Inclusive cross sections for one- and multi-nucleon removal from Sn, Sb, and Te projectiles beyond the $N = 82$ shell closure[†]

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Inclusive one- and multi-nucleon removal cross sections have been measured for several Sn, Sb and Te isotopes just beyond the $N = 82$ neutron shell closure. The beams were produced in the projectile fission of a ^{238}U beam at the Radioactive Isotope Beam Factory at RIKEN. The experimental cross sections were compared to predictions from two different versions of the Liege intranuclear cascade (INCL) model[1,2] as shown in Fig. 1. This figure shows an overall good agreement between the calculations and the experimental results. In particular for the 0pxn removal from the $N = 83$ projectiles ^{133}Sn, ^{134}Sb, and ^{135}Te as well as the stable ^{112}Sn[3] both the magnitude and the gentle odd-even staggering of the cross sections is nicely reproduced by both calculations. In contrast, none of them correctly describes the measured cross sections for one- and two-neutron removal from the $N = 84$ isotones ^{134}Sn and ^{135}Sb. This failure of the INCL model could be traced to the peculiar structure of these nuclei with only a few valence neutrons above the $N = 82$ shell gap.[4]

Turning now to the one-proton knockout cross sections, Fig. 1(b) clearly shows that both calculations fail to reproduce the experimental values for all three studied $N = 84$ projectiles, *i.e.* ^{134}Sn, ^{135}Sb and ^{136}Te. Note, however, that in this case the refinements, which have been introduced in the modified version of the INCL code, have a much stronger effect as compared to the case of one-neutron knockout, reducing the calculated one-proton knockout cross sections by roughly a factor of two. The underlying reasons for the overestimation of the cross section for the removal of the stronger bound nucleon species by the INCL model, which had already been recognized in the past, are still awaiting explanation. The present data for multi-nucleon removal indicate that an ad-hoc increase of the excitation energy in the INCL model at the end of the cascade process, an approach which has been suggested to cure the incapacity of the model to correctly describe the removal of deeply bound nucleons, does not address the origin of this problem.

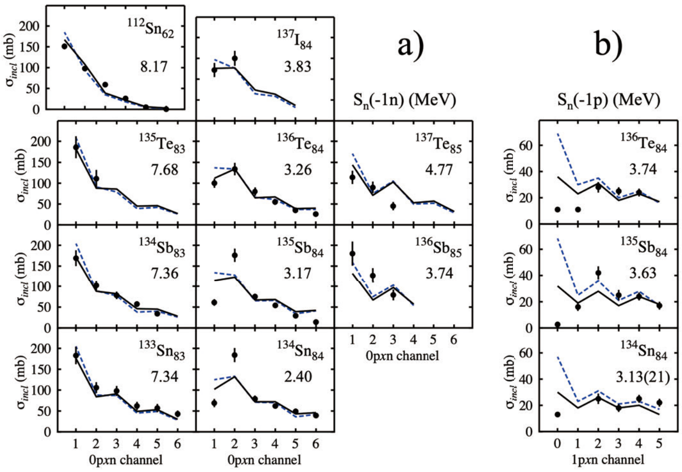

Fig. 1. Comparison between experimental inclusive removal cross sections and the results of calculations performed with two different versions (standard[1] as dashed blue and modified[2] as solid black lines) of the INCL code for a) the 0pxn and b) the 1pxn removal channels. The experimental cross sections for 0pxn removal from ^{112}Sn shown in a) are taken from Ref. 3).

Finally, we mention that the experimental inclusive cross section for one-proton removal from semi-magic ^{134}Sn was also compared with calculations based on eikonal direct reaction theory with structure information from the nuclear shell model and refer to the original publication for further details.

References
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† Condensed from the article in Phys. Lett. B **795**, 356 (2019)
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