Regularity of the Mass surface and the use of trends in the Mass Surface

B. Pfeiffer[1,2], Shreesha Rao D.S.[3], K. Rajasimha[3] , K. Venkataramaniah[2,3*], U. Czok[1] and C. Scheidenberger[1,2]

[1]*II. Physikalisches Institut, Justus-Liebig-Universit¨at Gießen, Gießen, GERMANY*
[2]*GSI Helmholtzzentrum f¨ur Schwerionenforschung, Darmstadt, GERMANY*
[3]*Department of Physics, Sri Sathya Sai Institute of Higher Learning, Prasanthinilayam, INDIA*
** email: vrkamisetti@gmail.com*

Introduction

All the information contained in the mass table [1] and in the nuclear reactions and separation energy tables can in principle be displayed in a plot of the binding energy or the mass versus Z, N or A. Such a of plot, in which the binding energies vary rapidly is complicated by the fact that there are four sheets, corresponding to the four possible combinations of parity for Z and N. These sheets are nearly parallel almost everywhere in this three dimensional space and have remarkably regular trends, as one may convince oneself by making various cuts (equal Z or N or A constant).Any derivative of the binding energies also defines four sheets. In the present context, derivative means a specified difference between the masses of two nearby nuclei. They are also smooth and have the advantage of displaying much smaller variations. For a derivative specified in such a way that differences are between nuclides in the same mass sheet, the nearly parallelism of these leads to an almost unique surface for the derivative, allowing regular trends in the mass surface.

Evaluation and Analyses:

Our new compilation of atomic masses, AMC12 [1] and the subsequent comparison with the atomic masses of Audi eta al [2] Pfeiffer et al [3] suggested a more plausible extrapolation using the changed mass surfaces as these masses will impact future calculations through their influence on the extrapolation of masses toward the drip lines and future mass models.

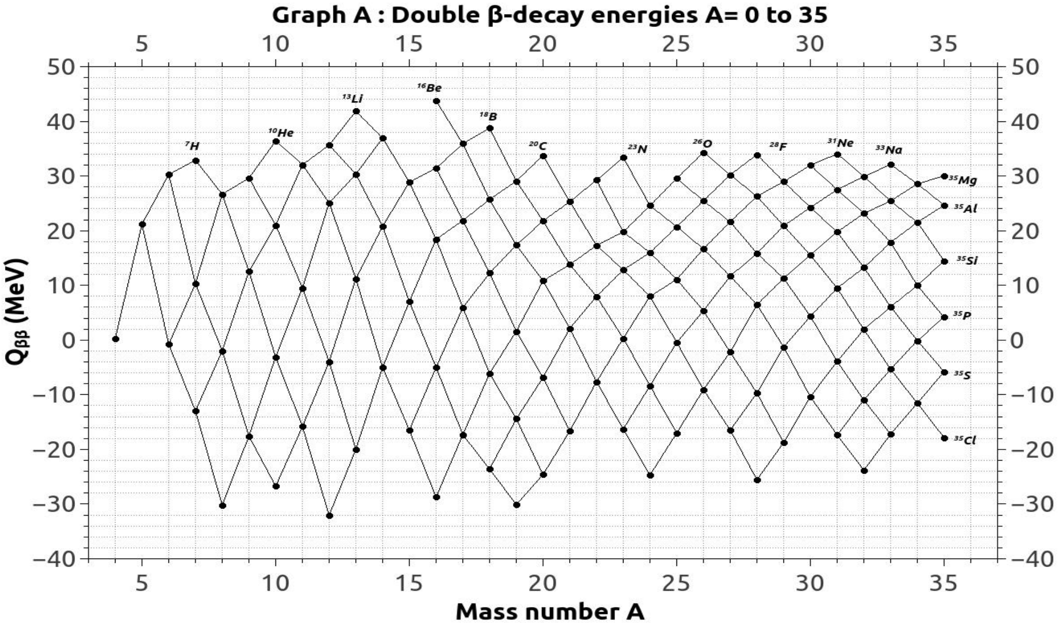
For this purpose four derivatives of the last type were chosen.

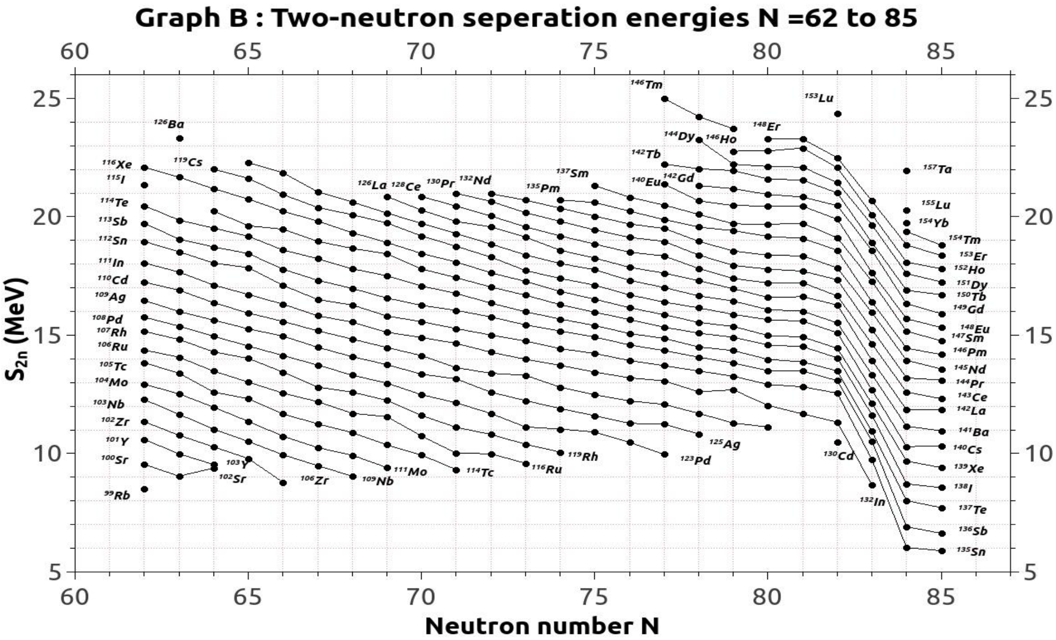
1. The two-neutron separation energies versus N with lines connecting the isotopes of a given element.
2. The two-proton separation energies versus Z, with lines connecting the isotones
3. The α-decay energies versus N, with lines connecting the isotopes of a given element.
4. The double beta decay energies versus A, with lines connecting the isotopes and isotones.

Separation energies in (MeV) of particles or groups are obtained as the following combination of atomic masses from the AMC12 mass data.

$$Q_\alpha = M(A,Z) - M(A-4,Z-2) - M(\,^4He)$$
$$Q_{2\beta^-} = M(A,Z) - M(A,Z+2)$$
$$S_{2n} = -M(A,Z) + M(A-2,Z) + 2M(n)$$
$$S_{2p} = -M(A,Z) + M(A-2,Z-2) + 2M(\,^1H)$$

Other various representations are possible (e.g. separately for odd-odd and even-even nuclei and odd mass nuclei, one neutron separation energies versus N, one-proton separation energies versus Z, beta decay energy versus A etc, they can all be built from the mass values of the AMC12 compilation [1]. Two representative mass surfaces are shown in Graphs A and B clearly showing the trends in the mass surface. Thus, dependable estimates of unknown, poorly known or questionable masses have been obtained by extrapolation from well-known mass values on the same sheet. These graphs will be used for extrapolation of masses





toward the drip lines and also to test the theoretical models.

References:

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[3] B.Pfeiffer et al Proceedings of DAE Symp. on Nucl. .Phys. 57 (2012) 382