

## Three-quasiparticle isomers in odd-even $^{159, 161}\text{Pm}$ : Calling for modified spin-orbit interaction for the neutron-rich region

Neutron-rich Pm ( $Z$

=

61

) isotopes were studied by delayed

$\gamma$

-ray spectroscopy at RIBF, RIKEN Nishina Center using the in-flight fission of a 345 MeV/nucleon

$^{238}\text{U}$

beam. A cluster-type Ge detector array, EURICA, was used to measure the delayed

$\gamma$

rays from stopped ions. Isomeric

$\gamma$

decays were observed in

$^{159}\text{Pm}$

and

$^{161}\text{Pm}$

with half-lives of 4.97(12)

$\mu\text{s}$

and 0.79(4)

$\mu\text{s}$

, respectively. Level schemes for

$^{159}\text{Pm}$

and

$^{161}\text{Pm}$

were constructed in this study. The isomeric states of

$^{159}\text{Pm}$

and

$^{161}\text{Pm}$

could be interpreted as two quasiparticle excitations of neutrons with the configurations of

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, respectively. They are analogous to the isomers that have been observed systematically in other even-mass  $N = 98$  and  $N = 100$  isotones in this region. A projected shell model calculation was performed and it reproduced the order of three-quasiparticle states only if new Nilsson parameters with an  $N$ -dependent spin-orbit interaction were used. This work demonstrates that the strength of spin-orbit interactions in standard Nilsson parameters needs to be modified to study the properties of neutron-rich rare-earth nuclei around  $A = 165$ , and provides new evidence supporting the existence of the deformed  $N = 98$  subshell gap in odd-mass nuclei for the first time.

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