CORRELATED MASS MODEL FOR CALCIUM ISOTOPES

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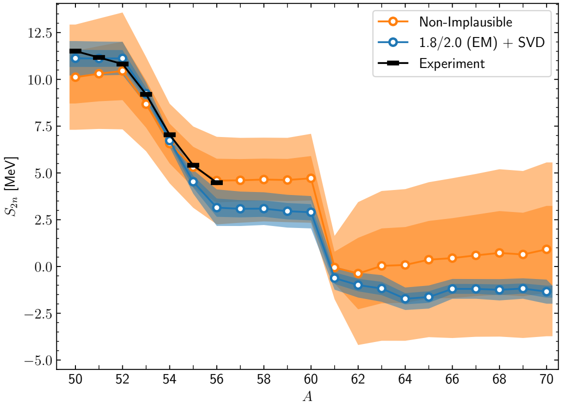
Introduction & Motivation

- Goal: Statistical Model for S_{2n} of Ca isotopes
- Distribution of interactions to understand uncertainties and correlations
- 34 Non-implausible (NI) Hu et al. NP (2022)
- 101 1.8/2.0 (EM) + SVD

  Hebeler et al. PRC (2011), Plies et al. arXiv:2509.24671 (2025)
- VS-IMSRG(2) and $e_{\max} = 12$
- In our model:
  - Include additional uncertainties
  - Condition on experimental data



Error model

- Assume **independent normally distributed errors**

$$\mathcal{N}(\mu, \Sigma) = \mathcal{N}(\mu_0, \Sigma_0) + \sum_i \mathcal{N}(\Delta\mu_i, \Sigma_i)$$

- Systematic shift (Fit for NI from Ca isotopes) Stroberg et al. PRL (2021)

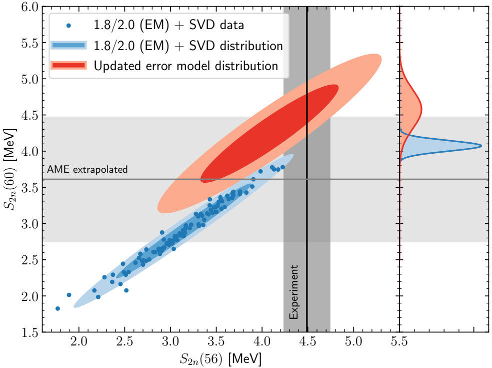
$$\delta S_{2n}(A) = S_{2n}^{\mathrm{th}}(A) - S_{2n}^{\mathrm{exp}}(A) = aS_{2n}^{\mathrm{th}}(A) + b$$

- Include **experimental data** by taking conditional probability

$$p(S_{2n} \mid S_{2n,\mathrm{exp.}}) = \frac{p(S_{2n}, S_{2n,\mathrm{exp.}})}{p(S_{2n,\mathrm{exp.}})}$$

Error model example

- Two-dimensional distribution for ^{56}Ca and ^{60}Ca
- Error model gives **updated prediction** accounting for various sources of uncertainty
- Good agreement with AME 2020
  Meng, et al. CPC (2021)
- Additional uncertainties:
  - Model-space uncertainty (e_{max})
  - Many-body truncations
- Details see poster

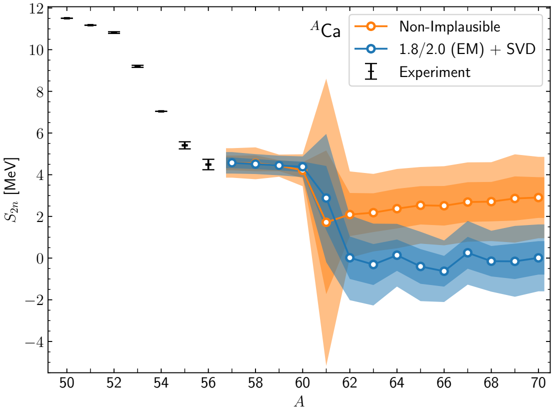


Results for Ca isotopic chain

- Experimental data for even S_{2n} $^{50-56}$Ca $\rightarrow$ **predictions** for neutron-rich Ca isotopes
- **Neutron dripline** between ^{62}Ca and ^{70}Ca
- Largest uncertainty from:

  interaction distribution (Non-implausible)

  interaction systematics (1.8/2.0 (EM) + SVD)
- Limited by number of calculations per nucleus



Summary & Outlook

- Statistical error model based on ab initio calculations
- Various sources of uncertainty
- Predictions for S_{2n} of neutron rich Ca isotopes
- Need efficient emulators for IMSRG calculations
  - Validate underlying assumptions (independence of uncertainties)
  - Application to heavy nuclei
- Propagation of uncertainties to astrophysical applications see, e.g., Kuske et al. arXiv:2509.19131 (2025)