LOUISIANA STATE UNIVERSITY

BLUE WATERS SUSTAINED PETASCALE COMPUTING

NERSC

Dominant features of nuclei from the ab initio symmetry-adapted no-core shell model

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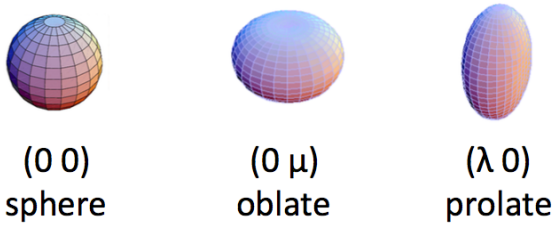
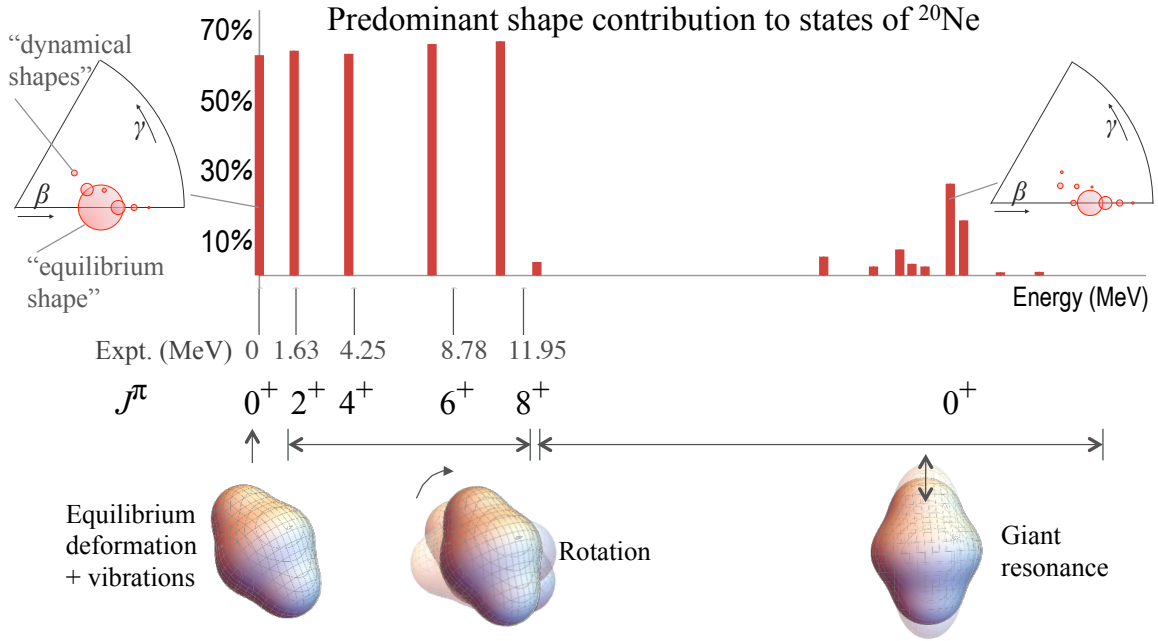
Symmetry-adapted no-core shell model (SA-NCSM)

Collective basis based on deformation and vibrations plus rotations

symmetry-adapted → SU(3)

symmetry-adapted → Sp(3,R)

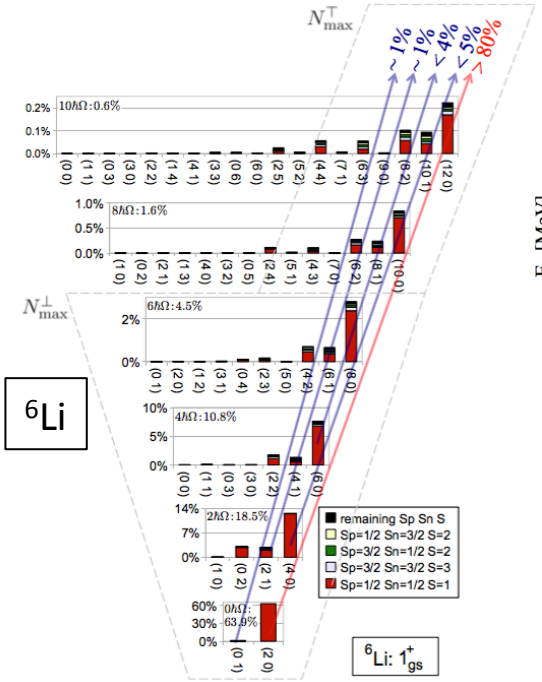




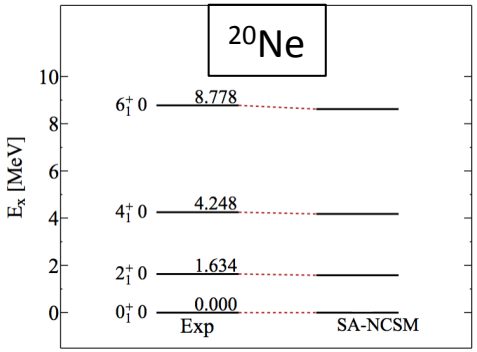
Realistic interactions have a preference for a small subset of possible basis states (an emergent symmetry).

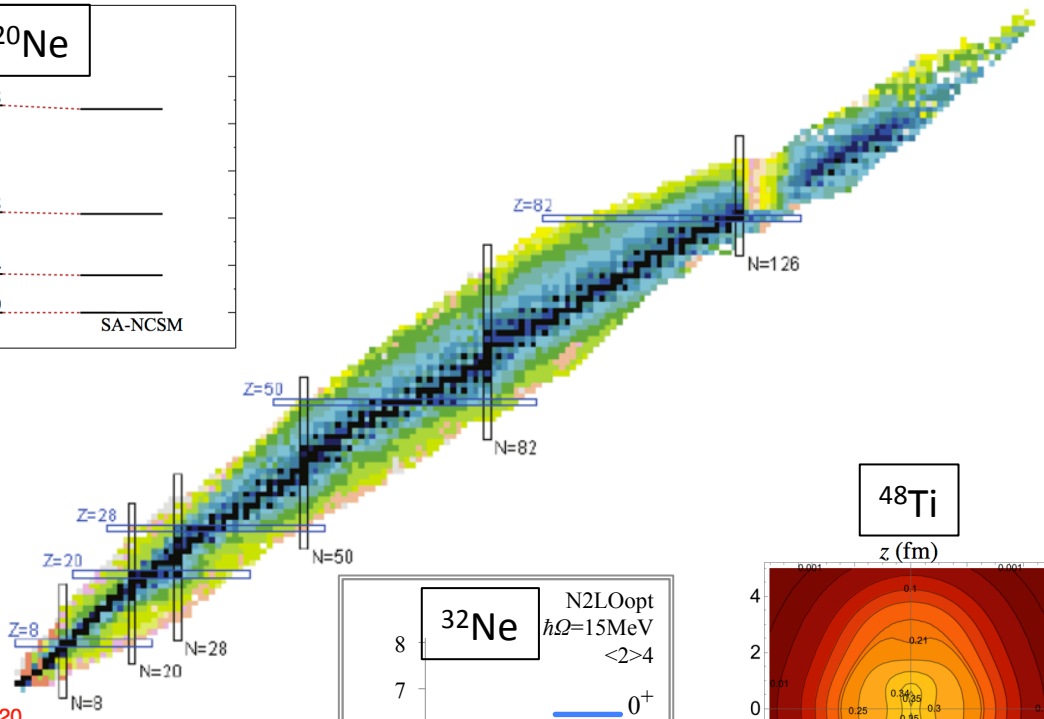
T. Dytrych et al., arxiv:1810.05757

Symmetry-adapted no-core shell model (SA-NCSM)

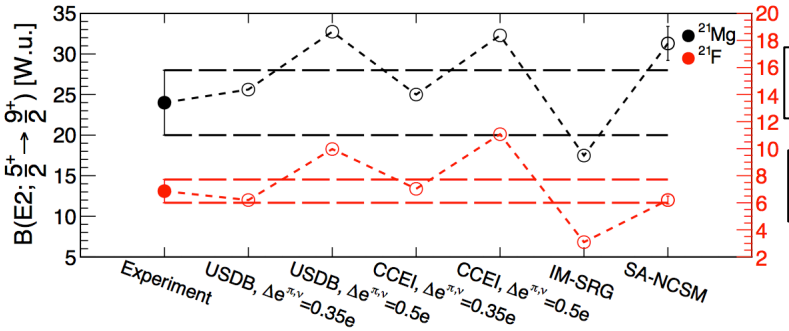


^{6}Li





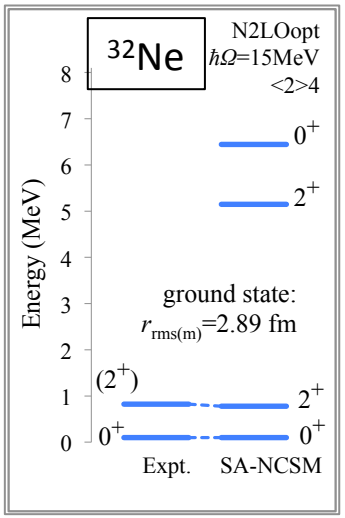
K.D. Launey et al., Prog. Part. Nucl. Phys. **89** (2016) 101

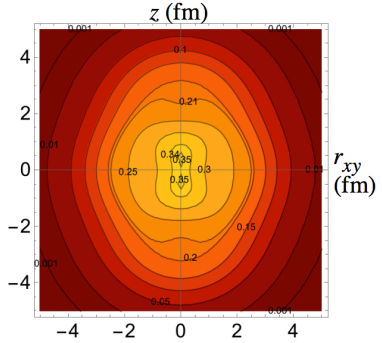


^{21}Mg

^{21}F

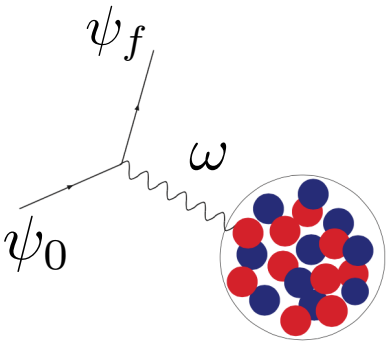
P. Ruotsalainen et al., arxiv:1811.00774

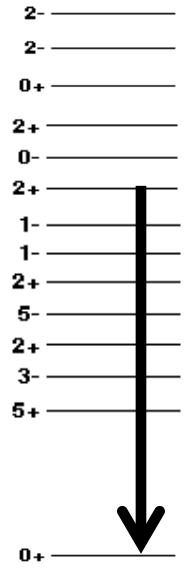


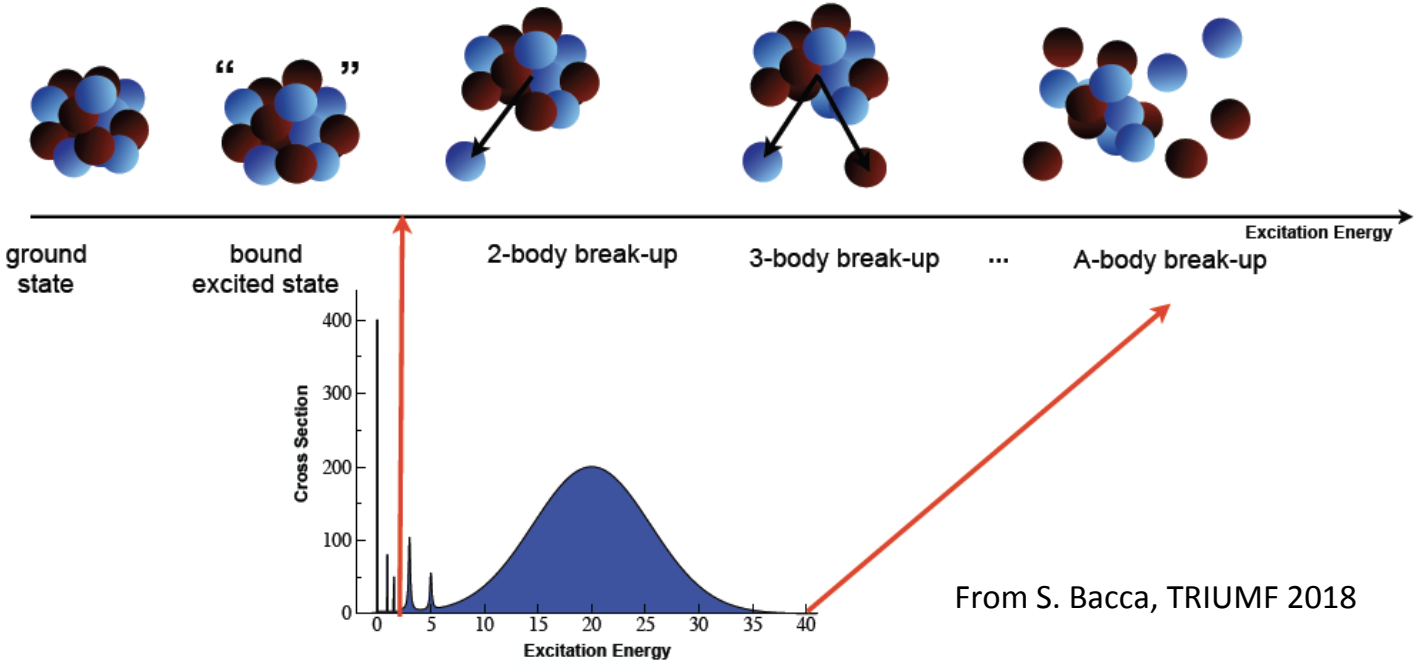


K.D. Launey et al., doi:10.1063/1.5078823

The continuum





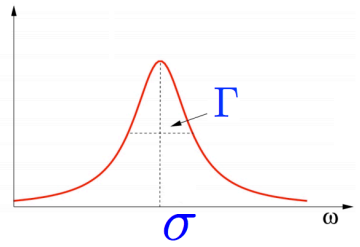


From S. Bacca, TRIUMF 2018

response function

$$R(\omega) = \sum_f \left| \langle \psi_f | \hat{O} | \psi_0 \rangle \right|^2 \delta(E_f - E_0 - \omega)$$

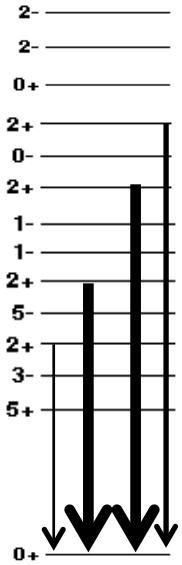
Lorentz integral transform method (LIT)



$$L(\sigma,\Gamma) = \frac{\Gamma}{\pi}\int d\omega \frac{R(\omega)}{(\omega-\sigma)^2+\Gamma^2}$$

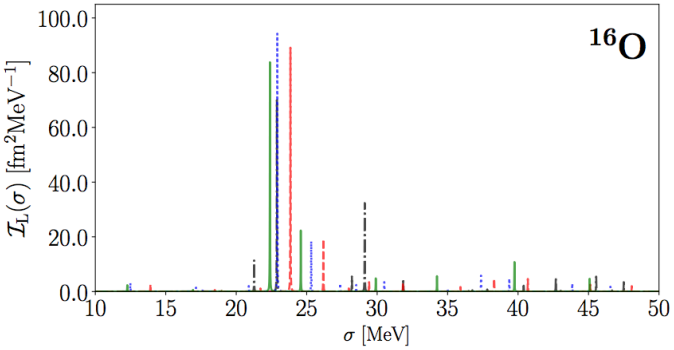
sum rules

$$m_n = \int d\omega\, \omega^n\, R(\omega)$$



discretized response

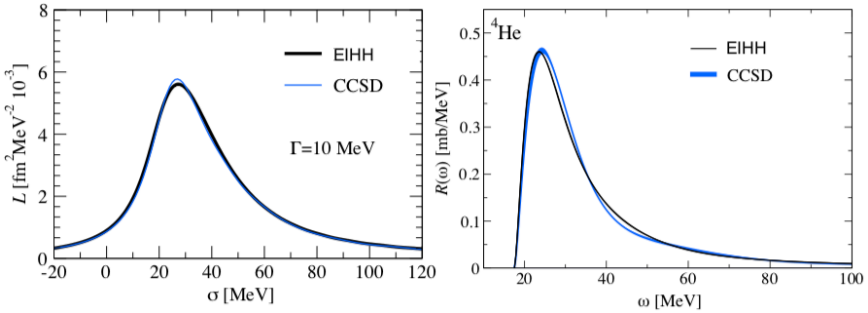
$$L(\sigma,\Gamma\to 0) = \int d\omega\, R(\omega)\delta(\omega-\sigma) = R(\sigma)$$



Miorelli et al., PRC **98** 014324 (2018)

inverting the LIT

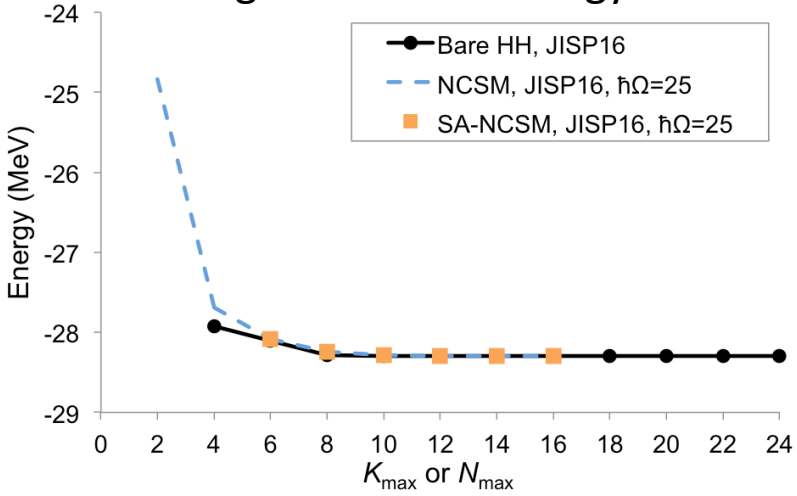
$$L(\sigma,\Gamma) \longrightarrow R(\omega)$$



Bacca et al., PRL **111** 122502 (2013)

Sum rules: Benchmark calculations

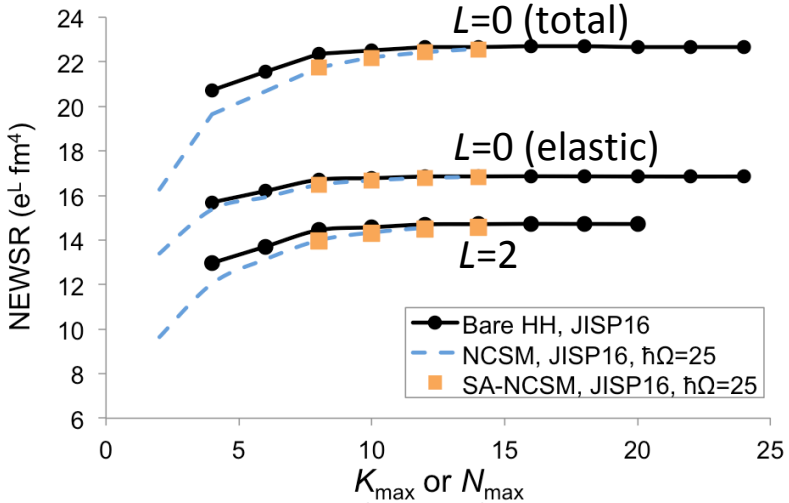
^{4}He ground state energy



Preliminary

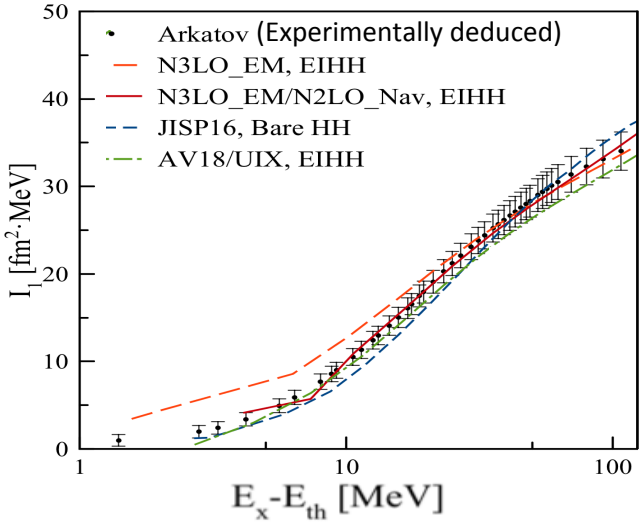
	JISP16		
	HH	NCSM	SA-NCSM
	Monopole $L=0$		
m_0	22.7	23.1±0.3	22.9±0.2
m_1	150.4	154±3	147±6
m_{-1}	0.25	0.30±0.03	0.27±0.02
	Dipole $L=1$		
m_0	0.86	0.88±0.02	0.865±0.007
m_1	41.35	44±3	44±3
m_{-1}	0.023	0.021±0.005	0.021±0.005

Non-energy weighted sum rules



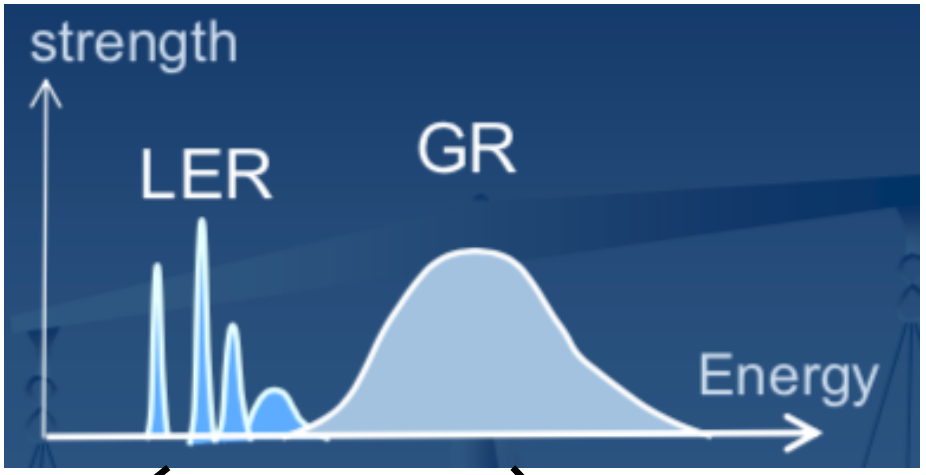
Baker et al., arXiv:1812.07787

Energy weighted sum rule

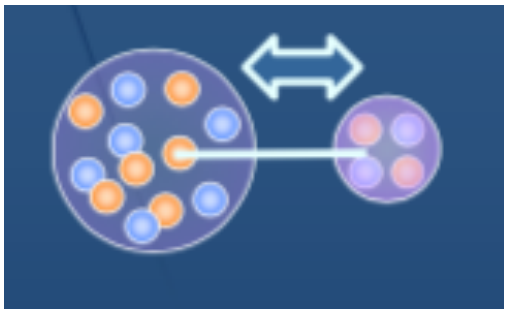


Response functions

Can be used to probe cluster structures from an ab initio perspective.



Y. Kanada-En'yo, WNCP 2017

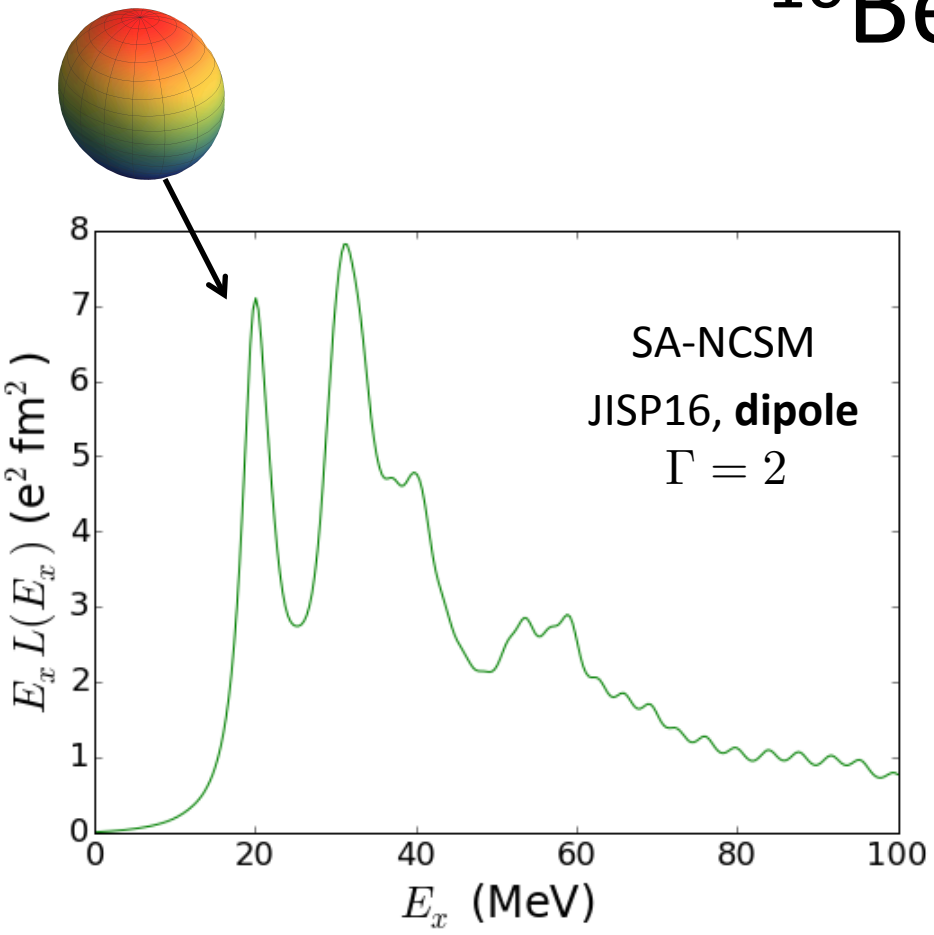


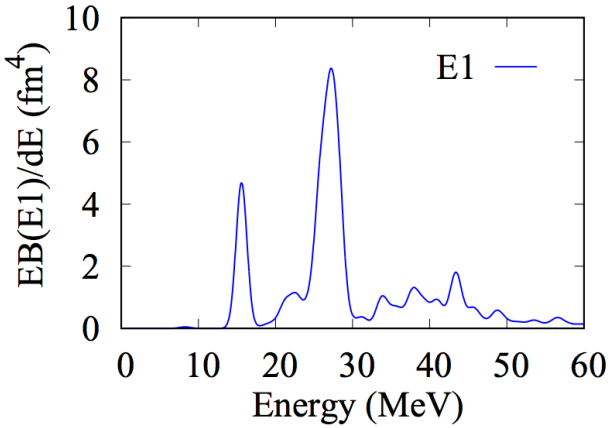
inter-cluster motion

collective motion

^{10}Be

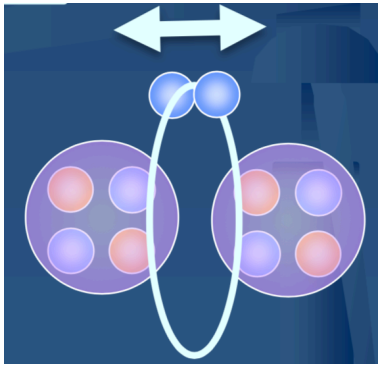
SA-NCSM allows us to examine the underlying shape and dynamics





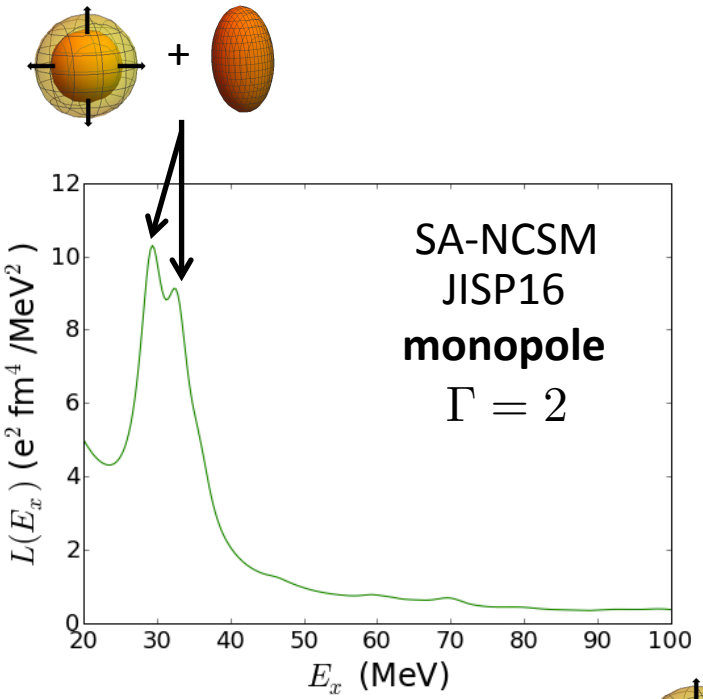
Y. Kanada-En'yo, PRC **93** 024322

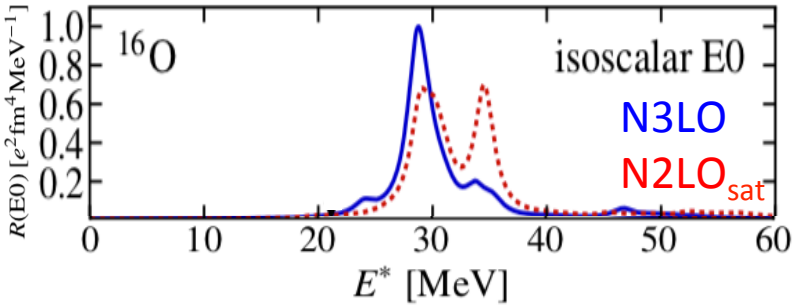
Lowest 1^- does not contribute to E1 strength



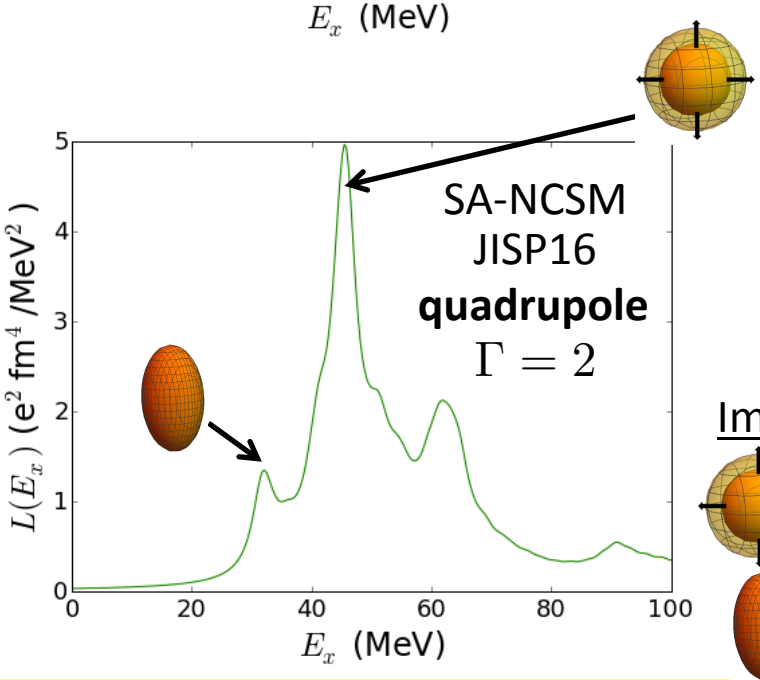
^{16}O

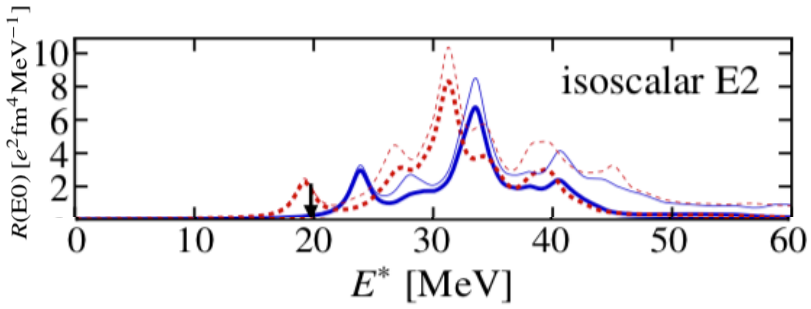
SA-NCSM allows us to examine the underlying shape and dynamics





Stumpf et al., arXiv:1709.06840





Important results

- describes giant monopole/quadrupole resonance: 1p-1h vibration of the spherical ground state

- deformed 2p-2h configuration (third 0^+)

Thanks!