

Two-neutron transfer: shape phase transitions and coexistence

José Antonio Lay¹, P. Jodidár^{1,2}, L. Fortunato², A. Vitturi²

(1) Universidad de Sevilla

(2) Universita degli Studi di Padova & INFN

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1 Motivation

2 Quantum Phase Transition (QPT): Sm

3 QPT driven by shape-coexistence: Zr

4 Conclusions

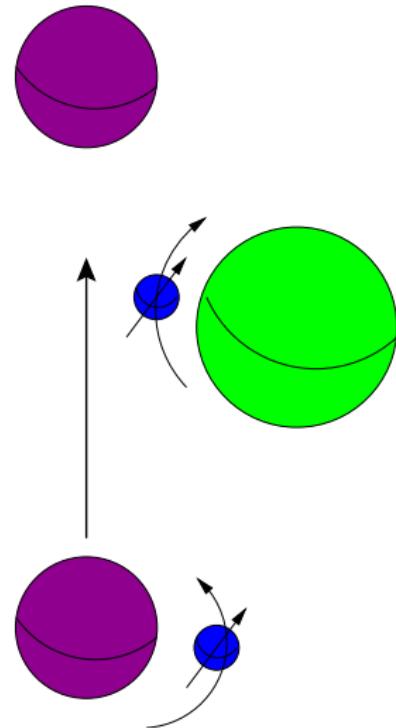
Motivation

⇒ One and two-neutron transfer is a subtle peripheral process

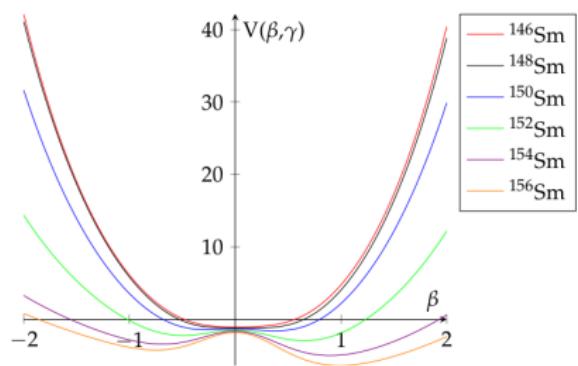
- ✗ small cross sections
- ✓ selectivity



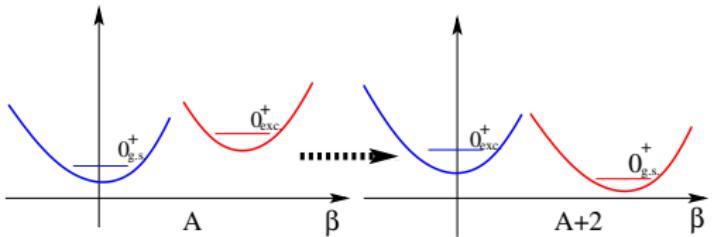
⇒ A and $A + 2$ nuclei should present similar deformations ⇒ good for shape-phase transitions



⇒ Shape-phase transition



⇒ Transition driven by
Shape Coexistence

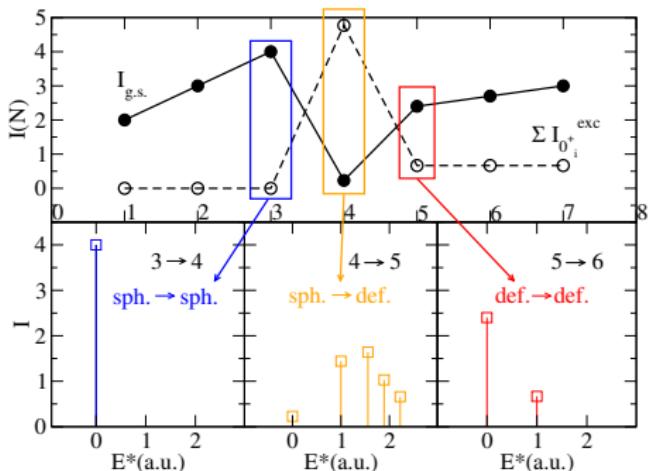


Let start from IBM as a benchmark model for considering all possible deformations

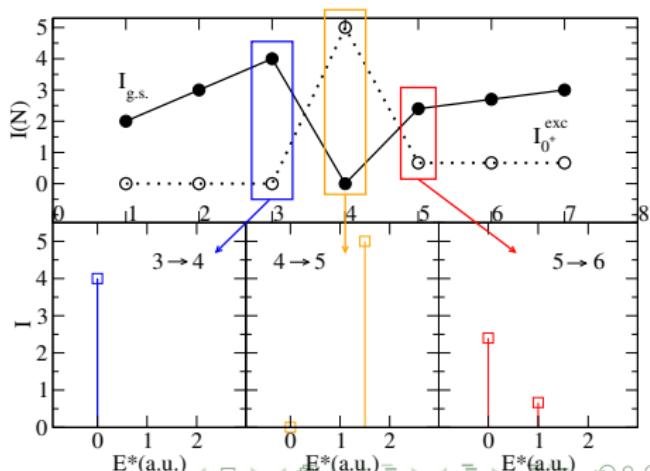
⇒ Fossion et al. PRC76, 014316 (2007), Two neutron transfer intensities:

$$I(N, i \Rightarrow N+1, j) = |\langle N+1, 0_j^+ | P^+ | N, 0_i^+ \rangle|^2$$

Normal QPT scenario

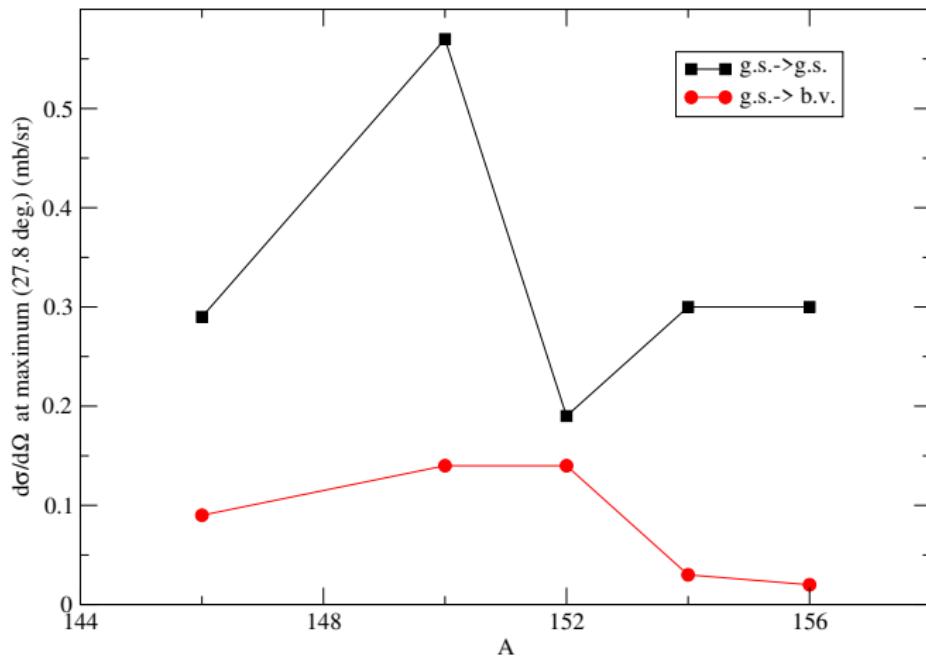


QPT within Shape Coexistence scenario



Sm as a well-known case of QPT

$^{A-2}\text{Sm}(t,p)^A\text{Sm}$ @ 12 MeV tritons



J. H. Bjerregaard *et al.* Nucl. Phys. 86 (1966) 145

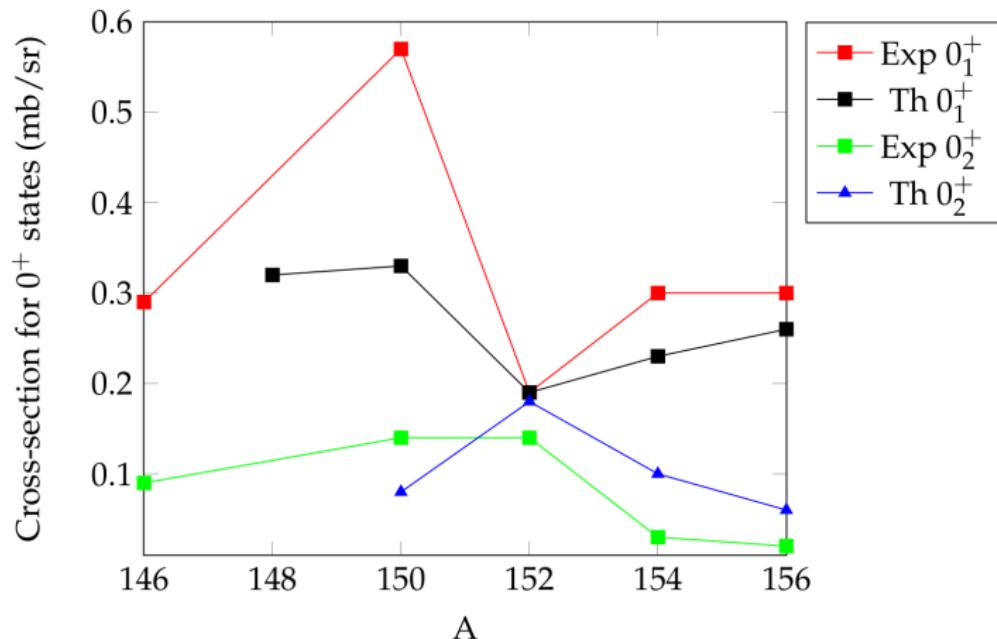
Some problems with IBM

IBM1 calculations with parameters from PRC56 (1997) 829

- ✗ We need information about the orbital
- ⇒ Therefore we **fit one** reaction to data and keep relative strengths to look at the **rest** of isotopes

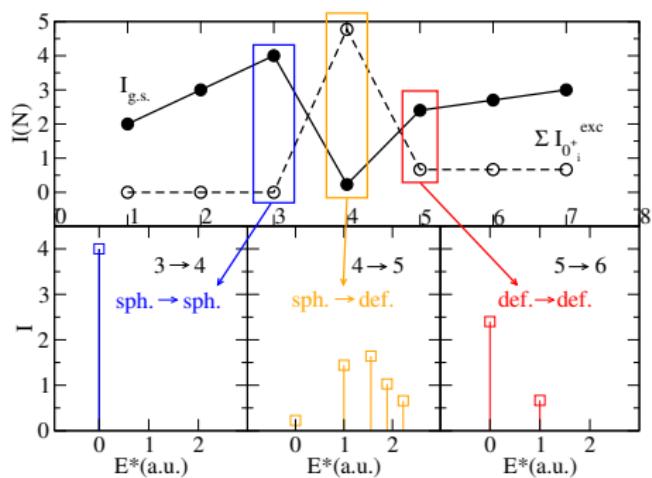
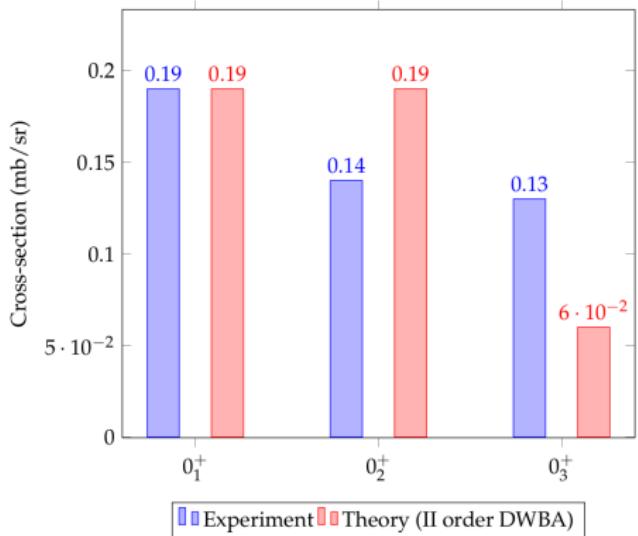
Sm as a well-known case of QPT

$$^{A-2}\text{Sm}(t,p)^A\text{Sm}$$

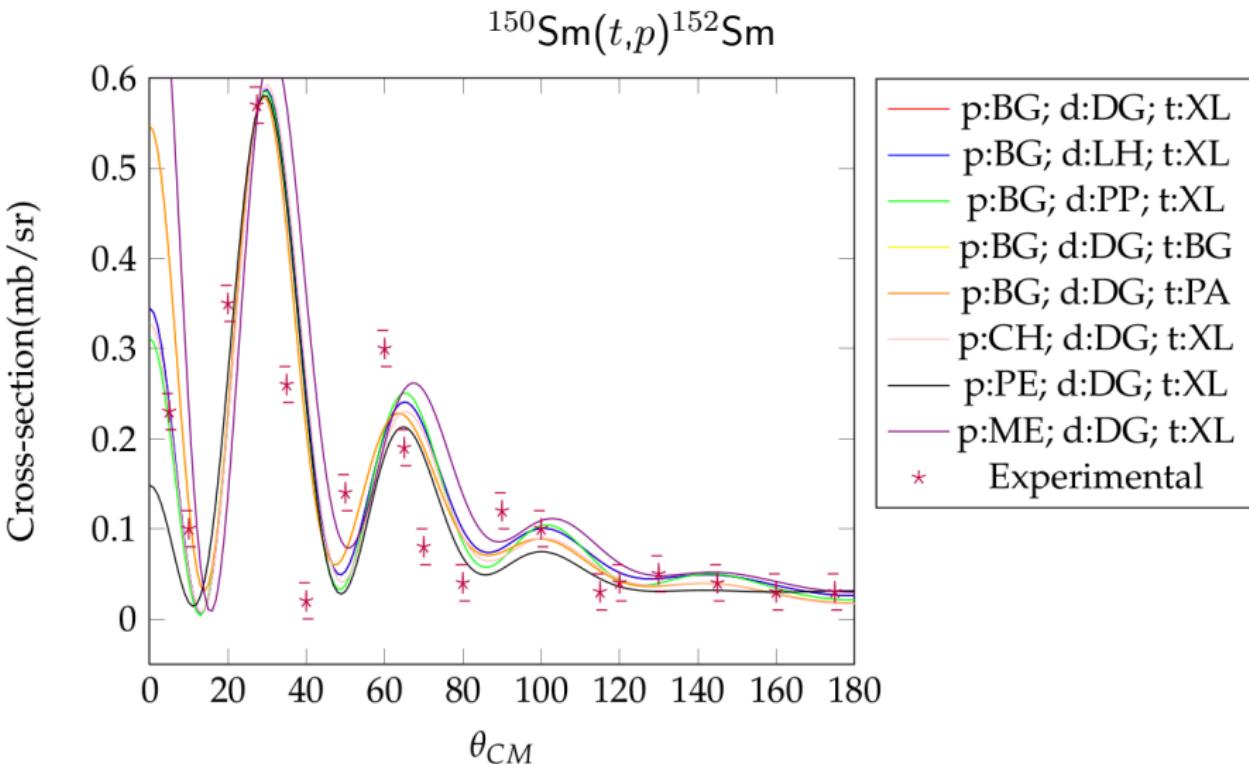


Sm as a well-known case of QPT

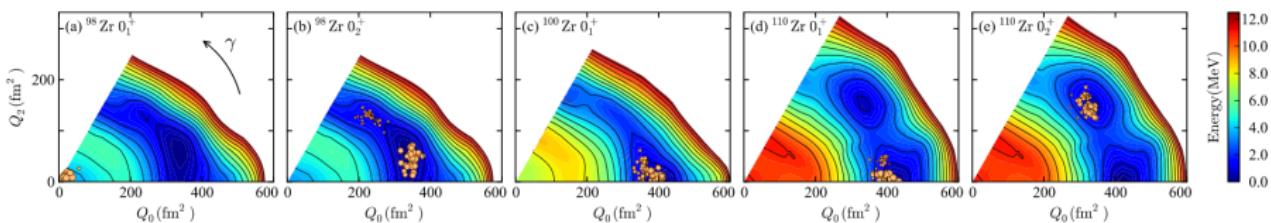
Normal QPT scenario

 $^{150}\text{Sm}(t,p)^{152}\text{Sm}$ 

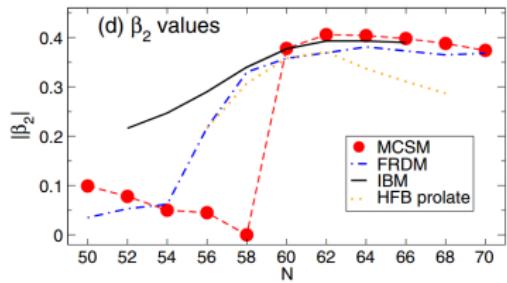
Sm as a well-known case of QPT



Zr as a case of shape-coexistence

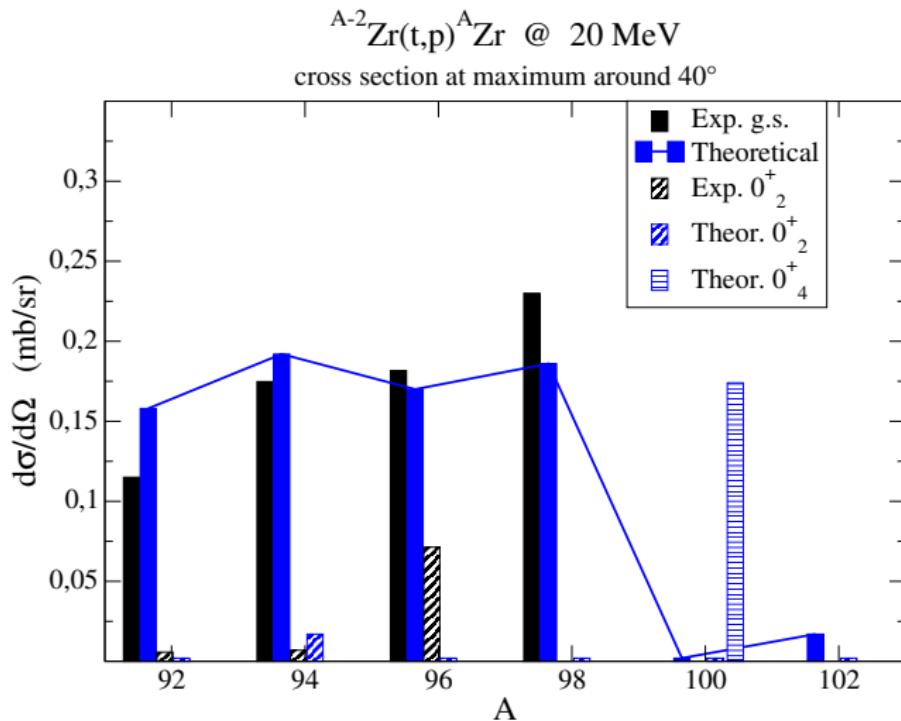


⇒ Monte Carlo Shell Model calculations from
T. Togashi, Y. Tsunoda, T. Otsuka, *et al.* [PRL117 (2016) 172502]



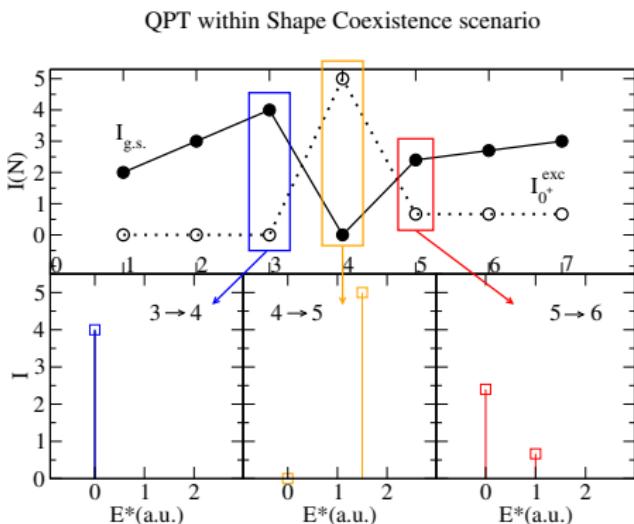
⇒ Two Neutron Amplitudes $\langle A + 2 || [a_j^\dagger a_j^\dagger]^0 || A \rangle$

Zr as a case of shape-coexistence

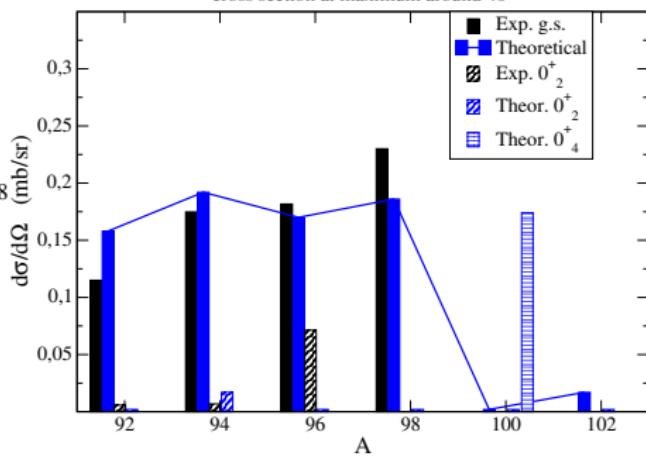


E. R. Flynn *et al.* NPA218 (1974) 285
 J. A. Lay *et al.* arXiv:1905.12976

Zr as a case of shape-coexistence



$^{A-2}\text{Zr}(t,p)^A\text{Zr}$ @ 20 MeV
cross section at maximum around 40°



Conclusions

Transfer with shape-phase transitions and shape coexistence

- ⇒ Transfer reactions are perfect probes to pinpoint critical points in QPT
- ⇒ Also a promising tool to disentangle shape-phase transitions and shape coexistence
- ⇒ Non critical sensitivity to optical potentials

Thank you!!



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Zr as a case of shape-coexistence

	90-92gs	92-94gs	94-96gs	96-98gs	98-100gs	98-100(0_4^+)	100-102gs
$1d_{5/2}$	0.74	0.86	0.86	0.13	~ 0.0	0.16	0.08
$2s_{1/2}$	0.10	0.08	0.10	0.90	~ 0.0	0.16	0.05
$1d_{3/2}$	0.13	0.18	0.16	0.07	~ 0.0	0.90	0.04
$0h_{11/2}$	0.22	0.20	0.19	0.08	~ 0.0	0.14	0.55

