Enchancing the accuracy of optical potentials

C. Hebborn, November 15 2022

Cf recent white paper arXiv: 2210.07293

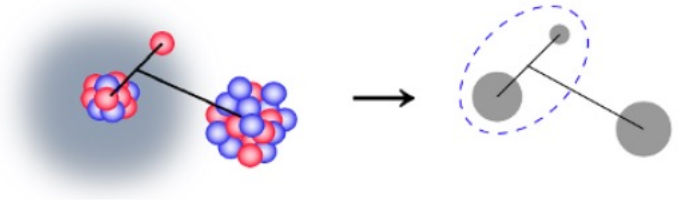
Theory Alliance
FACILITY FOR RARE ISOTOPE BEAMS

Lawrence Livermore National Laboratory

MICHIGAN STATE UNIVERSITY

- Importance:

  Optical potentials are key ingredients to predict reaction observables, needed to address a wide range of applications from **fundamental science discoveries to astrophysics to nuclear energy and security**



- Status:

  — Phenomenological **global nucleon-nucleus** potentials are widely used (e.g. Koning Delaroche)
  → **Quality of these optical potentials away from stability unclear**

  — Recent efforts to derive **microscopic potentials** from many-body calculations

  — Less progresses for **nucleus-nucleus potentials**

  — **Often no uncertainties associated**

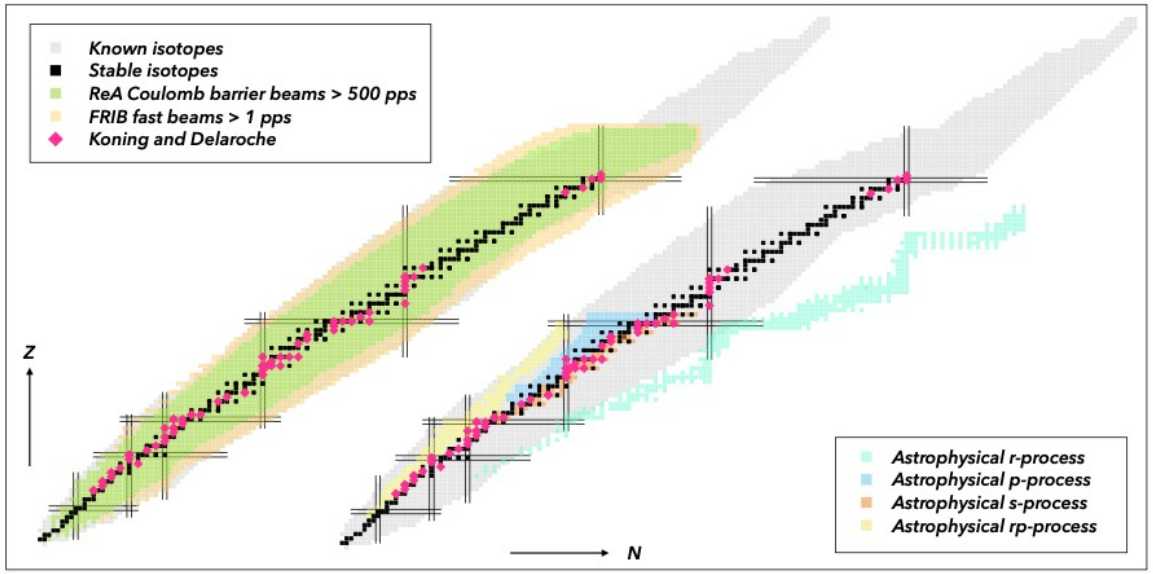


Figure 1: The chart of nuclides showing (a) estimates of the reach of reaccelerated beams at FRIB and (b) 'fast' fragmentation beams at FRIB and (c) the well-known astrophysical processes. Also indicated (pink diamonds) are the nuclei whose properties were used to constrain the Koning and Delaroche optical potential [14], highlighting the dramatic extrapolations made.

Outlook and recommendations

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Optical potentials for the rare-isotope beam era

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- **Need for exp-theory collaboration:**

  → Data along isotopic chains to constrain **isospin dependence** of optical potentials & constrain with **non-elastic probes**

- Inclusion of **uncertainty quantification:** Bayesian framework well suited for UQ, extrapolation & interpolation

- To reach more **accurate microscopic optical potential:** many-body methods should include **additional correlations**

- Learning from **microscopic approaches:** What are the 1° non-local and 2° the spin-orbit form factors? How does it evolve in E, A, N/Z?

- Need to respect **dispersion relations** potentials to unify description of structure and reaction properties

- **Upgrade reaction formalisms** in order to integrate modern optical potentials

- Sharing **tools & resources :** https://sites.google.com/view/opticalpotentials/

- Need for efforts to build **nucleus-nucleus potentials**

Need for workforce development !!