Towards an Improved Parametrisation of Relativistic Mean Field Lagrangian

A. Bhagwat[1],* M. Gupta[2], and Y. K. Gambhir[2,3]
[1] *UM-DAE Centre for Excellence in Basic Sciences, Mumbai 400 098, INDIA*
[2] *Manipal University, Manipal 576104, INDIA and*
[3] *Dept. of Physics, IIT Bombay, Powai, Mumbai 400076, INDIA*

Introduction

The relativistic mean field (RMF) model is one of the most successful models to describe ground state properties of nuclei spanning the entire periodic table [1–3]. In particular, it is well established that the binding energies, charge radii, deformation parameters etc. are reproduced very well, almost in all the regions of the nuclear chart. However, at a finer level, specifically near the shell closures, the binding energies obtained by using the RMF model are found to be significantly larger than the corresponding experimental values [4]. In the present work, we make an attempt to improve upon this deficiency, without compromising the quality of agreement already achieved elsewhere in the periodic table. Here, we report preliminary results of our investigations.

Results and Discussion

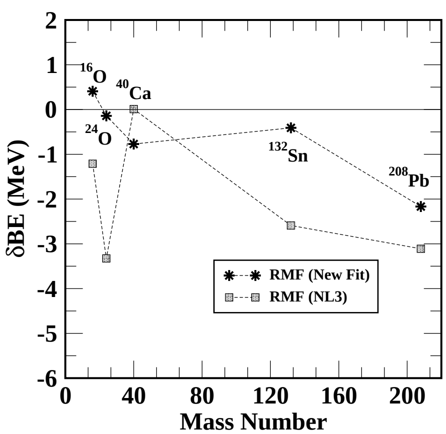

FIG. 1: Difference between the calculated and the experimental [4] binding energies near closed shells.

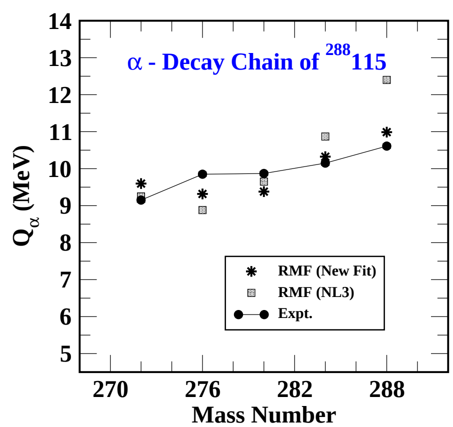

FIG. 2: The calculated and the experimental [7] α decay Q values for the decay chain of the nucleus Z=115 and A=288. The corresponding Q values obtained [6] by using the NL3 parameters are also presented for comparison.

We carry out a re-fit of the conventional RMF parametrisation, with additional constraints on the isospin channel. It is found that the resulting Lagrangian parameters are within 2% of one of the most successful Lagrangian parameters, NL3 [5]. The difference between the calculated and experimental [4] values of binding energies for the doubly closed shell nuclei is plotted in Fig. 1. The corresponding differences obtained by using the NL3 parameters [5] have also been shown for comparison. It is clear from the figure, that there is an overall improvement in the binding energies at the shell closures.

To check the validity of the new parame-

*Electronic address: ameeya@cbs.ac.in

ters further, we explore the superheavy region, which is of current interest. In particular, we investigate the α decay chain of the nucleus with Z=115 and A=288. The calculated and the corresponding experimental α decay Q values [7] for this chain are plotted in Fig. 2, along with those obtained [6] by using the NL3 parameters. It is seen that both the calculations agree well with the experiment, but at a finer level, the new parameter set yields results closer to the experiment.

In conclusion, the new RMF parameters are found to improve the agreement of binding energies at shell closures, without compromising the agreement achieved elsewhere in the periodic table. More detailed work is in progress.

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