Shape transition in the neutron-rich W isotopes on behalf of the E673 Experiment collaboration AGATA+FATIMA



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Shape transitions in the neutron-rich W, Os and Pt isotopes



Pt Transition region starts with A=192 and persists till A \approx 200 with γ -soft ground states F. Todd Baker et al., Nucl. Phys. A266 (1976) 337.

Os Decrease in deformation, ¹⁹⁶Os γ -soft with a slight oblate deformation

P.R. John et al., Phys. Rev. C 90 (2), 021301.





Data taken from: Nuclear Data Database NUDAT 2, http://www.nndc.bnl.gov/nudat2.

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W Prolate to oblate shape transition predicted for A=190 till A=194

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What we know of ¹⁹⁰W



Yrast band interpreted as prolate deformed

Yang Sun et al., Phys. Lett. B 659 (2008) 165â169

- ► Oblate shaped 10⁻ isomer in ¹⁹⁰W PM. Walker, FR. Xu / Phys. Lett. B 635 (2006) 2868289 G.J. Lane et al, Phys. Rev. C 82, 051304(R) (2010) Yang Sun et al, Phys. Lett. B 659 (2008) 165á169
- ► Candidate for the 2⁺₂ state observed N. Alkhomashi et al., Phys. Rev. C 80, 064308 (2009)
- Triaxial degree of freedom important for the description

P. Sarriguren et al., Phys. Rev. C 77, 064322 (2008 L.M. Robledo et al., J. Phys. G 36, 115104 (2009).



Experiment E673



Goals

- First in-beam γ -ray spectroscopy of ¹⁹⁰W and ¹⁹²W
- Measurement the of $B(E2; 2^+_1 \rightarrow 0^+_{gs})$ of ¹⁹⁰W and ¹⁹²W
- Reaction ¹⁹²Os + ¹³⁶Xe at 900 MeV
- ▶ 0.2pnA
- ► 45 mg/cm² ¹⁹²Os target
- AGATA nominal position
- ► FATIMA (Array of 24 LaBr₃(Ce)) at 90° for fast timing, shielded with 1 mm µ material



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Typical use of AGATA

Ancillary device, such as Vamos, MuGasT, selects good events





Trigger Experiment E673



- ► AGATA γ − γ + FATIMA γ − γ, i.e. quadruple coincidences for lifetime measurement
- Also higher fold γ data



Obtaining prompt events How to do it?



- TAC between AGATA and RF
- TAC between FATIMA and RF
- only in the datastream with FATIMA data
- Timestamped data
- ► Frequency of the cyclotron: 9.4565 MHz
- ► Every 105 ns a new bunch

Prompt events with FATIMA

What does it mean?



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Time difference between FATIMA events and $\gamma-\gamma$ events



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identification



Time difference for $\gamma-\gamma$ Trigger

Identified!





Sorting higher Cubes and Hypercubes

Determation of correct time differences





Lifetime measurement with FATIMA (near line results)



- highest cross section for transfer ¹⁹⁰Os
- demonstartion that we can measure lifetimes with this setup



Identification Beam-like recoils



		¹³¹ La	¹³² La	¹³³ La	¹³⁴ La	¹³⁵ La	¹³⁶ La		¹³⁸ La		¹⁴⁰ La					
	¹²⁹ Ba		¹³¹ Ba								¹³⁹ Ba	¹⁴⁰ Ba	¹⁴¹ Ba	¹⁴² Ba	¹⁴³ Ba	
¹²⁷ Cs	¹²⁸ Cs	¹²⁹ Cs	¹³⁰ Cs		¹³² Cs		¹³⁴ Cs	¹³⁵ Cs	¹³⁶ Cs	¹³⁷ Cs	¹³⁸ Cs	¹³⁹ Cs	¹⁴⁰ Cs	¹⁴¹ Cs	¹⁴² Cs	¹⁴³ Cs
	¹²⁷ Xe						¹³³ Xe		¹³⁵ Xe	¹³⁶ Xe	¹³⁷ Xe	¹³⁸ Xe	¹³⁹ Xe	¹⁴⁰ Xe	¹⁴¹ Xe	¹⁴² Xe
125	¹²⁶		128	¹²⁹	130	¹³¹	132	133	¹³⁴	¹³⁵	¹³⁶	137	138	¹³⁹	140	141
			¹²⁷ Te	¹²⁸ Te	¹²⁹ Te	¹³⁰ Te	¹³¹ Te	¹³² Te	¹³³ Te	¹³⁴ Te	¹³⁵ Te	¹³⁶ Te	¹³⁷ Te	¹³⁸ Te		
	¹²⁴ Sb	¹²⁵ Sb	¹²⁶ Sb	¹²⁷ Sb	¹²⁸ Sb	¹²⁹ Sb	¹³⁰ Sb	¹³¹ Sb	¹³² Sb	¹³³ Sb	¹³⁴ Sb	¹³⁵ Sb	¹³⁶ Sb	¹³⁷ Sb	¹³⁸ Sb	¹³⁹ Sb
¹²² Sn	¹²³ Sn	¹²⁴ Sn	¹²⁵ Sn	¹²⁶ Sn	¹²⁷ Sn	128Sn	¹²⁹ Sn	¹³⁰ Sn	¹³¹ Sn	¹³² Sn	¹³³ Sn	¹³⁴ Sn	¹³⁵ Sn	¹³⁶ Sn	¹³⁷ Sn	

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Identification target-like recoils



		¹⁹² TI	¹⁹³ TI	¹⁹⁴ TI	¹⁹⁵ TI	¹⁹⁶ TI	¹⁹⁷ TI	¹⁹⁸ TI	¹⁹⁹ TI	²⁰⁰ TI	²⁰¹ TI	²⁰² TI	²⁰³ TI	²⁰⁴ TI	²⁰⁵ TI	2
	¹⁹⁰ Hg	¹⁹¹ Hg	¹⁹² Hg	¹⁹³ Hg	¹⁹⁴ Hg	¹⁹⁵ Hg	¹⁹⁶ Hg	¹⁹⁷ Hg	¹⁹⁸ Hg	¹⁹⁹ Hg	²⁰⁰ Hg	²⁰¹ Hg	²⁰² Hg	²⁰³ Hg	²⁰⁴ Hg	2
	¹⁸⁹ Au	¹⁹⁰ Au	¹⁹¹ Au	¹⁹² Au	¹⁹³ Au	¹⁹⁴ Au	¹⁹⁵ Au	¹⁹⁶ Au	¹⁹⁷ Au	¹⁹⁸ Au	¹⁹⁹ Au	²⁰⁰ Au	²⁰¹ Au	²⁰² Au	²⁰³ Au	2
	¹⁸⁸ Pt	¹⁸⁹ Pt	¹⁹⁰ Pt	¹⁹¹ Pt	¹⁹² Pt	¹⁹³ Pt	¹⁹⁴ Pt	¹⁹⁵ Pt	¹⁹⁶ Pt	¹⁹⁷ Pt	¹⁹⁸ Pt	¹⁹⁹ Pt	²⁰⁰ Pt	²⁰¹ Pt	²⁰² Pt	2
	¹⁸⁷ lr	¹⁸⁸ lr	¹⁸⁹ lr	¹⁹⁰ lr	¹⁹¹ lr	¹⁹² lr	¹⁹³ lr	¹⁹⁴ lr	¹⁹⁵ lr	¹⁹⁶ lr	¹⁹⁷ lr	¹⁹⁸ lr		²⁰⁰ lr	²⁰¹ lr	
	¹⁸⁶ Os	¹⁸⁷ Os	¹⁸⁸ Os	¹⁸⁹ Os	¹⁹⁰ Os	¹⁹¹ Os	¹⁹² Os	¹⁹³ Os	¹⁹⁴ Os		¹⁹⁶ Os	¹⁹⁷ Os		¹⁹⁹ Os	²⁰⁰ Os	
	¹⁸⁵ Re	¹⁸⁶ Re	¹⁸⁷ Re	¹⁸⁸ Re	¹⁸⁹ Re	¹⁹⁰ Re	¹⁹¹ Re	¹⁹² Re		¹⁹⁴ Re	¹⁹⁵ Re					
	¹⁸⁴ W	¹⁸⁵ W	¹⁸⁶ W	¹⁸⁷ W	¹⁸⁸ W	¹⁸⁹ W	¹⁹⁰ W									
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Identification target-like recoils Isomeric states



		¹⁹² TI	¹⁹³ TI	¹⁹⁴ TI	¹⁹⁵ TI	¹⁹⁶ TI	¹⁹⁷ TI	¹⁹⁸ TI	¹⁹⁹ TI	²⁰⁰ TI	²⁰¹ TI					
	¹⁹⁰ Hg	¹⁹¹ Hg	¹⁹² Hg	¹⁹³ Hg	¹⁹⁴ Hg	¹⁹⁵ Hg	¹⁹⁶ Hg	¹⁹⁷ Hg	¹⁹⁸ Hg	¹⁹⁹ Hg	²⁰⁰ Hg			²⁰³ Hg		
	¹⁸⁹ Au	¹⁹⁰ Au	¹⁹¹ Au	¹⁹² Au	¹⁹³ Au	¹⁹⁴ Au	¹⁹⁵ Au	¹⁹⁶ Au		¹⁹⁸ Au	¹⁹⁹ Au	²⁰⁰ Au	²⁰¹ Au	²⁰² Au	²⁰³ Au	
	¹⁸⁸ Pt	¹⁸⁹ Pt	¹⁹⁰ Pt	¹⁹¹ Pt	¹⁹² Pt	¹⁹³ Pt	¹⁹⁴ Pt	¹⁹⁵ Pt	¹⁹⁶ Pt	¹⁹⁷ Pt	¹⁹⁸ Pt	¹⁹⁹ Pt	²⁰⁰ Pt	²⁰¹ Pt	²⁰² Pt	
	¹⁸⁷ lr	¹⁸⁸ lr	¹⁸⁹ lr	¹⁹⁰ lr	¹⁹¹ lr	¹⁹² lr	¹⁹³ lr	¹⁹⁴ lr	¹⁹⁵ r	¹⁹⁶ lr	¹⁹⁷ lr	¹⁹⁸ lr		²⁰⁰ lr	²⁰¹ r	
	¹⁸⁶ Os	¹⁸⁷ Os	¹⁸⁸ Os	¹⁸⁹ Os	¹⁹⁰ Os	¹⁹¹ Os	¹⁹² Os	¹⁹³ Os	¹⁹⁴ Os		¹⁹⁶ Os	¹⁹⁷ Os		¹⁹⁹ Os	²⁰⁰ Os	
	¹⁸⁵ Re	¹⁸⁶ Re	¹⁸⁷ Re	¹⁸⁸ Re	¹⁸⁹ Re	¹⁹⁰ Re	¹⁹¹ Re	¹⁹² Re		¹⁹⁴ Re	¹⁹⁵ Re					
	¹⁸⁴ W	¹⁸⁵ W	¹⁸⁶ W	¹⁸⁷ W	¹⁸⁸ W	¹⁸⁹ W	¹⁹⁰ W									
r																

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Conclusions



- The Data at TU Darmstadt is only 1.5 days of the experiment
- The Grid transfer is not yet available at TU Darmstadt, IT of TU Darmstadt is working on it
- Cube and Hypercube sorting developed for the available data, However, we need to apply to the full experiment
- Experiment worked fine, huge effort
- ► No obvious lines for ¹⁹⁰W yet!
- ► Identification of isomeric decays ⇒ cleaner gating
- Identification of many new γ -ray transitions
- Obviulsly, no Replay yet, touch the tracking parameters