

# N=82 shell quenching below $^{132}_{50}\text{Sn}_{82}$

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The influence of nuclear structure on the r-process nucleosynthesis can best be studied within the "waiting-point" concept [1]. Within this framework, the successful reproduction of the global isotopic abundances ( $N_{r,\odot}$ ) as well as remaining deficiencies have been interpreted by our group as signatures of nuclear structure near the neutron drip-line [1]. Pronounced abundance troughs prior to the  $N_{r,\odot}$  peaks at  $A \simeq 130$  and 195, respectively, have their origin in an overestimation of the N=82 and 126 shell strength in global mass models such as FRDM and ETFSI-1.

Fig. 1 displays the  $S_{2n}$  values for Cd isotopes. Experimental values from the 1995 mass evaluation of Audi et al. [3] (crosses) did not include Cd isotopes at or above N=82. First detailed  $\beta$ - and  $\gamma$ -spectroscopic studies of the N=82 nuclide  $^{130}\text{Cd}$  at CERN-ISOLDE yielded a surprisingly high  $Q_\beta$  value of 8.34 MeV, which is only in agreement with recent mass models that include the phenomenon of N=82 shell quenching [5].

Based on this result, the 2003 mass evaluation [4] could extrapolate to more neutron-rich isotopes with  $N \geq 82$ . As is indicated in Fig. 2, the shell strength is weakened relative to the maximum at the double-magic  $^{132}_{50}\text{Sn}_{82}$  with increasing isospin, as requested by our group from astrophysical considerations since a long time [1].

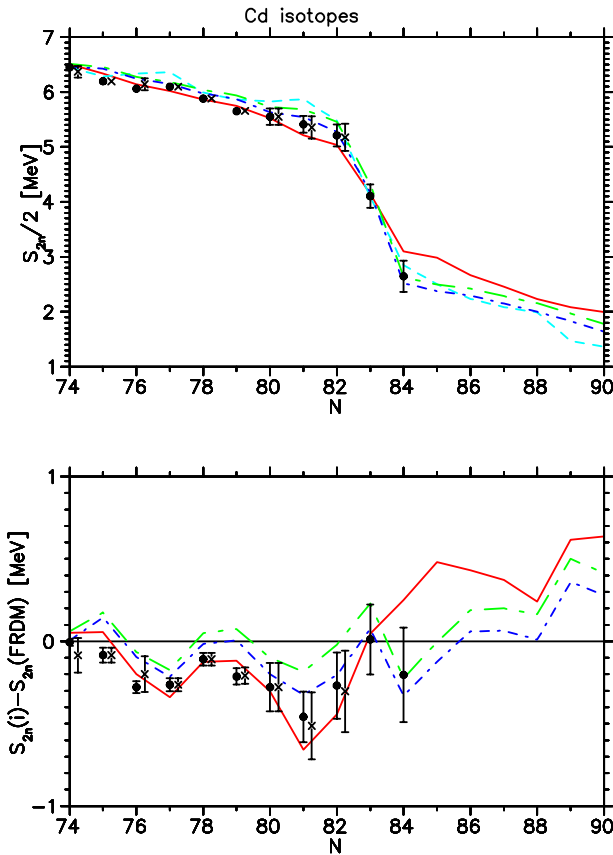


Figure 1: The two-neutron separation energies ( $S_{2n}$ ) across the shell gap at N=82 for Cd-isotopes (upper part) and the differences to the FRDM model (lower part). Experimental values: crosses from 1995 mass evaluation [3] and circles from 2003 evaluation [4]. Theoretical masses: FRDM: cyan, ETFSI-1: green, ETFSI-Q: blue, HFB-2: red

A weakening ("quenching") of spherical shells with increasing isospin, resulting in a gradual setting in of collectivity, is well established for the lower neutron-magic numbers and has been predicted by HFB calculations for the spherical shells at N=82 and 126 [2]. Signatures for a quenching of the shell strength can be derived from the difference of two-neutron separation energies ( $S_{2n}$ ) across a magic neutron number. As an example,

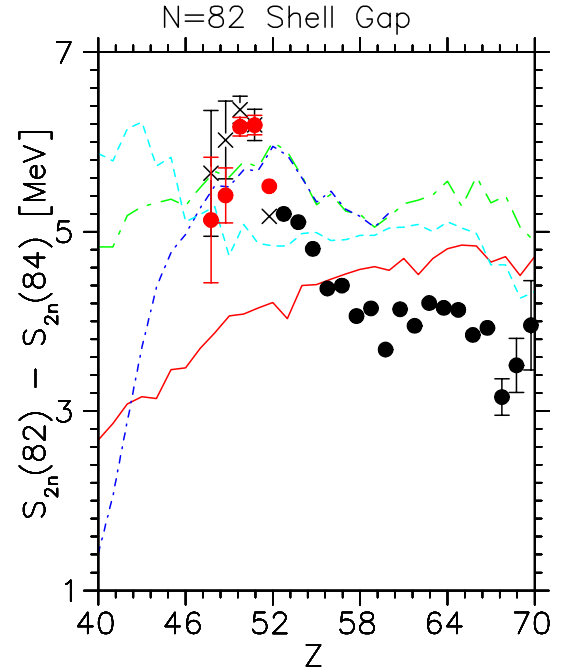


Figure 2: The N=82 shell gap as a function of Z. Experimental values from the 2003 mass evaluation [3] (black and red circles) are compared to the 1995 ones [4] (crosses and black circles). [The colour coding for the mass models is the same as in Fig. 1.]

Direct mass measurements at the FRS-ESR of the GSI will in future extend the range of experimental masses at N=82, as well as to more neutron-rich isotopes near N=126.

## References

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