_{5/2}$, $1d_{3/2}$, $2s_{1/2}$, $0h_{11/2}$ for both type of nucleons. For $^{118-130}$Te; $0g_{7/2}$ and $1d_{5/2}$ neutron orbitals have been truncated to have maximum possible neutrons while truncation has been only applied to $0g_{7/2}$ for neutrons in ^{116}Te. The proton and neutron single-particle energies have been obtained from the [5].

Calculations have been performed using unnormalized two-body effective interactions based on G-matrix formalism derived from BonnA, BonnB and BonnC [6] free *NN* potentials for both type of nucleons. Comparison of observed and calculated results using BonnA has been displayed in Fig. 1. For 124 ≤ A ≤ 130 three types of interactions show similar results up to around 10^+ states which agree well with experiments. Whereas for lower mass region; 116 ≤ A ≤ 120 the results of three potentials agree well with the observed ones up to around 6^+ states. Moreover, in lower mass region; calculated results using BonnA also deteriorate at higher spins. Thus it has been concluded that BonnA is the most suitable potential. The $g_{9/2}$ orbitals have not been included in the valence space. But, the contribution of holes in $g_{9/2}$ produced by exciting protons to $h_{11/2}$ becomes prominent in lower mass. As mass number increases the contribution from neutrons dominate over the contribution of proton-holes in $g_{9/2}$. This may be the probable reason that the calculated results deviate at higher spins in lower mass region.

For nuclei lying between two shell closures B(E2) values should follow a parabolic nature attaining maximum at around mid-shell [7]. Fig. 2 shows the comparison of variation of B(E2) with the mass number "A" in case of Te isotopes. B(E2) calculations have been done with effective charge of proton and neutron to be equal to 1.5e and 1.8e respectively. Calculated B(E2) values agree well with the observed ones for the higher mass nuclei with 126 ≤ A ≤ 130 while deviate for lower mass region. This may be because of applied neutron truncation scheme thereby affecting the core-polarization [2, 7].

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References

[1] http://www.nndc.bnl.gov/.
[2] A. Ekström *et al.* Phys. Rev. Lett. **101**, 012502 (2008).

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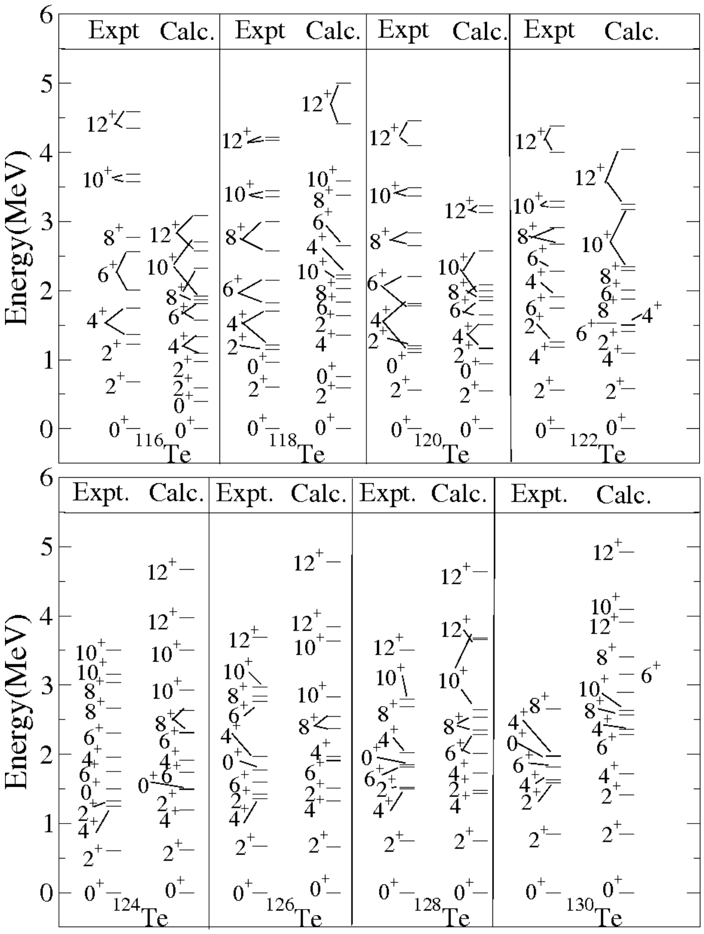

FIG. 1: Comparison of experimental and calculated level schemes of $^{116-130}$Te using BonnA potential.

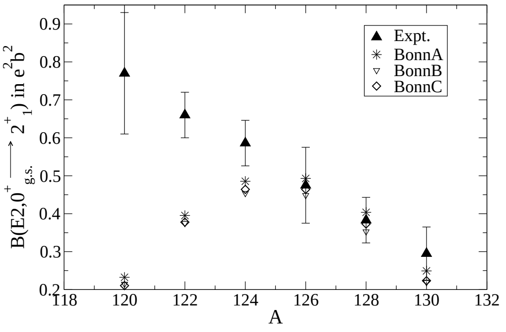

FIG. 2: Comparison of experimental and calculated B(E2, $0^+ \to 2^+_1$) for Te isotopes.

[3] S. Sarkar and M. Saha Sarkar Phys. Rev. C **78**, 024308, (2008).

[4] B. A. Brown and W. D. M. Rae, Nushell@MSU, MSU-NSCL report (2007).

[5] B. A. Brown *et al.* Phys. Rev. C **71**, 044317 (2005).

[6] R. Machleidt Adv. Nucl. Phys., 19, 189-376 (1989).

[7] M. Saha Sarkar and S. Sarkar, PoS (NIC X)147.