

First observation of β -delayed γ -proton decay in ⁵⁶Zn





Complementarity of β decay and CE reactions

Under the assumption of **isospin symmetry**, **mirror Fermi and Gamow Teller** transitions are expected to have the same strength \blacksquare β decay gives access to the absolute **B(F)** and **B(GT)** values The CE cross section is proportional to B(F) and B(GT)

• Y. Fujita et al., Physical Review Letters 95 (2005) 212501

- Y. Fujita, B. Rubio, W. Gelletly, Progress in Particle and Nuclear Physics 66 (2011) 549-606



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⁵⁸Ni²⁶⁺ (74.5 AMeV) + ^{nat}Ni @ GANIL



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Implanted ⁵⁶Zn ions

I As expected, beyond the $f_{7/2}$ -shell the production is more difficult



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Expected β decay of ⁵⁶Zn (T_z = -2)

I Since $S_p = 560$ keV, the decays is expected to proceed mostly by proton emission



Measured DSSSD-decay-energy spectrum



S.E.A. Orrigo et al., Phys. Rev. Lett. 112, 222501 (2014)

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Comparison of mirror transitions for A = 56



Half-life analysis for ${}^{56}Zn$ (T_Z = -2) using the β -delayed protons



Each proton decay is correlated with all the implants happening in the same pixel of DSSSD



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Constructing the ⁵⁶Zn decay scheme...



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Measured gamma spectrum



Indeed we oserved the γ transition deexciting the IAS

at 1834.5 ± 1.0 keV in the ⁵⁶Zn-correlated γ -spectrum



✓ In agreement with the β -implant time correlations value:

T_{1/2} = (32.9 ± 0.8) ms



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Proton-gamma coincidences



We have observed for the first time beta-delayed gamma-proton emission in three branches → very exotic !!





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⁵⁶Zn decay scheme: β feedings and strengths



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Isospin mixing in ⁵⁶Co



Isospin mixing: $< H_c > = 32.3(5)$ keV and $\alpha^2 = 28(1)\%$

H. Fujita et al., Phys. Rev. C 88, 054329 (2013)

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⁵⁶Zn decay scheme: isospin mixing



Comparison with mirror Charge Exchange



Comparison Mass Evaluation AME2003 and AME2012

Charge Exchange data H. Fujita et al., Phys. Rev. C 88, 054329 (2013)	S _p = 560(140) keV Syst. AME2003 G. Audi et al., Nucl. Phys. A 729, 1 (2003)	S _p = 190(200) keV Syst. AME2012 G. Audi et al., Chin. Phys. C 36, 1157 (2012)
Ex mirror 56Co [keV]	Ex 56Cu [keV]	Ex 56Cu [keV]

(Charge Exchange)	(Audi2003)	(Audi2012)
3599	3508	3138
3432, 3496, 3527	3423	3053
2729	2661	2291
2633	2537	2167
1720	1691	1321
1451	1391	1021
1451	1391	1021

- ✓ The energies of the corresponding levels in ⁵⁶Cu and ⁵⁶Co differ by less than 100 keV when using AME2003 and by ~ 400 keV when using AME2012
- Therefore in our discussion we used AME2003

A new mass measurement for ⁵⁶Cu gives a preliminary value

of S_p = 484(90) keV, in agreement with AME2003

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The ⁵⁶Zn decay scheme and β decay strengths





Summary

We have studied the β **decay of the** T_z **= -2** ⁵⁶**Zn proton rich-nucleus** at GANIL

✓ A new decay scheme and the corresponding B(F), B(GT) values have been determined

🔳 Isobaric Analogue State

- \checkmark Nuclear structure seems the responsible for the **competition of the proton and** γ **decays**
- Evidence for fragmentation due to strong isospin mixing of 33(10)%
- ✓ Important for the mass evaluation
- We have observed the β-delayed gamma-proton decay
 - for the first time in the *fp*-shell in 3 branches
 - \checkmark This exotic decay affects the conventional determination
 - of B(F) and B(GT) in proton-rich nuclei
 - ✓ It is expected to be important in heavier p-rich nuclei

⁵⁶Zn β⁺ **decay** \Leftrightarrow ⁵⁶Fe(³He,t)⁵⁶Co : nice mirror symmetry

 \checkmark Good understanding of the β decay also thanks to

the knowledge of the mirror ⁵⁶Co



The E556a Collaboration

PRL 112, 222501 (2014)

PHYSICAL REVIEW LETTERS

week ending 6 JUNE 2014

Observation of the β -Delayed γ -Proton Decay of ⁵⁶Zn and its Impact on the Gamow-Teller Strength Evaluation

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Thank you for your attention!

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