

Letter to the Editor

Absolute Ratio ^{252}Cf to ^{235}U Prompt Fission Neutron Spectra

The Prompt Fission Neutron Spectrum (PFNS) of ^{235}U is a very important parameter from the point of view of practical applications and the understanding of the mechanism of the fission process and neutron emission in fission. The problem of differences between microscopic and macroscopic data is not solved until now (see, e.g., the discussion in Ref. 1). New experimental results have been published recently.¹ The PFNS were measured by three liquid scintillation neutron detectors. The efficiencies of these detectors were measured relative to a ^{252}Cf standard neutron spectrum. After proper corrections, the spectra for each detector were normalized to unity. The spectra

and neutron multiplicity were in good agreement for each detector and previous experiments. The normalized spectra for each detector were averaged and presented in Ref. 1 in tabular form.

The nuclear community involved in the practical application of this result (based on International Atomic Energy Agency coordinated research projects; see <http://www-naweb.iaea.org/napc/nd/crps.asp>) strongly recommended to reevaluate and published our results as a direct ratio to ^{252}Cf . This is the basis of this report.

We took the ratio of the spectra for each detector [see Eq. (1) in Ref. 1] without any additional normalization to the total integral and without correction for neutron detector efficiency. All other corrections (neutron scattering in environment, random coincidence, the total amount of fission events)

TABLE I
Average Ratio ^{252}Cf to ^{235}U Spectra Measured by Three Detectors at 100 K Neutron Energy

E (MeV)	$R(E) = \text{Cf/U}$	dR/R	E (MeV)	$R(E) = \text{Cf/U}$	dR/R	E (MeV)	$R(E) = \text{Cf/U}$	dR/R	E (MeV)	$R(E) = \text{Cf/U}$	dR/R
0.7	1.436	0.005	6.3	1.920	0.028	3.5	1.608	0.012	9.1	2.208	0.067
0.8	1.437	0.003	6.4	1.936	0.029	3.6	1.628	0.012	9.2	2.395	0.072
0.9	1.438	0.003	6.5	1.932	0.030	3.7	1.632	0.013	9.3	2.120	0.071
1.0	1.449	0.003	6.6	1.979	0.031	3.8	1.651	0.014	9.4	2.185	0.074
1.1	1.464	0.003	6.7	1.954	0.032	3.9	1.678	0.014	9.5	2.282	0.078
1.2	1.453	0.003	6.8	1.924	0.032	4.0	1.681	0.015	9.6	2.243	0.081
1.3	1.468	0.003	6.9	1.993	0.034	4.1	1.674	0.015	9.7	2.236	0.084
1.4	1.481	0.004	7.0	2.028	0.034	4.2	1.673	0.016	9.8	2.422	0.091
1.5	1.480	0.004	7.1	1.999	0.036	4.3	1.711	0.017	9.9	2.709	0.101
1.6	1.478	0.004	7.2	1.990	0.036	4.4	1.696	0.017	10.0	2.560	0.102
1.7	1.483	0.004	7.3	2.047	0.038	4.5	1.694	0.019	10.1	2.573	0.106
1.8	1.497	0.004	7.4	2.071	0.039	4.6	1.710	0.018	10.2	2.512	0.110
1.9	1.500	0.005	7.5	2.174	0.041	4.7	1.728	0.019	10.3	2.061	0.103
2.0	1.500	0.005	7.6	2.059	0.041	4.8	1.736	0.021	10.4	2.569	0.122
2.1	1.513	0.006	7.7	2.091	0.043	4.9	1.754	0.021	10.5	2.759	0.134
2.2	1.520	0.006	7.8	2.093	0.044	5.0	1.794	0.019	10.6	2.333	0.126
2.3	1.532	0.006	7.9	2.177	0.046	5.1	1.827	0.020	10.7	2.600	0.142
2.4	1.526	0.007	8.0	2.134	0.046	5.2	1.812	0.021	10.8	3.106	0.169
2.5	1.534	0.007	8.1	2.059	0.048	5.3	1.835	0.021	10.9	2.493	0.152
2.6	1.546	0.008	8.2	2.223	0.050	5.4	1.873	0.021	11.0	2.117	0.144
2.7	1.557	0.008	8.3	2.095	0.051	5.5	1.839	0.022	11.1	2.281	0.161
2.8	1.552	0.009	8.4	2.217	0.053	5.6	1.871	0.022	11.2	2.052	0.155
2.9	1.588	0.009	8.5	2.278	0.055	5.7	1.842	0.024	11.3	2.189	0.171
3.0	1.576	0.009	8.6	2.199	0.056	5.8	1.849	0.024	11.4	2.880	0.200
3.1	1.560	0.009	8.7	2.219	0.059	5.9	1.845	0.025	11.5	1.680	0.200
3.2	1.590	0.010	8.8	2.259	0.061	6.0	1.901	0.026	11.6	2.442	0.230
3.3	1.601	0.011	8.9	2.313	0.064	6.1	1.919	0.027	11.7	2.012	0.230
3.4	1.613	0.011	9.0	2.447	0.067	6.2	1.925	0.027	11.8	2.334	0.250

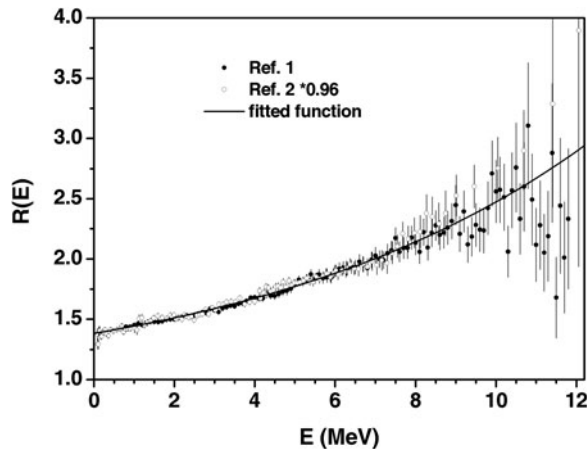


Fig. 1. Absolute ratio ^{252}Cf to ^{235}U PFNS.

were done. The average ratio is given in Table I. We also reduced the uncertainties because we removed the partial contribution due to the standard neutron spectrum.

Our results together with data from Ref. 2 multiplied by a factor of 0.96 are given in Fig. 1. The shape of this dependence according to independent experiments agrees inside the error bars. The total data set (number of points $N = 231$) was described by the function:

$$R(E) = \exp(a_0 + a_1 \cdot E + a_2 \cdot E^2) .$$

Fitted parameters and uncertainties in percents are as follows: $a_0 = 3.244 \times 10^{-1}$ (0.6%), $a_1 = 4.116 \times 10^{-2}$ (3.7%), $a_2 = 1.695 \times 10^{-3}$ (13.0%). The residual deviation per point is $\chi^2 = 1.02$.

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2. B. I. STAROSTOV et al., "The $^{235}\text{U}(n, f)$ Prompt Fission Neutron Spectrum at 100 K Input Neutron Energy," *Proc. 6th Natl. Soviet Conf. Neutron Physics*, Nejtronnaja Fizika, Kiev, USSR, October 10–14, 1983, V. 2. p. 285, 290, 294, EXFOR 40871, 40872, 40873 (1984); see also INDC/CCP-293L.