Gamma spectroscopy of neutron-rich isotopes in the A = 100 region produced in fission induced by cold neutrons with new FIPPS array

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Scientific motivation

M. Matejška-Minda, B. Fornal et al., PRC 80, 017302 (2009)

Z = 40

97Zr

N = 60

H. Hua et al., PRC 69, 014317 (2004)

100Zr
Scientific motivation

Level scheme – W. Urban et al., PRC 96, 044333 (2017)

Experimental details

EXILL
Institut Laue-Langevin (Grenoble)

- Cold neutrons from ILL reactor induced fission of $^{235}$U and $^{241}$Pu targets

Gamma spectroscopy HPGe (from EXOGAM and GASP)

- 10 clover detectors
- 6 large coaxial detectors

Lifetime measurements

- HPGe + 16 LaBr$_3$

~ 50 days of measurement in 2012/13

M. Jentschel et al. JINST 12 (2017) P11003
Setup upgrade

**FIPPS** (Fission Product Prompt $\gamma$-ray Spectrometer)

- 16 HPGe clover detectors
- Cold-neutron from ILL reactor induced fission on active $^{235}\text{U}$ target
- 25 days of beam time in 2018
- About 50 days of beam time in 2019 (also with the $^{233}\text{U}$ target)

C. Michelagnoli et al., EPJ 193, 04009 (2018)
C. Porzio (bachelor thesis)
G. Bocchi et al

\[ \beta \sim 0.4 \]

Typical in the region

\[ T_{1/2} = 175(25) \text{ ps} \]

\[ 98\text{Y} \text{ typical in the region} \]

\[ \beta \sim 0.4 \]

\[ 45(15) \text{ ps} \]

\[ 51(10) \text{ ps} \]

\[ 175(25) \text{ ps} \]

\[ 1 \text{ ns} (0.55 \text{ ns}) \]

\[ 98\text{Y} \text{n} + 235\text{U} \]
Ł. W. Iskra et al., EPL 117, 12001 (2017)

Counts

\[ T_{1/2} = 201(30) \text{ ns} \]

Time (ns)

122 - 731 keV

\[ \text{A2} = -0.08(1) \]

\[ \text{A4} = 0.01(1) \]
No connections with a spherical structure above $8^+$ isomer

Theoretical calculation based on complex Monster (Vampir) model predicts the presence of a deformed $6^-$ isomer as a bandhead of a rotational prolate structure

The structure above the isomer looks like a beginning of the rotational band
Shape evolution in the Y isotopic chain

No sudden onset of deformation at N = 60 but gradually decrease in energy !?
Identification in the $^{94}\text{Y}$ isotope
Shape evolution in the Y isotopic chain

No sudden onset of deformation at N = 60 but gradually decrease in energy !?
Summary

Using the data from fission of $^{235}\text{U}$ and $^{241}\text{Pu}$ targets it was possible to identify over 50 new gamma transitions and 32 states in the $^{94,96}\text{Y}$ isotopes.

Angular correlation analysis allowed to make spin-parity assignment for most of the identified levels.

The analysis also revealed the presence of the new deformed isomeric state in the $^{96}\text{Y}$ as a bandhead of the possible rotational structure – first observation of the shape coexistence at $N = 57$.

The recent results from the gamma spectroscopy study suggest that in case of yttrium isotopic chain we observe smooth evolution of the deformation rather than sudden onset.

The future is bright! – different fissile targets and gas-filled magnet.
Collaboration group

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(partial results)
Ł. W. Iskra et al., p.64 Annual Report ILL (2017)
Ł. W. Iskra et al., EPL 117, 12001 (2017)

Thank you for your attention