N=82 shell gap above $^{132}_{50}Sn_{82}$

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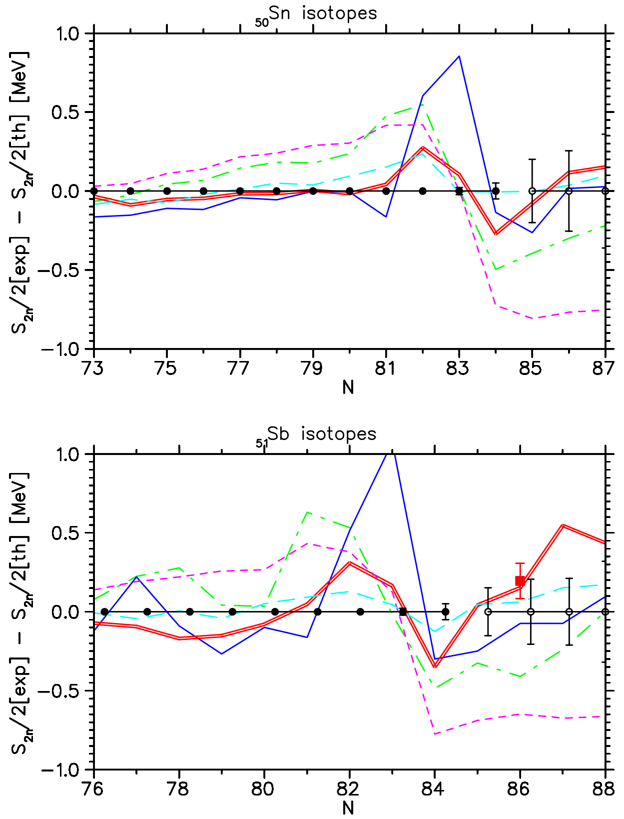

Figure 1: Differences between experimental two-neutron separation energies (S_{2n}) [black dots: 2003 mass evaluation [3], red squares: FRS/ESR measurements [4]] and theoretical values across the shell gap at N=82 are shown for $_{50}$Sn (upper part) and $_{51}$Sb isotopes (lower part). [Theoretical masses: Groote: magenta, FRDM: red, ETFSI-Q: cyan, HFB-2: green, HFB-8: blue]

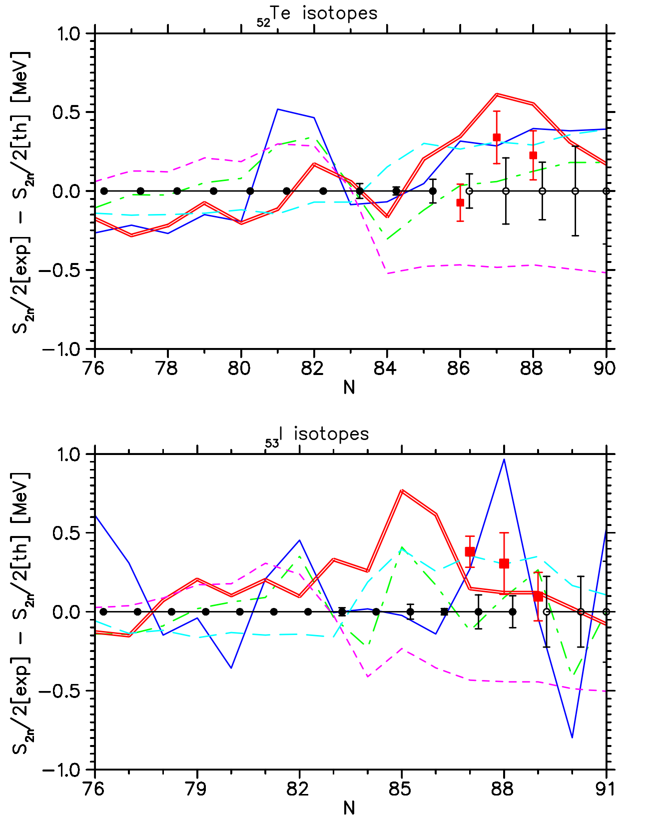

Figure 2: Same notation as for Fig. 1 for $_{52}$Te (upper part) and $_{53}$I isotopes (lower part).

The influence of nuclear structure on the r-process nucleosynthesis can be studied within the"waiting-point" concept [1]. The successful reproduction of the global isotopic abundances ($N_{r,\odot}$) as well as remaining deficiencies have been interpreted by our group as signatures for new nuclear structure patterns for unstable nuclei [1]. One such effect is an overestimation of the N=82 and 126 shell strength in global mass models such as FRDM and ETFSI-1. 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 two-neutron separation energies (S_{2n}) across a magic neutron number. Studies of the N=82 nuclide ^{130}Cd at CERN-ISOLDE yielded a surprisingly high Q_β value, which is only in agreement with recent mass models that include the phenomenon of N=82 shell "quenching" [5, 6]. First direct mass measurements on neutron-rich isotopes at FRS-ESR yielded data on isotopes beyond the double-magic nucleus ^{132}Sn. Together with the experimental and short-range extrapolated masses from the 2003 mass evaluation [3], a meaningful comparison with theoretical approaches is now possible. As an example, Figs. 1 and 2 display S_{2n} values for $_{50}$Sn, $_{51}$Sb, $_{52}$Te and $_{53}$I isotopes. Surprisingly, the "old" models ETFSI-Q and FRDM perform better than recent self-consistent HFB approaches as the HFB-2 and especially HFB-8 from the Brussels-Montreal group. But, the discrepancies increase with distance to the magic proton number Z=50 for all models.
Direct mass measurements with upgraded U-beams at FRS-ESR will extend the range of experimental masses at N=50 , 82 and 126 closer to the r-process "boulevard".

References

[1] K.-L. Kratz et al., Ap. J. **403**, 216 (1993).
[2] B. Pfeiffer et al., Acta Physica Polonica **27**, 475 (1996).
[3] G. Audi et al., Nucl. Phys. **A729**, 3 (2003).
[4] M. Matos, PhD thesis, Giessen (2004).
[5] I. Dillmann et al., Phys. Rev. Lett. **91**, 162503 (2003).
[6] B. Pfeiffer and K.-L. Kratz, Ann. Rep. 2003, Inst. f. Kernchemie, A13.