

Research Report

ICRR Inter-University Research Program 2021

Research Subject:

Search for the nucleon decay including multi pions in Super-Kamiokande

Principal Investigator: Jee-Seung Jang

Participating Researchers: Dong-Ho Moon, Ryeong-Gyoon Park, Seong-Hak Lee

Summary of Research Result :

This research group studied the **proton decay to $e^+ + 2\pi^0$ (SuperK I-IV) and $\mu^+ + 2\pi^0$ (SuperK IV)**.

- Monte-calro test for three body decay was done. Two body decay of proton has well studied in SuperK.

Based on Monte-Calro of two body decay to the charged lepton and pion, we modified that for this study and test.

- Sensitivity study to optimize the selection criteria was done and the efficiency and Background rate were calculated based on SuperK IV as follows.

Selection criteria	Signal MC efficiency [%]		Background MC rate [3244.4 days]	
	$p \rightarrow e^+ \pi^0 \pi^0$	$p \rightarrow \mu^+ \pi^0 \pi^0$	$p \rightarrow e^+ \pi^0 \pi^0$	$p \rightarrow \mu^+ \pi^0 \pi^0$
Total events (wallv > 200)	100.00	100.0	26295.82	26295.8
FCFV	99.76 ± 1.10	96.21 ± 1.51	25155.81 ± 20.61	25155.8 ± 20.61
nring(≥ 3)	60.65 ± 0.86	57.26 ± 1.04	3232.98 ± 7.38	3232.98 ± 7.38
All e-like ring / 1 mu-like ring	48.06 ± 0.76	38.62 ± 0.81	1489.37 ± 5.12	1210.75 ± 4.44
No Michel electron / 1 Michel electron	46.09 ± 0.75	35.56 ± 0.76	715.66 ± 3.58	573.19 ± 3.02
Total invariant mass (800 ≤ M ≤ 1050)	22.81 ± 0.53	17.41 ± 0.50	86.65 ± 1.24	93.28 ± 1.22
Total momentum (P ≤ 200)	19.35 ± 0.48	14.38 ± 0.45	0.52 ± 0.10	0.51 ± 0.09
Tagged neutron	18.95 ± 0.48	14.14 ± 0.44	0.13 ± 0.05	0.17 ± 0.06

- Breakdown of remained background events

<> $p \rightarrow e^+ + 2\pi^0$

CC interaction	# of event
CCQE	1
CC1π	π ⁺ (p) 2
	π ⁰ 1
	π ⁺ (n) 2
CCnπ	4
CCDIS	1
Total	11

<> $p \rightarrow \mu^+ + 2\pi^0$

CC interaction	# of event
CCQE	1
CC1π	π ⁰ 2
CCnπ	2
Total	5
NC interaction	# of event
NCnπ	1
NCDIS	1
Total	2

No.