Neutron Rich Matter on Heaven and Earth
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Machine-learning extrapolations for the masses of r-process relevant neutron-rich nuclei

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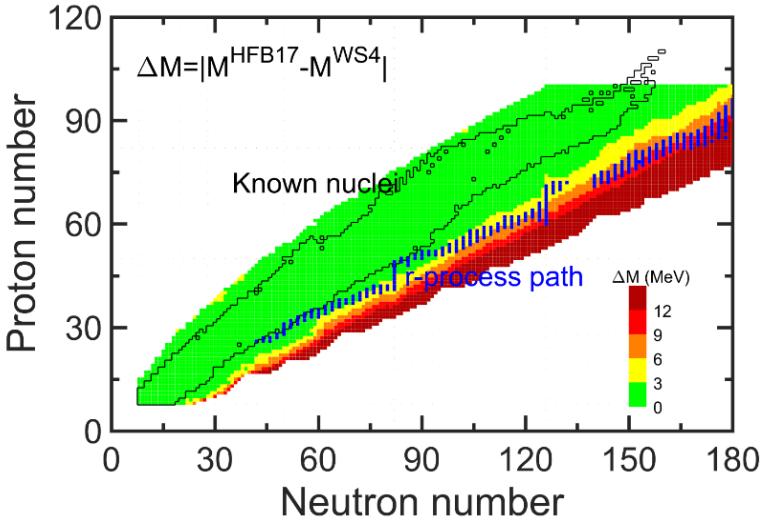
Mini - Introduction

- Nuclear masses of neutron-rich nuclei are important inputs for r-process



- Experiment: ~ 2500 nuclei, still not enough

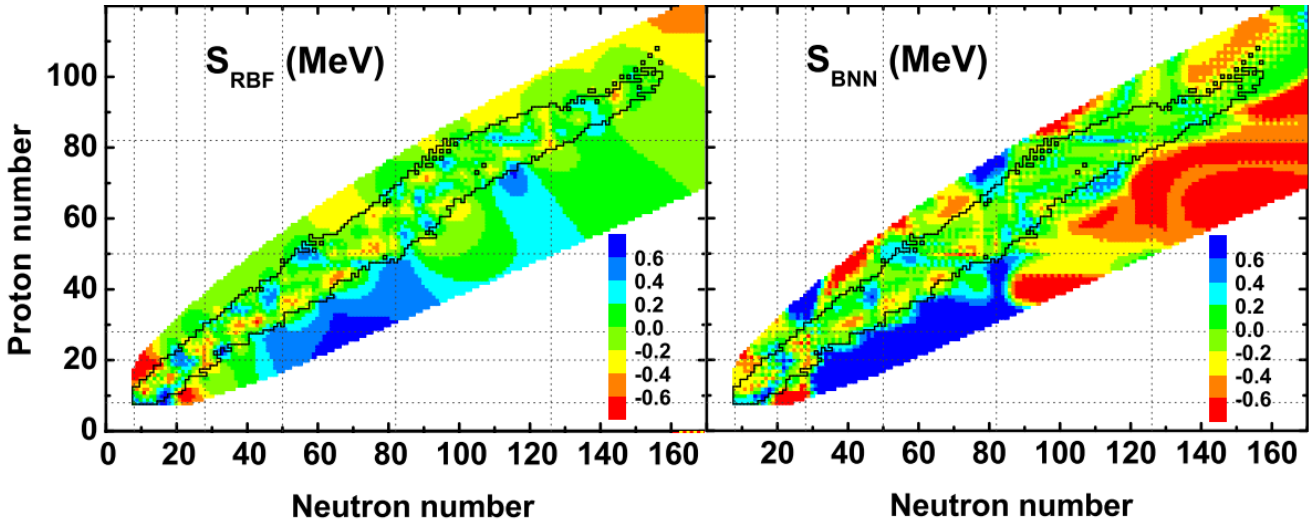
  Exp. data: Wang et.al., *Chin. Phys. C* 45, 030003 (2021)

- Theory: ~ 500 keV

  Uncertain outside experimental region

  HFB17: Goriely et.al., *Phys. Rev. Lett.*, 102, 152503 (2009)
  WS4: Wang et.al., *Phys. Lett. B* 734, 215 (2014)

- Machine-learning has been applied to improve mass predictions



- Precision: ~ 200 keV
- Extrapolation:

  Different ML approaches give different predictions

Trust which one?

Figure: Niu et.al., Phys. Rev. C 100, 054311 (2019)

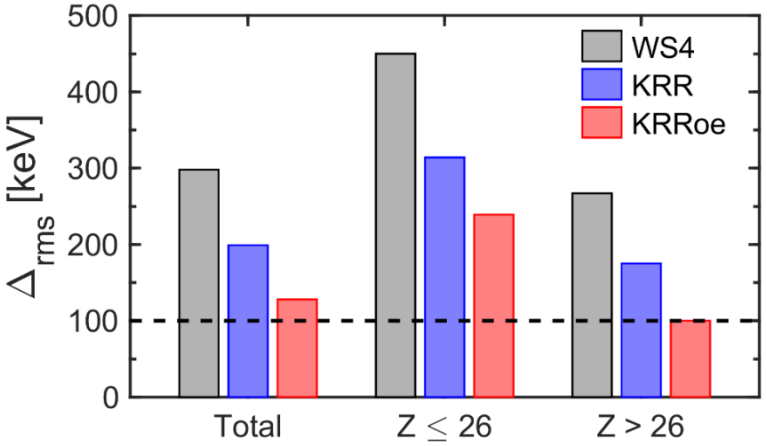
Results from the kernel ridge regression

- Precision on experimentally know nuclei
  - KRR: ~199 keV

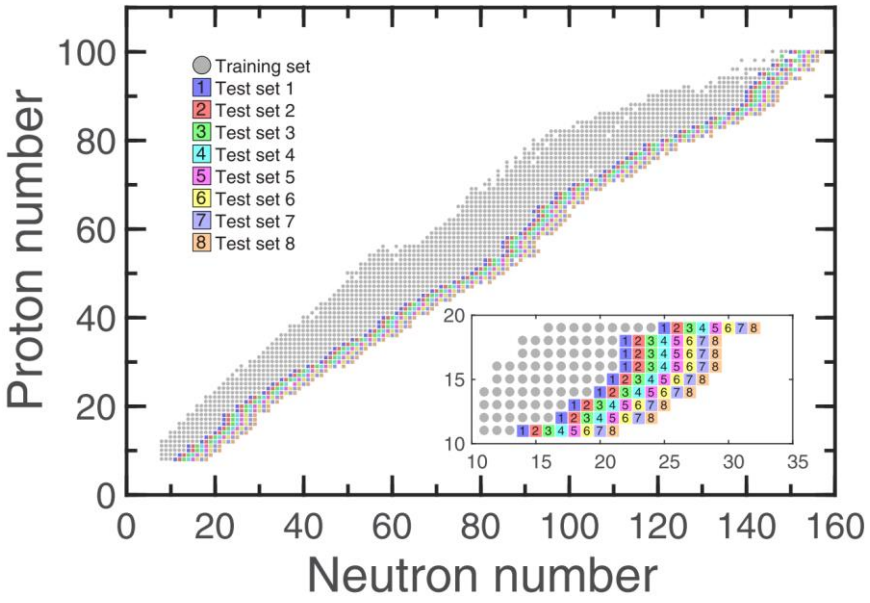
    XHW and Zhao, *Phys. Phys. C* 101, 051301 (R) (2020)
  - KRRoe: ~128 keV

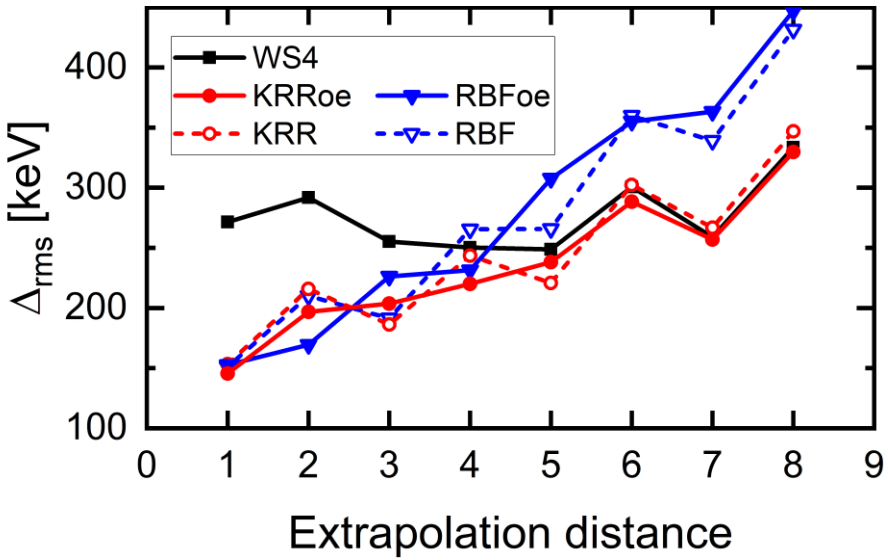
    Most precise ML mass model so far !

    XHW, Guo, and Zhao, *Phys. Lett. B* 819, 136387 (2021)



- Extrapolation performance



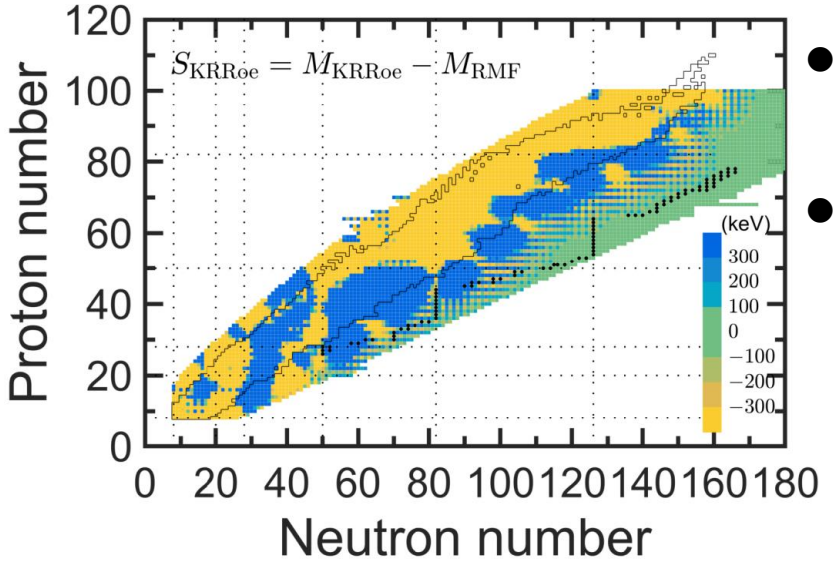


- KRR avoids worsening predictions by controlling correction strength with the increasing extrapolation.

The KRR predictions can be trusted; But still can do little at large extrapolation.

Applications in the r-process

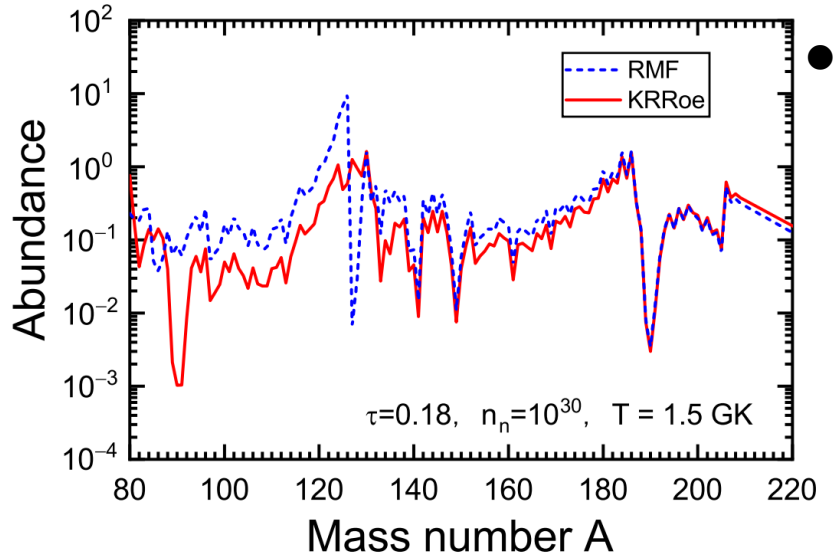
KRR corrections on the RMF mass model



- Corrections decays along the extrapolation away from the experimentally known region
- Corrections on the r-process path nuclei are remarkable only in the light mass region

RMF: Geng et.al., *Prog. Theor. Phys.*, 113, 785 (2005)
KRRoe : Guo, **XHW**, and Zhao, *Symmetry,* 14, 1078 (2022)

Influence on the r-process abundances



- Differences can be seen mainly for isotopes with relatively small mass number.

Guo, **XHW**, and Zhao, *Symmetry,* 14, 1078 (2022)

Machine-learning approach may influence the r-process abundance of the nuclei with relatively small mass number ($A < 150$).

The end

Thanks