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Three-quasiparticle isomers in odd-even 159 , 161 Pm : Calling for modified spin-orbit interaction for the neutron-rich region

Neutron-rich Pm ($Z = 61$) isotopes were studied by delayed γ -ray spectroscopy at RIBF, RIKEN Nishina Center using the in-flight fission of a 345 MeV/nucleon ^{238}U beam. A cluster-type Ge detector array, EURICA, was used to measure the delayed γ rays from stopped ions. Isomeric γ decays were observed in ^{159}Pm and ^{161}Pm with half-lives of 4.97(12) μs and 0.79(4) μs , respectively. Level schemes for ^{159}Pm and ^{161}Pm were constructed in this study. The isomeric states of ^{159}Pm and ^{161}Pm could be interpreted as two quasiparticle excitations of neutrons with the configurations of $\nu(7/2[633]\otimes 5/$

2
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523
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)
and
ν
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7
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2
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633
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⊗
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2
[
521
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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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