Table 1. Nuclear spectroscopic data and yields of fission products in the 3.72 MeV neutron-induced fission of 238U

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nuclide | Half-life | γ-rayEnergy(keV) | γ-rayabundance (%) | *YR*(%) | *YA* (%) |
| 84Br85Krm87Kr88Kr91Sr92Sr93Y95Zr97Zr99Mo103Ru105Ru105Rh112Ag113Ag115Cdg115Cdtotal117Cdm117Cdg117Cdtotal | 31.8 min4.48 h76.3 min2.84 h9.63 h2.71 h10.18 h64.02 d16.91 h65.94 h39.26 d4.44 h35.36 h3.13 h5.37 h53.46 h3.36 h2.49 h | 1616.2151.2304.9402.6196.3749.81024.31384.9266.9756.7724.3743.4140.5739.5497.1724.4319.1617.5298.6336.21066.01097.3273.4 | 6.275.014.049.625.923.633.090.07.354.044.293.089.412.1390.047.019.243.010.045.923.126.028.0 | 0.743±0.0980.913±0.0330.891±0.0251.494±0.1211.951±0.0643.440±0.2063.755±0.2843.603±0.2613.125±0.2915.016±0.2755.201±0.2486.086±0.2555.418±0.2665.380±0.1686.483±0.3973.211±0.1573.298±0.1960.076±0.0110.052±0.011.0326±.00540.038±0.006\*.0120±.0022.0117±.0027 .0185±.0033.0304±.0038 | 0.743±0.0980.913±0.0330.891±0.0251.494±0.1211.951±0.0653.440±0.2063.755±0.2843.608±0.2623.125±0.2915.016±0.2755.201±0.2486.097±0.2565.418±0.2665.380±0.1686.483±0.3973.217±0.1583.298±0.1960.076±0.0110.052±0.011.0326±0.00540.038±0.006\*.0304±.0038 |

\*The yields of 115Cdtotal is based on the ratio of 115Cdg/115Cdm =6 from Ref. [64]

Table 1. –continued

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nuclide | Half-life | γ-ray Energy(keV) | γ-ray abundance (%) | *YR*(%) | *YA* (%) |
| 127Sb128Sn129Sb131I132Te133I134Te135I138Csg139Ba140Ba141Ce142La143Ce144Ce147Nd149Nd151Pm153Sm | 3.85 d59.07 min4.32 h8.02 d3.2 d20.8 h41.8 min6.57 h33.41 min83.03 min12.75 d32.5 d91.1 min33.03 h284.89 d10.98 d1.728 h53.08 h46.28 h | 687.0482.3812.4364.5228.1529.9566.0767.21131.51260.41435.81009.8462.8165.8537.3145.4641.3293.3133.5531.0211.3270.2340.8 103.2 | 37.059.043.081.788.087.018.029.522.728.976.329.830.723.724.448.047.042.811.0913.125.910.623.0 30.0 | 0.288±0.0490.417±0.0890.791±0.0483.673±0.2844.749±0.2026.977±0.2877.885±0.2398.004±0.2675.547±0.2595.434±0.0547.015±0.3046.102±0.2426.646±0.2336.537±0.2095.684±0.2915.304±0.2664.233±0.1964.592±0.2974.847±0.2553.211±0.1911.975±0.1571.902±0.2120.999±0.0490.434±0.082 | 0.288±0.0490.460±0.0980.794±0.0483.673±0.2844.776±0.2036.977±0.2878.515±0.2588.644±0.2885.586±0.2615.472±0.0547.015±0.3046.102±0.2426.646±0.2336.537±0.2095.684±0.2915.304±0.2664.260±0.1974.592±0.2974.847±0.2553.211±0.1911.983±0.1581.911±0.2130.999±0.0490.434±0.082 |

*YR* – Cumulative yields, *YA* – Mass yields, 135I – Fission rate monitor.

Table 2. Nuclear spectroscopic data and yields of fission products in the 5.42 MeV neutron-induced fission of 238U

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nuclide | Half-life | γ-rayEnergy(keV) | γ-rayabundance (%) | *YR*(%) | *YA* (%) |
| 84Br85Krm87Kr88Kr91Sr92Sr93Y95Zr97Zr99Mo103Ru105Ru105Rh112Ag113Ag115Cdg115Cdtotal117Cdm117Cdg117Cdtotal | 31.8 min4.48 h76.3 min2.84 h9.63 h2.71 h10.18 h64.02 d16.91 h65.94 h39.26 d4.44 h35.36 h3.13 h5.37 h53.46 h3.36 h2.49 h | 1616.2151.2304.9402.6196.3749.81024.31384.9266.9756.7724.3743.4140.5739.5497.1724.4319.1617.5298.6336.21066.01097.3273.4 | 6.275.014.049.625.923.633.090.07.354.044.293.089.412.1390.047.019.243.010.045.923.126.028.0 | 0.755±0.0380.960±0.0310.976±0.0371.611±0.1462.152±0.2693.781±0.1573.967±0.2683.922±0.2413.490±0.0945.615±0.2735.998±0.3316.228±0.2615.235±0.1785.613±0.2626.251±0.2513.893±0.2823.965±0.2310.117±0.0140.094±0.0170.063±0.016 0.074±0.018\*0.016±0.0050.018±0.0060.042±0.0110.059±0.013 | 0.755±0.0380.960±0.0310.976±0.0371.619±0.1472.178±0.2733.781±0.1573.967±0.2683.926±0.2413.490±0.0945.615±0.2735.998±0.3316.235±0.2625.235±0.1785.613±0.2626.251±0.2513.913±0.2833.956±0.2310.117±0.0140.094±0.017 0.063±0.0160.074±0.018\*0.059±0.013 |

\*The yields of 115Cdtotal is based on the ratio of 115Cdg/115Cdm =6 from Ref. [64]

Table 2. –continued

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nuclide | Half-life | γ-rayEnergy(keV) | γ-ray abundance (%) | *YR*(%) | *YA* (%) |
| 127Sb128Sn129Sb131I132Te133I134Te135I138Csg139Ba140Ba141Ce142La143Ce144Ce147Nd149Nd151Pm153Sm | 3.85 d59.07 min4.32 h8.02 d3.2 d20.8 h41.8 min6.57 h33.41 min83.03 min12.75 d32.5 d91.1 min33.03 h284.89 d10.98 d1.728 h53.08 h46.28 h | 687.0482.3812.4364.5228.1529.9566.0767.21131.51260.41435.81009.8462.8165.8537.3145.4641.3293.3133.5531.0211.3270.2340.8 103.2 | 37.059.043.081.788.087.018.029.522.720.376.329.830.723.735.420.547.042.811.0913.125.910.623.0 30.0 | 0.362±0.0730.451±0.0670.940±0.0423.141±0.1364.778±0.1156.841±0.2117.135±0.2777.311±0.1715.051±0.2245.248±0.0526.804±0.2266.617±0.2046.436±0.2466.604±0.2735.930±0.2145.355±0.2264.288±0.0894.912±0.1215.211±0.1783.401±0.1992.104±0.2102.159±0.1390.855±0.0420.451±0.037 | 0.362±0.0730.497±0.0730.942±0.0423.154±0.1364.802±0.1156.841±0.2117.697±0.2997.887±0.1845.085±0.2265.285±0.0526.804±0.2266.617±0.2046.436±0.2466.604±0.2735.930±0.2145.355±0.2264.288±0.0894.912±0.1215.211±0.1783.401±0.1992.112±0.2112.167±0.1400.855±0.0420.451±0.037 |

*YR* – Cumulative yields, *YA* – Mass yields, 135I – Fission rate monitor.

Table 3. Nuclear spectroscopic data and yields of fission products in the 7.75 MeV neutron-induced fission of 238U

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nuclide | Half-life | γ-rayEnergy(keV) | γ-rayabundance (%) | *YR*(%) | *YA* (%) |
| 84Br85Krm87Kr88Kr91Sr92Sr93Y95Zr97Zr99Mo103Ru105Ru105Rh112Ag113Ag115Cdg115Cdtotal117Cdm117Cdg117Cdtotal | 31.8 min4.48 h76.3 min2.84 h9.63 h2.71 h10.18 h64.02 d16.91 h65.94 h39.26 d4.44 h35.36 h3.13 h5.37 h53.46 h3.36 h2.49 h | 1616.2151.2304.9402.6196.3749.81024.31384.9266.9756.7724.3743.4140.5739.5497.1724.4319.1617.5298.6336.21066.01097.3273.4 | 6.275.014.049.625.923.633.090.07.354.044.293.089.412.1390.047.019.243.010.045.923.126.028.0 | 0.726±0.0430.920±0.0750.956±0.0861.894±0.1562.315±0.1273.950±0.2284.020±0.1714.381±0.0973.954±0.2665.365±0.1885.096±0.2415.962±0.2255.455±0.2215.751±0.2476.151±0.2913.821±0.0593.912±0.1520.289±0.0480.230±0.0430.173±0.0320.202±0.037\*.0468±.0086.0425±.00430.121±0.0180.166±0.021 | 0.726±0.0430.920±0.0750.956±0.0861.894±0.1562.351±0.1293.950±0.2284.020±0.1714.385±0.0973.954±0.2665.365±0.1885.096±0.2415.968±0.2255.455±0.2215.751±0.2476.151±0.2913.844±0.0593.912±0.1520.289±0.0480.230±0.0430.173±0.0320.202±0.037\*0.166±0.021 |

\*The yields of 115Cdtotal is based on the ratio of 115Cdg/115Cdm =6 from Ref. [64]

Table 3. –continued

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nuclide | Half-life | γ-rayEnergy(keV) | γ-ray abundance (%) | *YR*(%) | *YA* (%) |
| 127Sb128Sn129Sb131I132Te133I134Te135I138Csg139Ba140Ba141Ce142La143Ce144Ce147Nd149Nd151Pm153Sm | 3.85 d59.07 min4.32 h8.02 d3.2 d20.8 h41.8 min6.57 h33.41 min83.03 min12.75 d32.5 d91.1 min33.03 h284.89 d10.98 d1.728 h53.08 h46.28 h | 687.0482.3812.4364.5228.1529.9566.0767.21131.51260.41435.81009.8462.8165.8537.3145.4641.3293.3133.5531.0211.3270.2340.8 103.2 | 37.059.043.081.788.087.018.029.522.728.976.329.830.723.724.448.047.042.811.0913.125.910.623.0 30.0 | 0.543±0.0270.769±0.0411.238±0.1343.514±0.1025.558±0.2346.818±0.2437.338±0.2557.133±0.1785.012±0.1345.381±0.0536.608±0.2176.724±0.2636.651±0.2096.480±0.1246.011±0.2585.268±0.2144.489±0.1824.660±0.1944.827±0.2043.620±0.1182.133±0.1672.004±0.1500.829±0.0220.473±0.027 | 0.543±0.0270.807±0.0431.243±0.1353.514±0.1025.585±0.2366.818±0.2437.890±0.2757.670±0.1795.047±0.1355.419±0.0546.608±0.2176.724±0.2636.651±0.2096.480±0.1246.011±0.2585.268±0.2144.525±0.1834.698±0.1954.827±0.2043.620±0.1182.142±0.1682.088±0.1510.829±0.0220.473±0.027 |

*YR* – Cumulative yields, *YA* – Mass yields, 135I – Fission rate monitor.

Table 4. Nuclear spectroscopic data and yields of fission products in the 10.09 MeV neutron-induced fission of 238U

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nuclide | Half-life | γ-ray Energy(keV) | γ-ray abundance (%) | *YR*(%) | *YA* (%) |
| 84Br85Krm87Kr88Kr91Sr92Sr93Y95Zr97Zr99Mo103Ru105Ru105Rh112Ag113Ag115Cdg115Cdtotal117Cdm117Cdg117Cdtotal | 31.8 min4.48 h76.3 min2.84 h9.63 h2.71 h10.18 h64.02 d16.91 h65.94 h39.26 d4.44 h35.36 h3.13 h5.37 h53.46 h3.36 h2.49 h | 1616.2151.2304.9402.6196.3749.81024.31384.9266.9756.7724.3743.4140.5739.5497.1724.4319.1617.5298.6336.21066.01097.3273.4 | 6.275.014.049.625.923.633.090.07.354.044.293.089.412.1390.047.019.243.010.045.923.126.028.0 | 0.825±0.0411.106±0.0791.115±0.0511.932±0.0962.445±0.1964.084±0.2153.908±0.2064.255±0.1883.947±0.1655.637±0.1545.528±0.1826.036±0.2955.205±0.0975.404±0.1026.125±0.2113.532±0.1813.589±0.1480.512±0.0380.403±0.0170.290±0.0340.338±0.039\*0.062±0.0100.057±0.0110.220±0.0260.279±0.028 | 0.825±0.0411.103±0.0791.115±0.0511.934±0.0972.480±0.1994.084±0.2153.908±0.2064.260±0.1883.947±0.1655.637±0.1545.528±0.1825.557±0.2955.205±0.0975.404±0.1026.125±0.2113.539±0.1813.589±0.1480.512±0.0380.404±0.0170.290±0.0340.338±0.039\*0.279±0.063 |

\*The yields of 115Cdtotal is based on the ratio of 115Cdg/115Cdm =6 from Ref. [64]

Table 4. –continued

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Nuclide | Half-life | γ-rayEnergy(keV) | γ-ray abundance (%) | *YR*(%) | *YA* (%) |
| 127Sb128Sn129Sb131I132Te133I134Te135I138Csg139Ba140Ba141Ce142La143Ce144Ce147Nd149Nd151Pm153Sm | 3.85 d59.07 min4.32 h8.02 d3.2 d20.8 h41.8 min6.57 h33.41 min83.03 min12.75 d32.5 d91.1 min33.03 h284.89 d10.98 d1.728 h53.08 h46.28 h | 687.0482.3812.4364.5228.1529.9566.0767.21131.51260.41435.81009.8462.8165.8537.3145.4641.3293.3133.5531.0211.3270.2340.8 103.2 | 37.059.043.081.788.087.018.029.522.728.976.329.830.723.724.448.047.042.811.0913.125.910.623.0 30.0 | 0.774±0.0630.992±0.1191.331±0.0743.418±0.2115.541±0.2326.501±0.1766.838±0.2116.732±0.2965.134±0.1925.688±0.0566.371±0.1486.190±0.2046.161±0.2445.889±0.3445.449±0.2324.863±0.2154.486±0.0854.471±0.1994.641±0.2063.811±0.2792.798±0.3342.821±0.2730.995±0.037 0.478±0.034 | 0.774±0.0631.044±0.1251.335±0.0743.418±0.2115.569±0.2336.501±0.1767.369±0.2267.254±0.3075.170±0.1935.728±0.0576.371±0.1486.190±0.2046.161±0.2445.889±0.3445.449±0.2324.863±0.2154.486±0.0854.471±0.1994.641±0.2063.811±0.2792.809±0.3362.832±0.2740.995±0.0370.478±0.034 |

*YR* – Cumulative yields, *YA* – Mass yields, 135I – Fission rate monitor.

Table.5. Yields of asymmetric (*Ya*) and symmetric (*Ys*) products and *P/V* ratio in neutron-induced fission of 238U.

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*En*(MeV) *E*∗(MeV) *Ya*(%) *Ys*(%) *P/V* ratio Ref.

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1*.*5 5*.*85 8.120 ± 0.400 0.0102 ± 0.0014 796.1 ±116.1 [64]

1*.*5 5*.*85 – 0.0075 ± 0.0008 825.0 [50]

1*.*72 6*.*07 7.830 ± 0.930 – – [68]

2*.*0 6*.*35 7.780 ± 0.370 0.0121 ± 0.0017 643.0 ±95.4 [64]

2*.*0 6*.*35 – 0.0135 ± 0.0014 452.0 [50]

2*.*16 6*.*55 7.510 ± 0.830 – – [68]

3*.*0 7*.*35 – 0.029 ±0.003 238.0 [50]

3*.*0 7*.*35 8.190 ± 0.840 0.034 ±0.006 240.9 ±49.2 [59]

3.72 8.07 7.945 ± 0.267 0.038 ±0.006 209.1±33.7 [A]

3*.*72 8*.*07 7.490 ± 0.790 – – [68]

3*.*9 8*.*25 7.760 ± 0.420 0.034 ±0.005 228.2 ±35.8 [64]

3*.*9 8*.*25 – 0.047 ±0.005 129.0 [50]

4*.*78 9*.*13 6.770 ± 0.700 – – [68]

4*.*8 9*.*15 – 0.068 ±0.007 89.0 [50]

5.42 9.77 7.223 ± 0.277 0.074 ±0.018 97.6 ±24.1 [A]

5*.*5 9*.*85 7.000 ± 0.500 0.077 ±0.011 90.9 ±14.5 [64]

5*.*98 10*.*33 6.290 ± 0.800 – – [68]

6*.*0 10*.*35 6.132 ± 0.699 0.124 ±0.010 49.5 ±6.9 [67]

6*.*9 11*.*25 7.240 ± 0.860 0.134 ±0.018 54.0 ±9.7 [64]

7*.*1 11*.*45 6.839 ± 0.595 0.121 ±0.009 56.5 ±6.5 [67]

7*.*7 12*.*05 7.020 ± 0.430 0.191 ±0.032 36.8 ±6.6 [64]

7*.*75 12*.*1 7.257 ± 0.215 0.202 ±0.037 35.9 ±6.7 [A]

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Table.5. -continued

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8*.*1 12*.*45 6.713 ± 0.665 0.135 ±0.011 49.7 ±6.4 [67]

8.27 12*.*72 7.210 ± 0.430 0.227 ±0.009 31.2 ±1.6 [66]

9*.*1 13*.*45 6.308 ± 0.688 0.191 ±0.016 33.0 ±4.5 [67]

10*.*09 14*.*55 6.785 ± 0.286 0.338 ±0.039 20.1 ±2.5 [A]

11*.*3 15*.*65 6.660 ± 0.260 0.430 ±0.050 15.5 ±1.9 [69]

13*.*0 17*.*35 – 0.570 ±0.070 8.8 [50]

14*.*0 18*.*35 6.500 ± 0.150 0.860±0.090 7.6± 0.8 [52]

14*.*0 18*.*35 -- 0.970±0.150 -- [61]

14*.*1 18*.*45 6.000 ± 0.210 0.950±0.090 6.6± 0.6 [58]

14*.*4 18*.*75 6.340 ± 0.340 0.843 ±0.048 7.5 ±0.6 [62]

14*.*4 18*.*75 -- 0.975 ±0.055 -- [62]

14.7 19.05 6.360 ± 0.450 0.860 ±0.090 7.4 ±0.9 [34]

14*.*7 19*.*05 -- 0.930 ±0.120 -- [34]

14*.*8 19*.*15 6.350 ± 0.300 0.870 ±0.150 7.3± 1.3 [60]

14*.*8 19*.*15 -- 0.950 ±0.070 -- [60]

14*.*9 19*.*25 6.50 ± 0.300 0.985 ±0.039 6.6± 0.4 [67]

14*.*9 19*.*05 -- 0.834 ±0.039 -- [67]

15*.*0 19*.*35 – 0.780 ±0.090 6.5 [50]

16*.*4 20*.*75 – 0.870 ±0.100 5.8 [50]

17*.*7 22*.*05 – 0.740 ±0.090 6.8 [50]

A-Present work

Table 6. Average light mass (<*A*L>), heavy mass (<*A*H>), and average neutron numbers (<*v*>expt

 and <*v*>calc) in the neutron -induced fission of 238U.

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En (MeV) E\* (MeV) <AL><AH><ν>expt Ref

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238U(n,f)

 1.5 5.85 97.5 139 2.5 [64]

 2.0 6.35 97.5 139 2.5 [64]

 3.0 7.35 97.46 139 2.54 [59]

 3.72 8.07 97.44 138.89 2.67 [A]

 3.9 8.25 97.4 138.9 2.7 [64]

 5.42 9.77 97.27 138.82 2.91 [A]

 5.5 9.85 97.4 138.6 3.0 [64]

 6.0 10.35 97.44 138.47 3.09 [63]

 6.9 11.51 97.5 138.4 3.1 [64]

 7.1 11.45 97.4 138.35 3.25 [63]

 7.7 11.05 97.4 138.3 3.3 [64]

 7.75 12.1 97.37 138.33 3.31 [A]

 8.1 12.45 97.48 138.13 3.39 [63]

 8.27 12.72 97.4 138.2 3.4 [66]

 9.1 13.45 97.4 138.06 3.6 [63]

 10.09 14.55 97.37 138.03 3.6 [A]

 11.3 15.65 97.51 137.75 3.74 [69]

 14.1 18.45 98.09 136.79 4.12 [61]

 14.8 19.15 98.0 136.8 4.2 [60]

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A-Present work