Surface Delta interaction and properties of medium mass nuclei

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Introduction

The idea of Surface Delta Interaction (SDI) is that because of Pauli principle, the interaction between nucleons is peaked near the surface of the nucleus. The delta potential is short ranged like free NN interaction. It has some interesting properties which makes it a quite "realistic" interaction [1], to use. SDI gives matrix elements which are quite close to empirical matrix elements found from shell model studies [2]. Also this interaction reproduces deformation properties quite well in complex nuclei [3–5].

We compare SDI matrix elements with two modern interactions, namely, JUN45 and G-f5pg9 interaction of Ref. [6] and report some applications to finite nuclei.

Surface Delta Interaction

The SDI is of the following form:

$$V(\vec{r}_{12}) = -2F(R_0u_0)^{-4}\delta(r_1 - R_0)\delta(r_2 - R_0) \times\delta(\cos\omega_{12} - 1) \ , \quad (1)$$

where R_0 is the nuclear radius, u is radial wave function (here the radial wave functions are approximated to be same at the nuclear surface) and ω_{12} is angle between the position vectors of the nucleons.

Eq. (1) can be rewritten in the following form,

$$V(\vec{r}_{12}) = -V_0 \sum_{lm} Y^*_{lm}(\omega_1)Y_{lm}(\omega_2) \ . \quad (2)$$

Here V_0 is the strength of pp, nn and pn interactions among the active nucleons. This is a reasonable interaction which has been used in various mass regions [3, 5]. SDI compares quite well, in sign as well as in magnitude with empirical shell model interaction matrix elements [2]. As an effective interaction, SDI is very good for configuration mixing in a limited shell model space (see Ref. [2]) and describes quite well the deformed properties of nuclei.

Results and Discussions

We have compared the two body matrix element (TBME) obtained by Surface Delta Interaction with the matrix element obtained by Honma et. al., [6] for other modern interaction modern interaction JUN45 and G-f5pg9. We find close correspondence among them as it can be seen from Fig. 1

We have used a self-consistent microscopic model, namely, the Deformed Hartree-Fock model based based on deformed Hartree-Fock and angular momentum technique to describe some medium mass nuclei in a comparably larger model space spanned by $f_{5/2}pg_{9/2} - sdg_{7/2}h$ shells for both proton and neutron. We have used surface delta interaction as two-body residual interaction to generate self-consistent wave functions. A number of nuclear properties (e.g., spectra and electromagnetic moments) have been investigated in the present study.

The present model along with SDI, reproduces the BE(2) systematics quite well, as it is shown in Fig. 2 for the case of Se nuclei.

We have also studied the magnetic moment for ground state of a number of nuclei (from Ge to Xe) and find our results are very close

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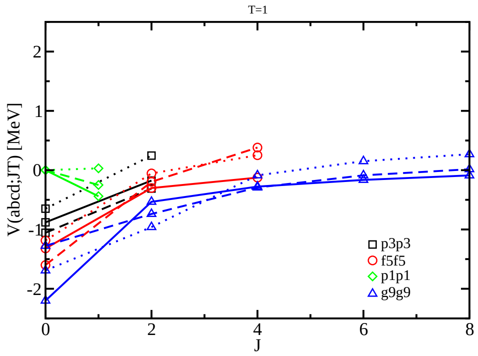

FIG. 1: Comparison of the pp diagonal matrix elements V(ab;JT) among the effective interactions SDI, JUN45 and G-f5pg9. Solid line is for SDI, dotted line for JUN45 and dashed line for G-matrix interactions. The label 'p3p3' stands for $a = 1p_{3/2}$ and $b = 1p_{3/2}$, for example.

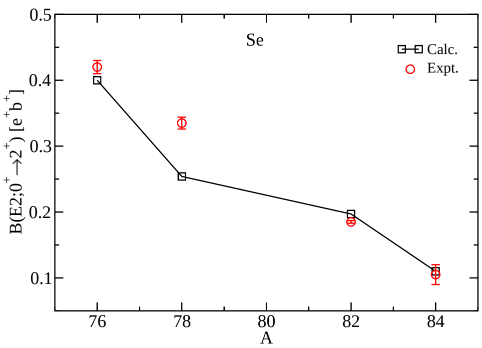

FIG. 2: Comparison of calculated and experimental B(E2) values for Se.

to experimental values, as shown in Fig. 3.

Conclusions

The surface delta interaction results are compareable to that of other modern interactions. It is quite successful in describing properties of finite nuclei.

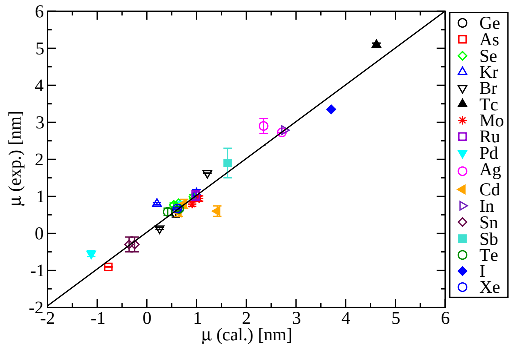

FIG. 3: Comparison of calculated and experimental magnetic dipole moments for various nuclei.

Acknowledgments

We acknowledge the support of the Council for Scientific and Industrial Research (CSIR), Govt. of India, (project No. 03(1216)/12/EMR-II) and the Department of Science and Technology (DST), Govt. of India (Project. SR/S2/HEP-37/2008) during this work.

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