TRIUMF

Canada’s national laboratory for particle and nuclear physics
Laboratoire national canadien pour la recherche en physique nucléaire
et en physique des particules

Electric dipole polarizability for medium-heavy nuclei

Mirko Miorelli | TRIUMF – UBC

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G. Orlandini, T. Papenbrock

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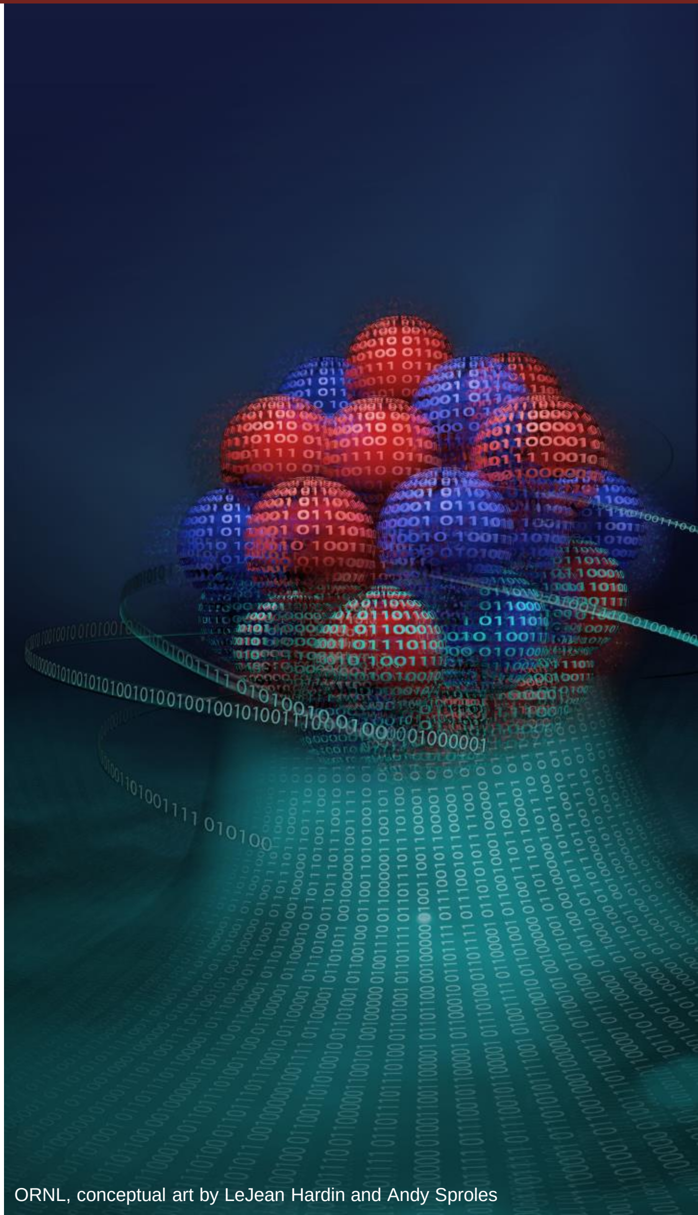
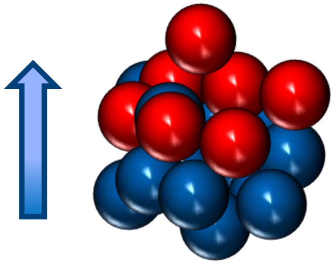
UBC a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA


ORNL, conceptual art by LeJean Hardin and Andy Sproles

Electric dipole polarizability

$$\alpha_D = 2\alpha \int \frac{R(\omega)}{\omega} d\omega$$

E



$$D = \alpha_D E$$

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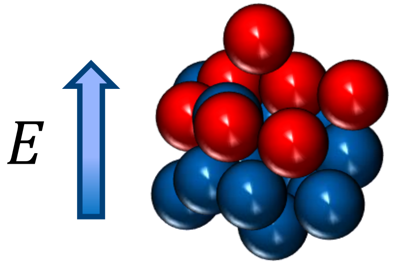
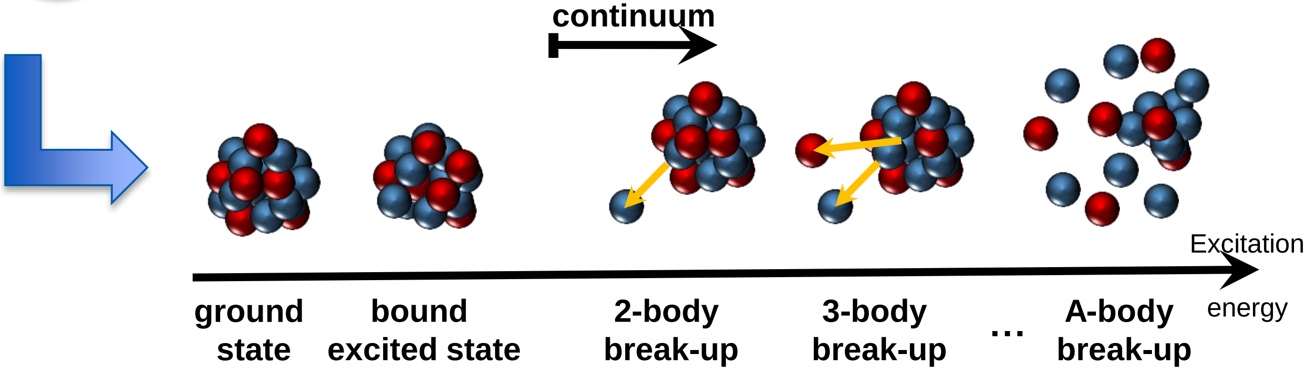


$$D = \alpha_D E$$

$$R(\omega) = \sum_f \left| \langle \Psi_f | D | \Psi_0 \rangle \right|^2 \delta(\omega - E_0 - E_f)$$



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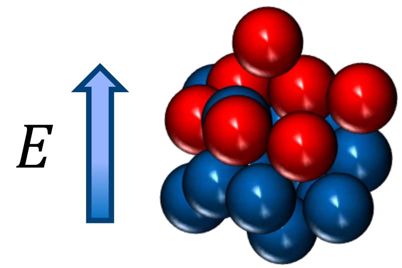

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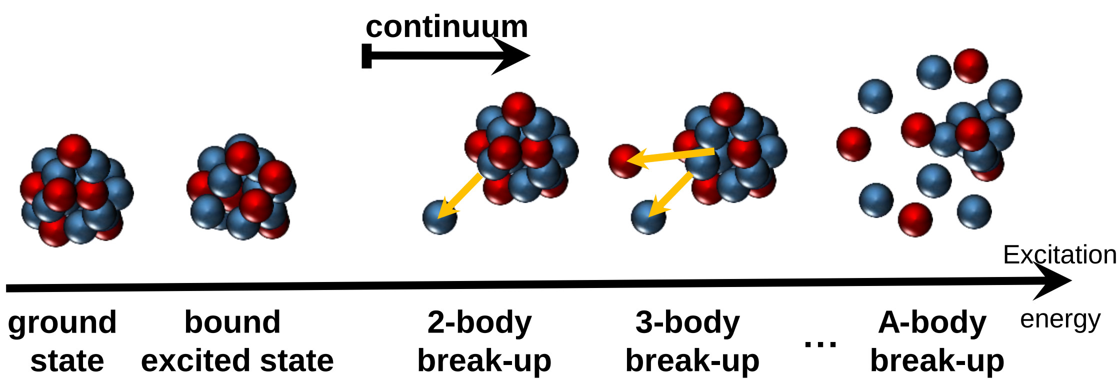

- Continuum problem

- Integral transforms
  Reduce the continuum problem to a bound-state one

Integral transforms

$$R(\omega) = \sum\!\!\!\!\!\!\!\int_f |\langle \Psi_f | D | \Psi_0 \rangle|^2 \delta(\omega - E_0 - E_f)$$

Calculate integral transform (Lorentz integral transform for example)

Inversion

$$\mathcal{L}(\{\sigma_i\}) = \int K(\{\sigma_i\}, \omega) R(\omega) d\omega = \langle \tilde{\Psi} | \tilde{\Psi} \rangle$$

$|\tilde{\Psi}\rangle$ is the solution of a bound-state many-body equation

Use a bound-state technique (coupled cluster theory)

Technical details in the poster

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Results with 3NF

$$\alpha_D = 2\alpha \int \frac{R(\omega)}{\omega} d\omega$$

α_D is sensitive to the dipole strength at low energy, thus can be used to study neutron-rich nuclei

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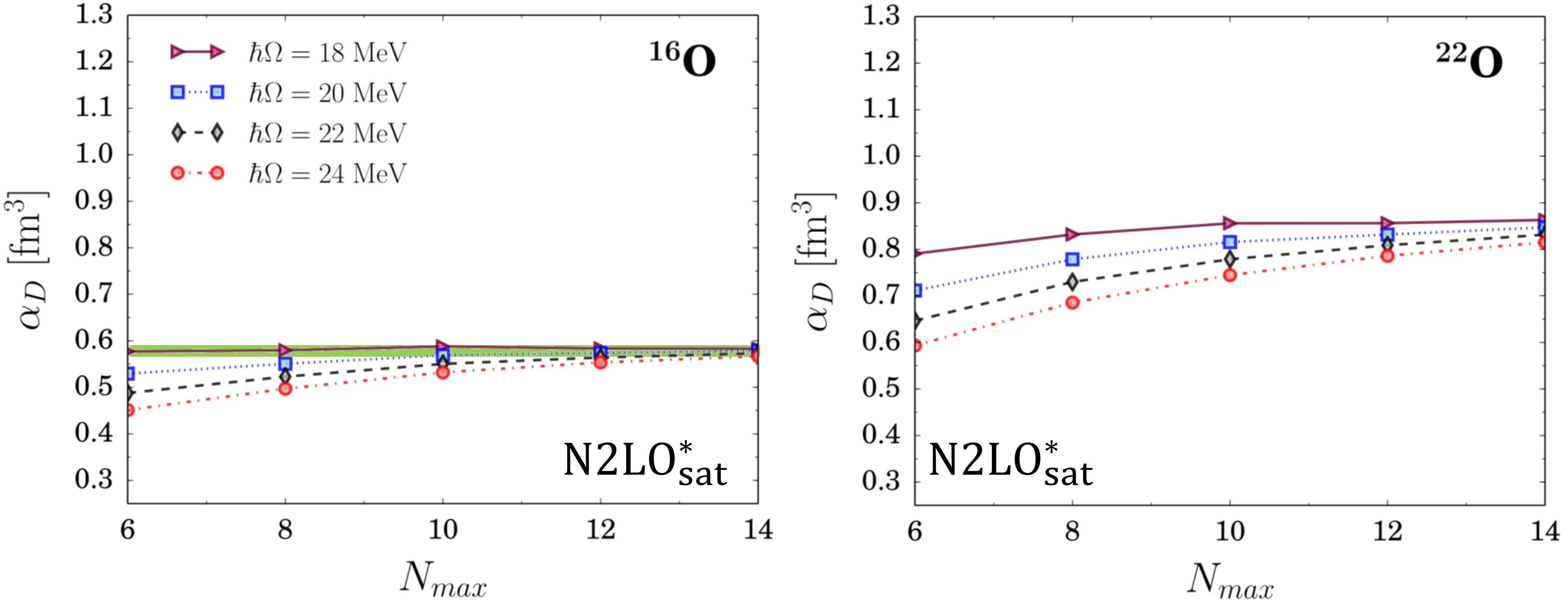
M.M. *et al*, in preparation.



$$\alpha_D(^{16}O) < \alpha_D(^{22}O)$$

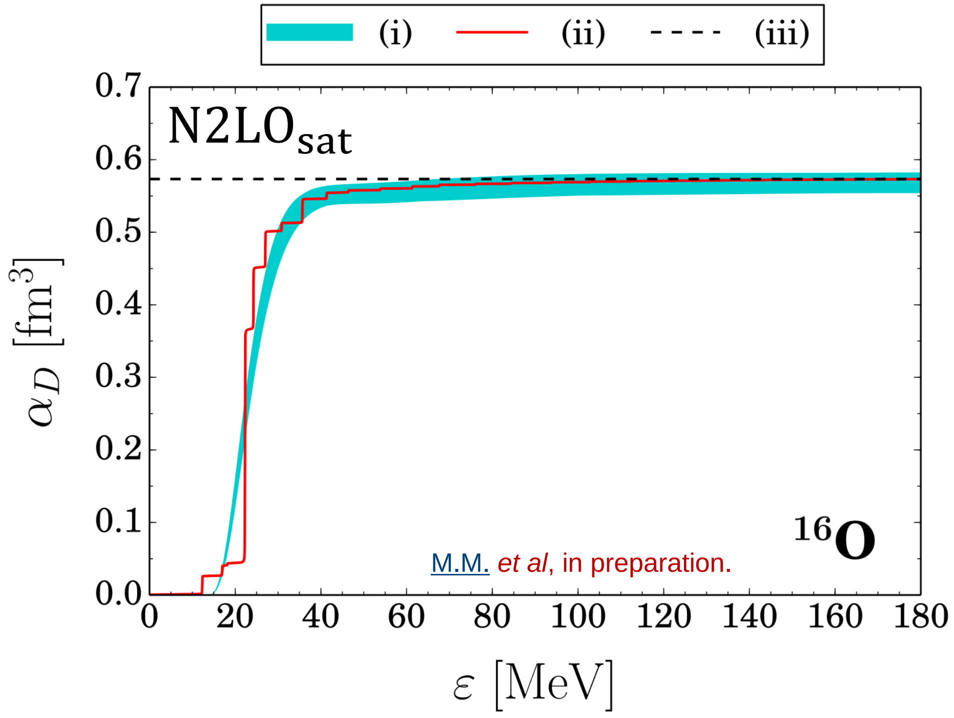
Low energy dipole strength, indication of a pigmy dipole resonance in ^{22}O as observed experimentally at GSI from Leistenschneider *et al.* [Phys. Rev. Lett. 86, 5442 (2001)]

* A. Ekström *et al*., Phys. Rev. C91, 051301 (2015)

Energy dependent polarizability

$$\alpha_D(\varepsilon) = 2\alpha \int_0^{\varepsilon} \frac{R(\omega)}{\omega} d\omega$$

Polarizability as a function of the upper integration limit



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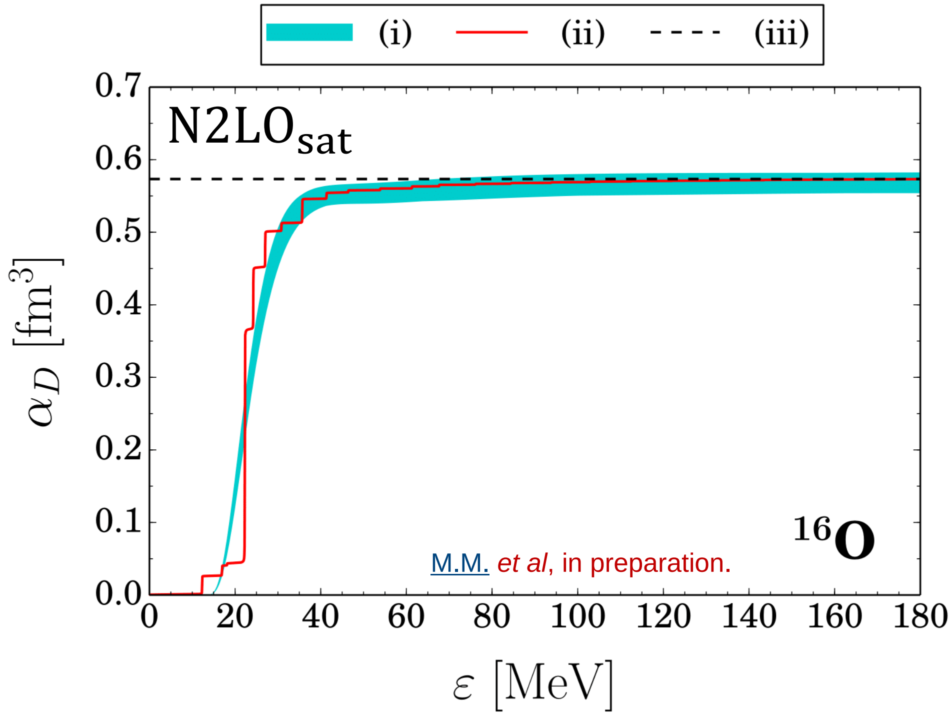

- Different methods show agreement
- More details on the poster

Useful to compare calculations with experimental data which are usually only available to the low-energy region

Correlations

A tool to estimate the uncertainty in the calculations arising from the incomplete knowledge of the nuclear Hamiltonian

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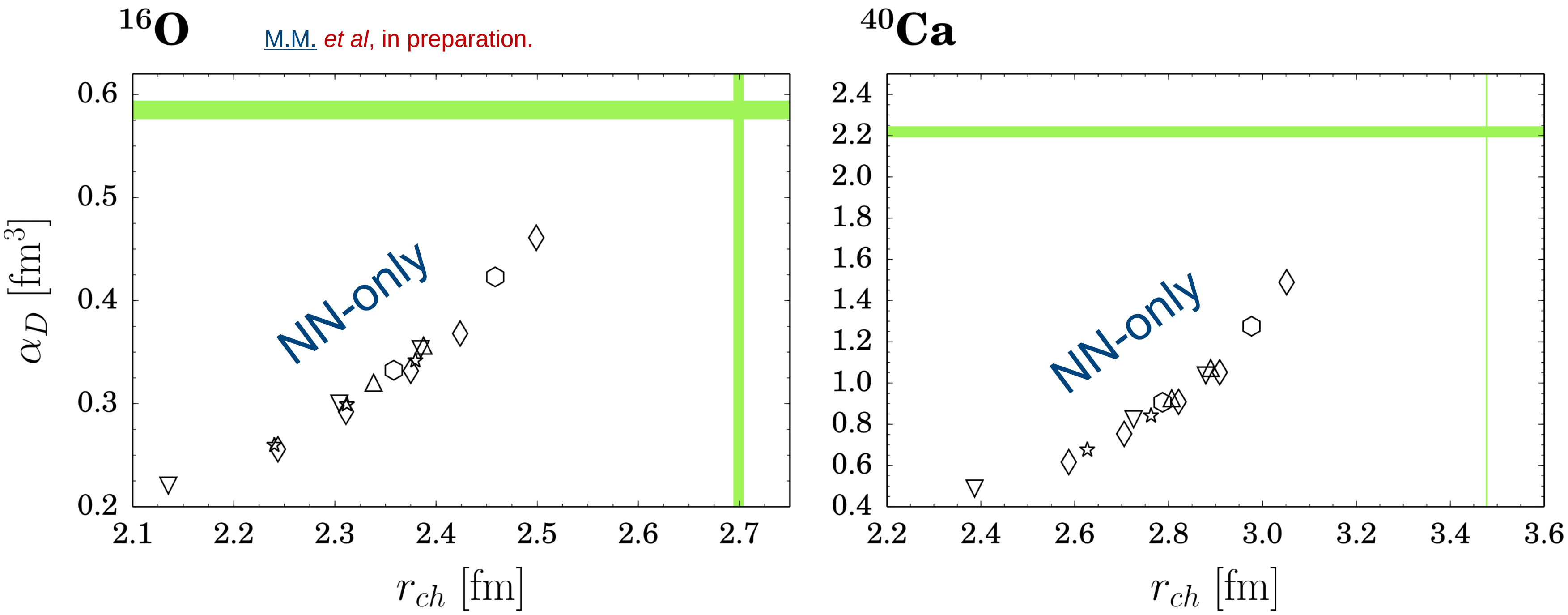

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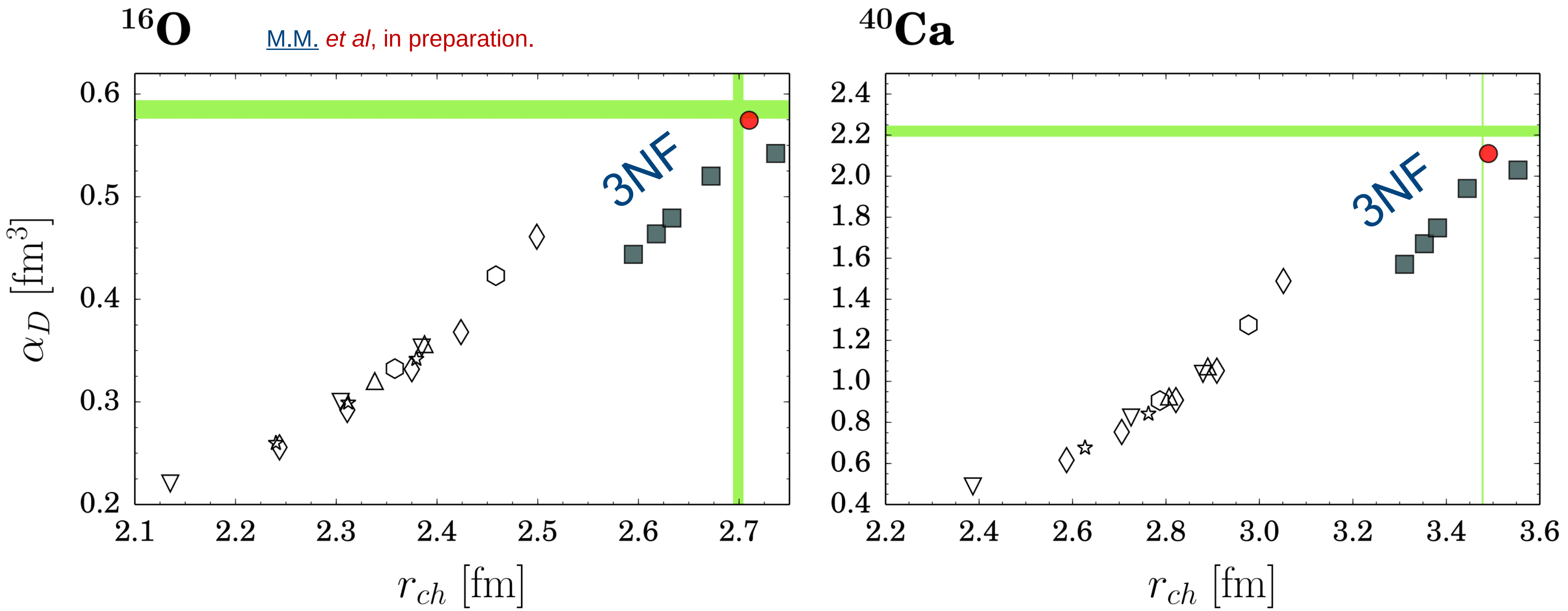


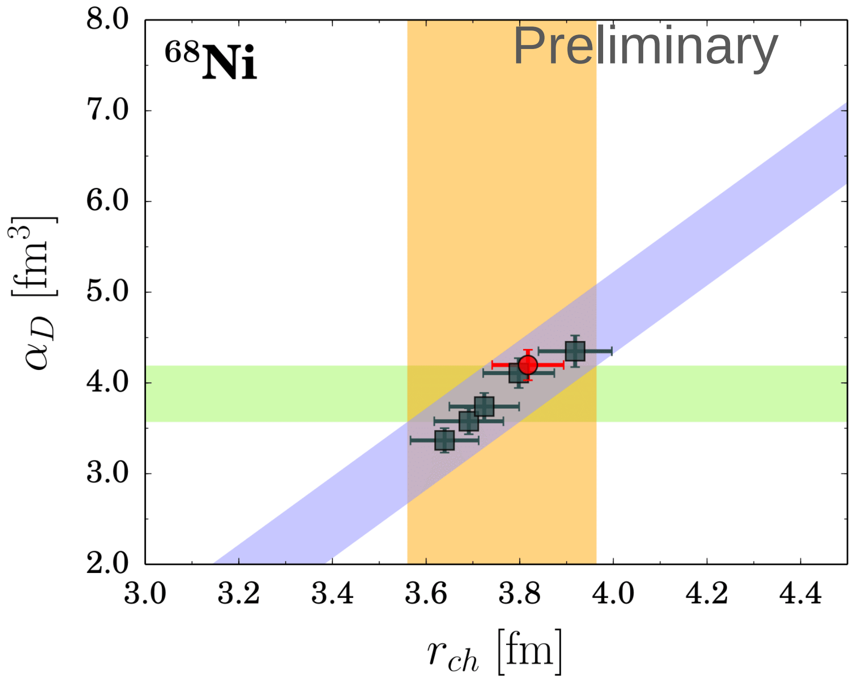
● A. Ekström *et al.*, Phys. Rev. C91, 051301 (2015)

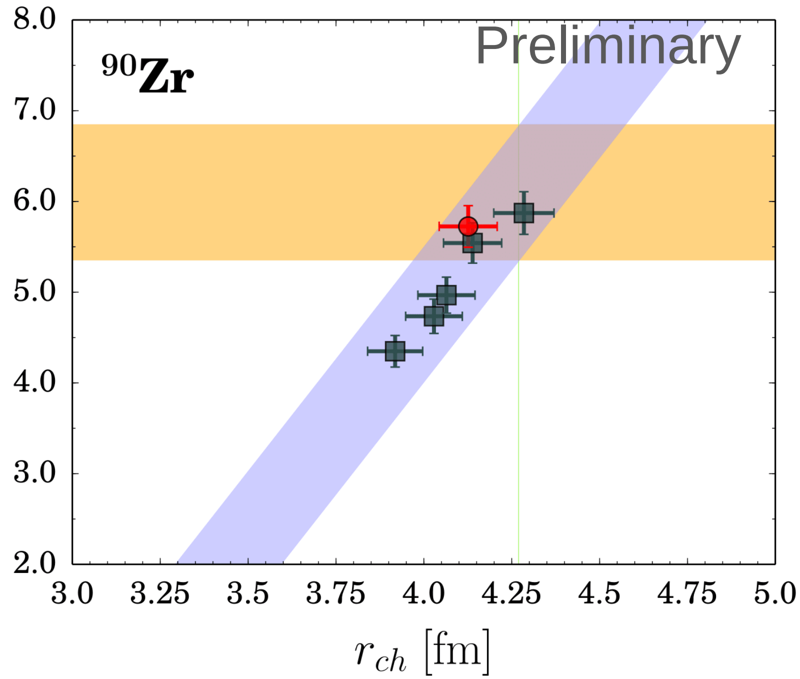
■ K. Hebeler *et al.*, Phys. Rev. C83, 031301 (2011)

Same interactions used for ^{48}Ca (Nature Physics 12, 186–190 (2016))

Towards heavier nuclei…

Correlations can be used to predict observables





Charge radius of ^{68}Ni is not know experimentally

$$r_{ch}^{exp}(^{64}\text{Ni}) = 3.86\text{ fm}$$

Attempt to measure α_D at TRIUMF for ^{90}Zr

$$\alpha_D^{DFT} \approx 5.65 fm^3$$

Summary

Come to visit my poster….

Thank you!