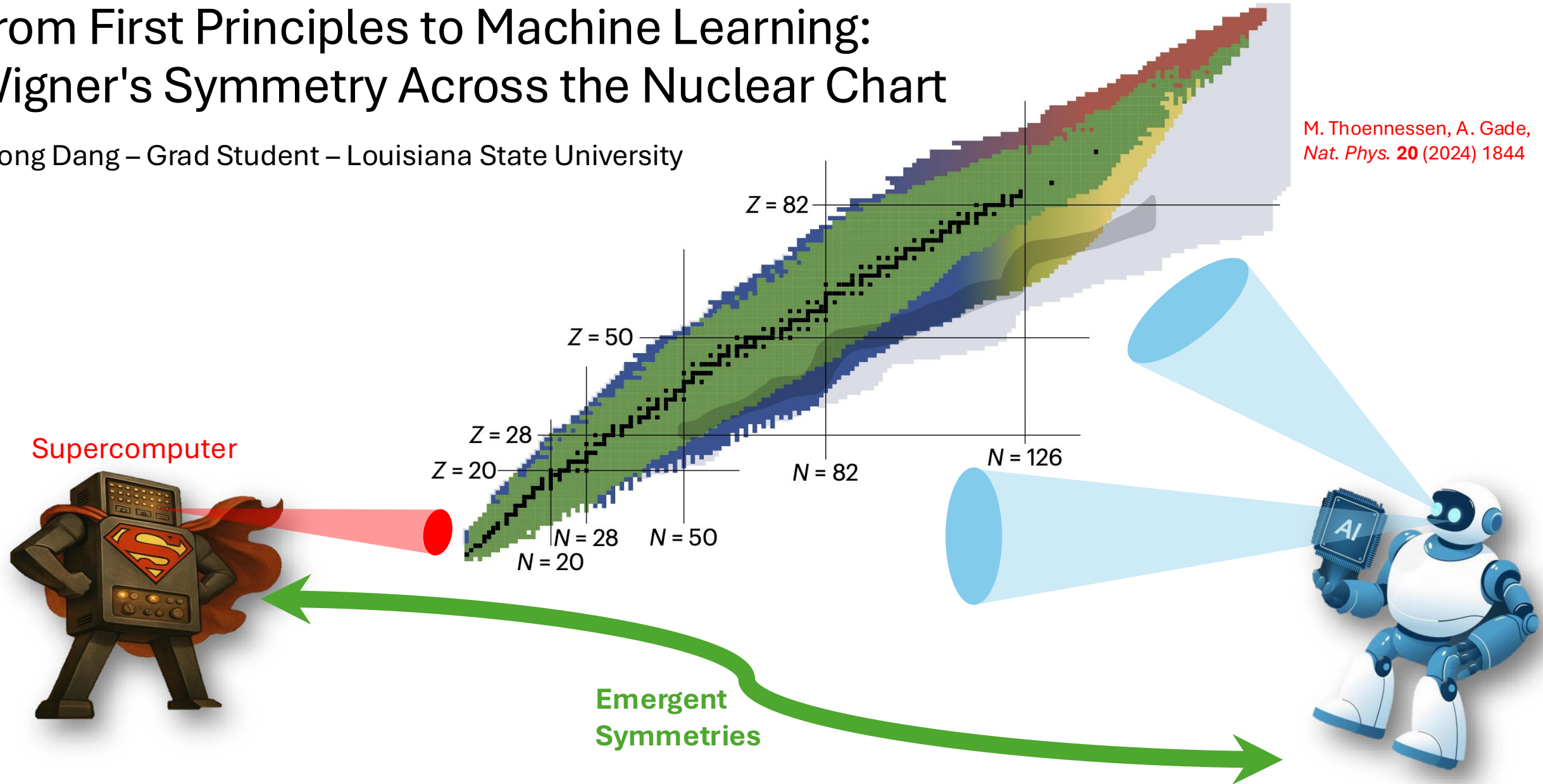


# From First Principles to Machine Learning: Wigner's Symmetry Across the Nuclear Chart

Phong Dang – Grad Student – Louisiana State University

M. Thoennessen, A. Gade,  
*Nat. Phys.* **20** (2024) 1844



# Wigner's Supermultiplet Symmetry

- Nuclear forces depend on “space coordinates alone”

E.P. Wigner, *Phys. Rev.* **51** (1937) 106; **56** (1939) 519

- Emerge from the strong interaction at large  $N_c$  limit

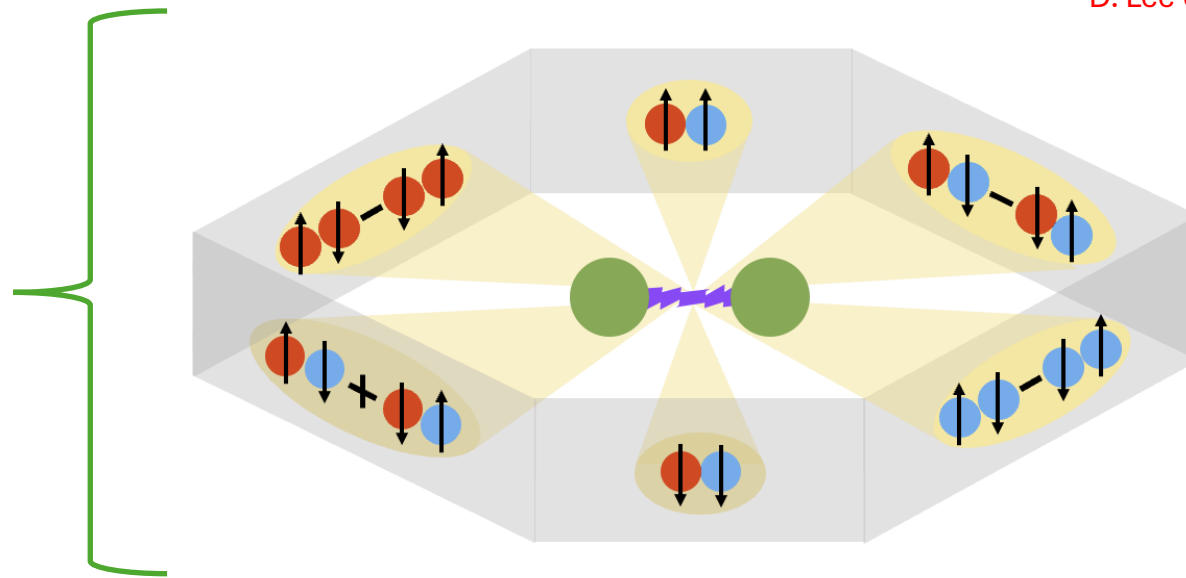
D.B. Kaplan and M.J. Savage, *PLB* **365** (1996) 244

D.B. Kaplan and A.V. Manohar, *PRC* **56** (1997) 56

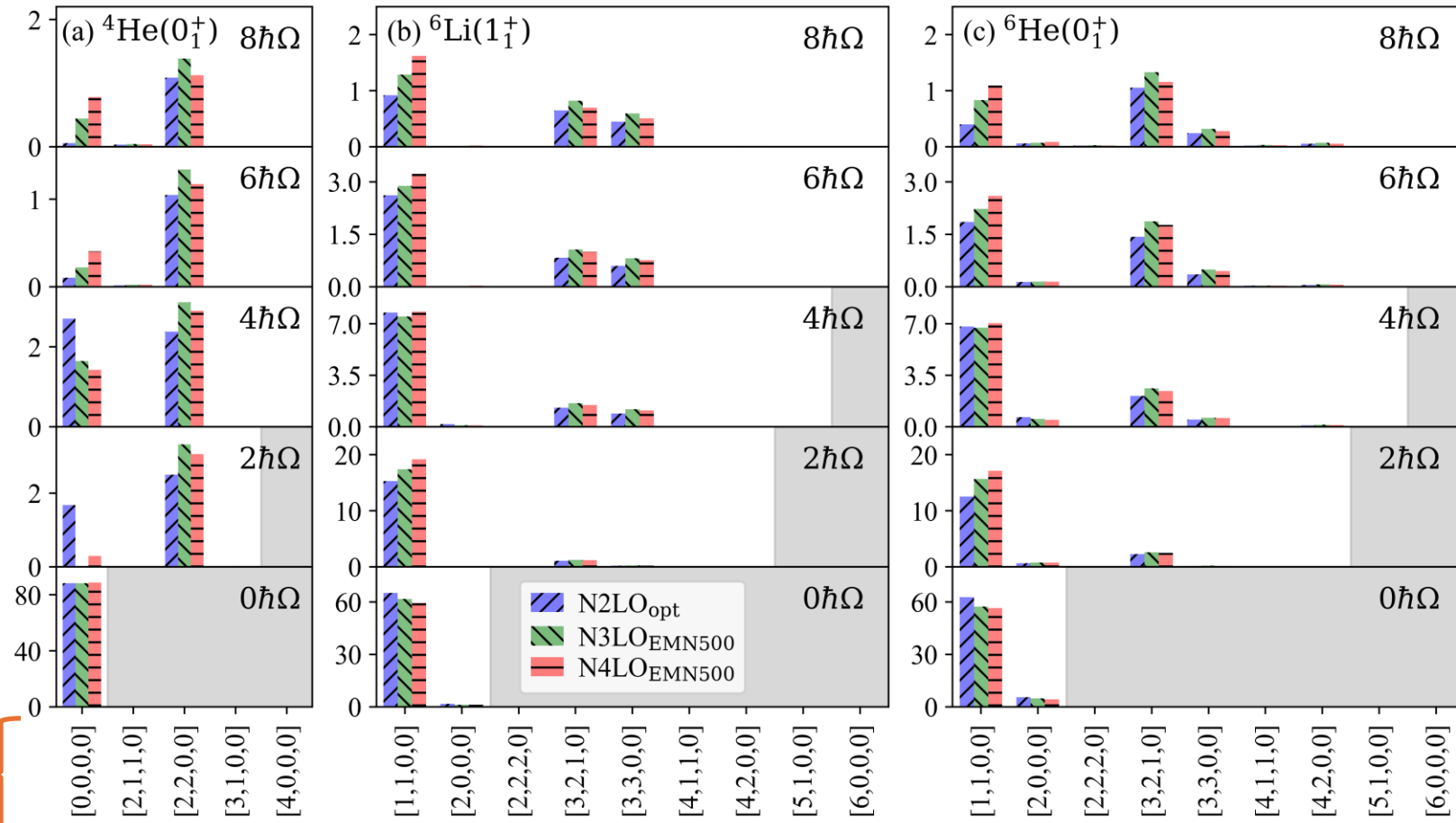
D. Lee et al, *PRL* **127** (2021) 062501

Two-nucleon  
s-wave channels:

- pp, nn:  $^1S_0$
- np:  $^1S_0$  and  $^3S_1$



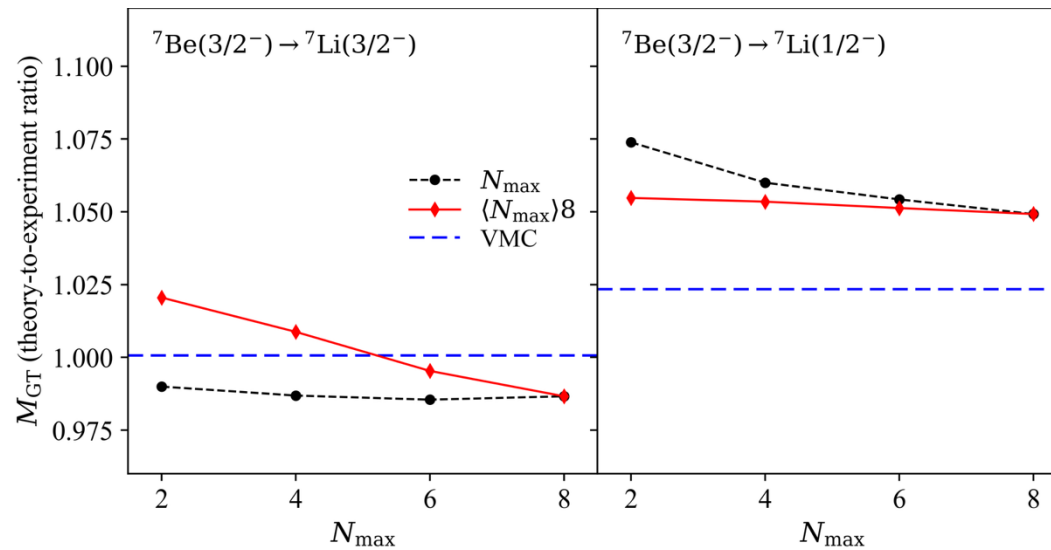
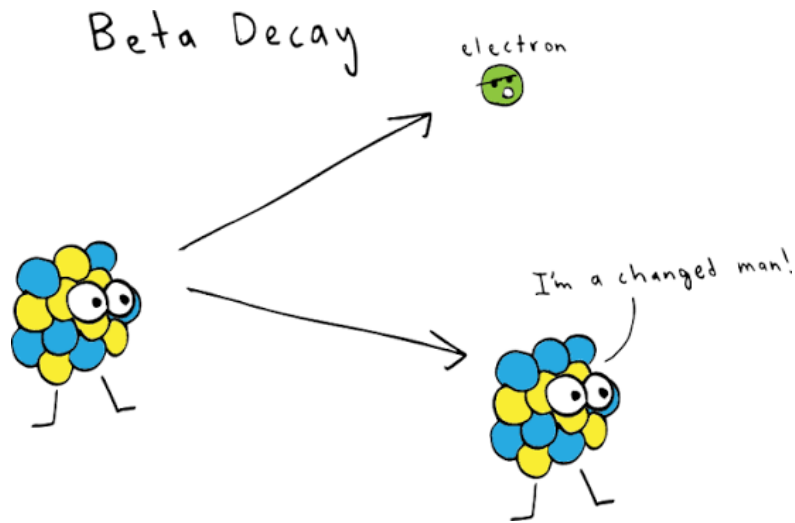
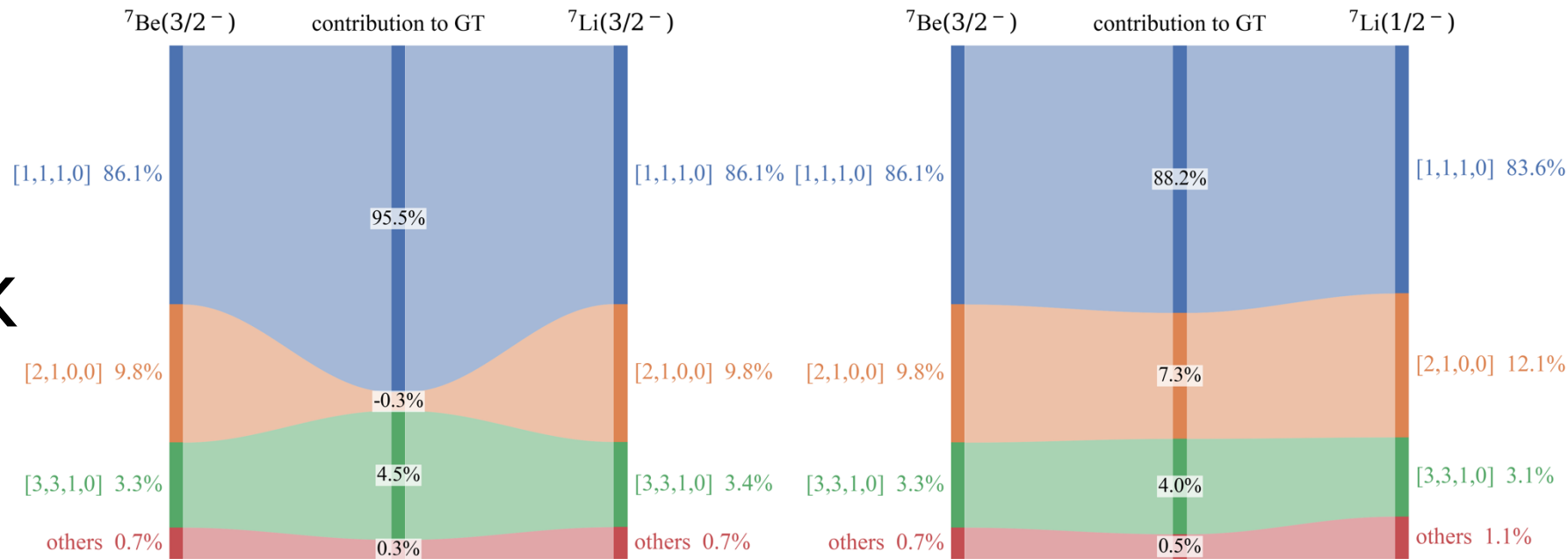
# Dominating nuclear structure



Quantum numbers  
representing  
Wigner's symmetry  
in wave functions



# Governing electroweak processes



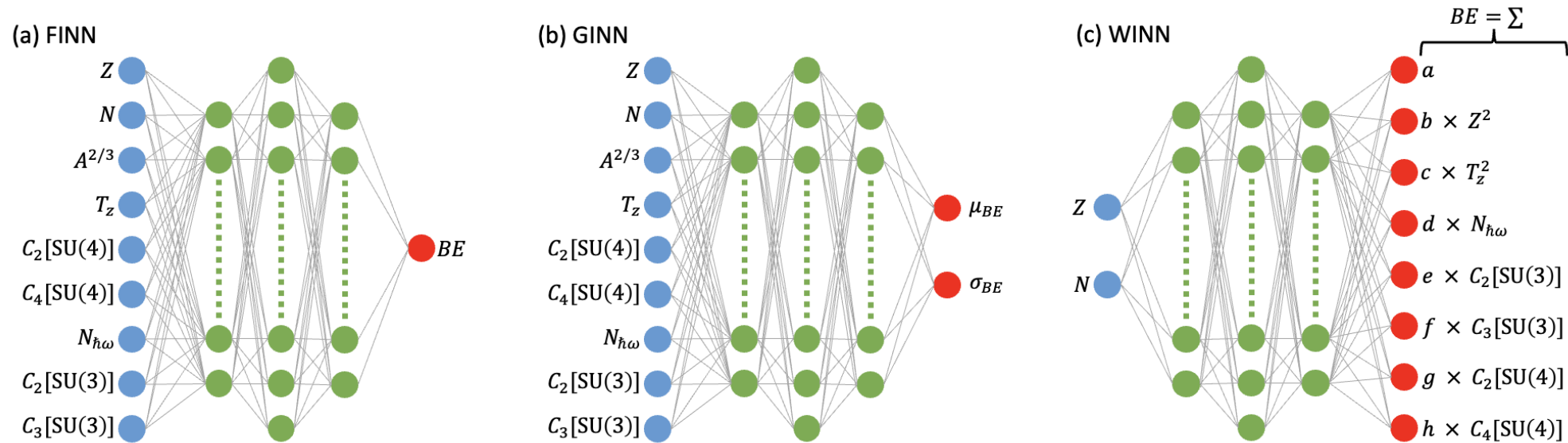
${}^7\text{Be}$  and  ${}^7\text{Li}$  wave functions are computed with EM1.8/2.0 interaction, including 3B forces through NO2B approximation with IMSRG code (Ragnar Stroberg's and Andre Johnson's talks)



# Influencing nuclear binding

Mass database:

- AME2016: Train (80%), Test (20%)
- New in AME2020: Validation



Feature set	FINN			GINN			WINN		
	Train	Test	Validation	Train	Test	Validation	Train	Test	Validation
LDM	0.944	1.111	1.270	0.869	1.149	1.304			
LDM+SU(4)	0.521	0.588	1.024	0.604	0.654	1.046			
LDM+SU(3)	0.915	1.306	1.603	1.036	1.404	1.280			
LDM+SU(4)+SU(3)	<b>0.411</b>	<b>0.552</b>	<b>0.624</b>	<b>0.400</b>	<b>0.488</b>	<b>0.793</b>	<b>0.400</b>	<b>0.447</b>	<b>0.430</b>



# Unmasking Hidden Wigner's Symmetry from First Principles

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<sup>4</sup>*Nuclear Physics Institute, Academy of Sciences of the Czech Republic, Řež, 25068, Czech Republic*

**Both are available on arXiv**

## Bridging *Ab Initio* Symmetries and Global Nuclear Masses with Interpretable Neural Networks

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