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NEW RESULTS CN ABSOLUTE MEASUREMENTS OF ^{252}CF PROMPT FISSION NEUTRON SPECTRUM AT THE LOW ENERGY RANGE

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Abstract: Low energy californium neutron spectrum data are determined by use of new, refined neutron detector efficiency values. The efficiency of the neutron detector, that of a 0,95 cm thick NE-912 glass detector, was determined by an independent measurement, where a 0,0835 cm thin glass detector was used as a reference, the efficiency of which was determined by a Monte-Carlo calculation.
A new evaluation of the efficiency of the thick neutron detector results some per cent changes in data compared with those of the earlier evaluations.
The paper contains the new efficiency data for the thick ^{6}Li glass detector and the californium neutron spectrum evaluated by them. This spectrum can be well described by the complex evaporation model spectrum calculated by H.Märten using a/β=0,1 anisotropy value.

The energy spectrum of prompt neutrons from spontaneous fission of ^{252}Cf serves as IAEA proposed standard. The correct measurement of the spectrum required the precious knowledge of the efficiencies of the neutron detectors.

Some years ago we had measured the californium fission neutron spectrum at range of 25 keV-1,22 MeV by time-of-fligth method /1/. Our data were included in Mannhard's evaluated spectra /2/. However, there was some inconsistency between our data and those of Blinov et al./3/ and of Poenits et al./4/ in the energy range 125-315 keV. Therefore data in this range some data in this energy range have been excluded from his evaluation.

A relatively thick, 0,95 cm glass scintillator was applied in our time-of--flight integral neutron spectrum measurement for detection of neutrons. However, due to multiple scattering event, the neutron detection efficiency of this detectors can not be obtained directly from the elementary 6Li(n,) cross section values. therefore an independent measurement /5/ was performed for determination of the absolute efficiency values of our NE-912 glass detector. Namely a thin (0,0835 cm) NE-908 glass scintillator served as a standard detector, the efficiency of which was determined by Monte-Carlo calculation.

The detailed control analyses have revailed errors at several energy values in the earlier MC efficiency calculation. The results of the new, more detailed MC calculations, performed at the Institute of Physics and Power Engineering, Obninsk, are shown in Fig.1, where the correction factors, are shown. They express the multiple scattering efficiency effects relative to the efficiencies for the pure ^{6}Li(n,α) reactions.

The increase of efficiency in the energy range of 20-150 keV is small, 3-3,5 %, but at higher energies it can be go up to 18 %, as it is at 440 keV due to the scattering resonance of oxigen.

These results agree with those of

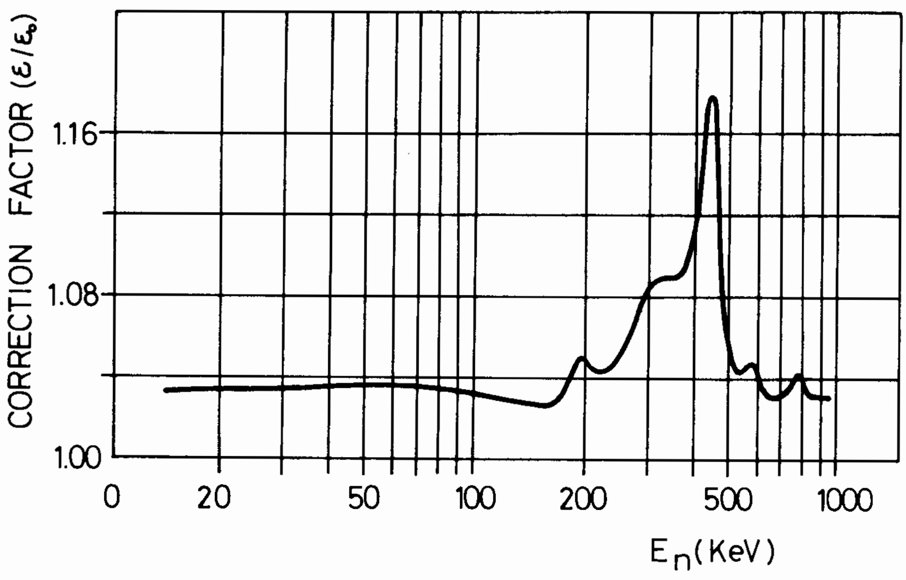

Fig.1 Efficiency correction factors for the thin ^{6}Li glass detector (Monte Carlo calc.)

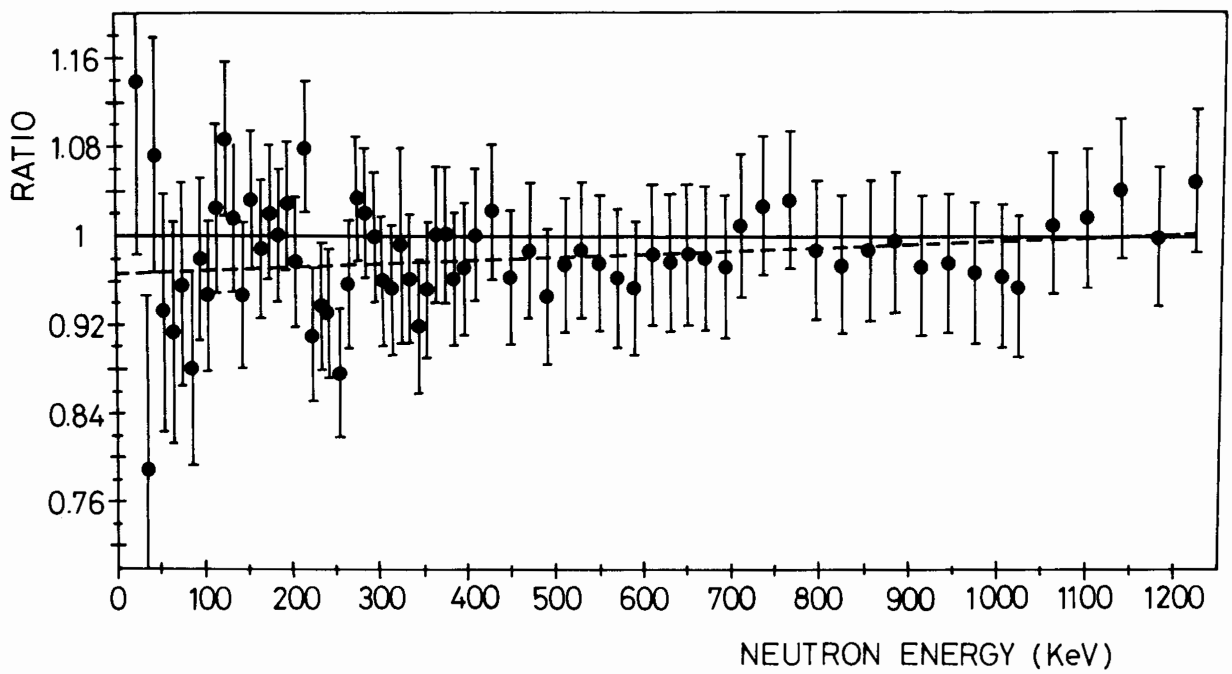

Fig.2 Ratio of californium neutron spectrum to a Maxwellian distribution with temperature of 1,42 MeV. Dashed line is the Märten's calculation.

Table I.

E_n(keV)	N(E)	ERRORS	N(E)/MAXW (T=1.42)	EFFICIENCY (%)	ERRORS
25	3.530	0.48	1.140	1.748	0.079
35	2.870	0.46	0.790	1.609	0.051
45	4.406	0.48	1.075	1.505	0.044
55	4.200	0.45	0.934	1.444	0.043
65	4.435	0.44	0.913	1.389	0.040
70	4.962	0.45	0.958	1.318	0.039
85	4.834	0.43	0.883	1.305	0.038
95	5.640	0.41	0.981	1.331	0.039
105	5.688	0.39	0.948	1.341	0.039
115	6.402	0.47	1.028	1.388	0.074
125	7.032	0.47	1.089	1.459	0.079
135	6.786	0.45	1.018	1.558	0.085
145	6.495	0.42	0.947	1.672	0.091
155	7.308	0.46	1.038	1.860	0.101
165	7.140	0.44	0.990	2.103	0.114
175	7.546	0.45	1.023	2.473	0.134
185	7.545	0.44	1.002	2.919	0.158
195	7.914	0.46	1.031	3.523	0.192
205	7.674	0.44	0.979	4.264	0.226
215	8.587	0.49	1.080	5.256	0.213
225	7.354	0.43	0.911	5.887	0.321
235	7.695	0.44	0.939	6.580	0.356
245	7.749	0.45	0.933	6.641	0.360
255	7.391	0.43	0.879	6.211	0.337
265	8.167	0.47	0.959	5.497	0.230
275	8.918	0.52	1.035	4.900	0.263
285	8.907	0.53	1.022	4.257	0.230
295	8.798	0.51	1.000	3.635	0.198
305	8.538	0.50	0.961	3.208	0.174
315	8.551	0.50	0.954	2.904	0.158
325	8.984	0.53	0.994	2.585	0.141
335	8.771	0.52	0.962	2.343	0.128
345	8.454	0.50	0.920	2.147	0.117
355	8.831	0.53	0.954	1.981	0.108
365	9.357	0.56	1.004	1.848	0.101
375	9.404	0.56	1.003	1.745	0.095
385	9.075	0.55	0.962	1.679	0.091
395	9.192	0.55	0.970	1.565	0.085
410	9.577	0.56	1.001	1.495	0.080
430	9.888	0.59	1.024	1.375	0.075
450	9.393	0.55	0.964	1.313	0.071
470	9.712	0.62	0.989	1.114	0.061
490	9.362	0.56	0.947	1.001	0.054
510	9.697	0.57	0.975	0.902	0.049
530	9.889	0.60	0.989	0.844	0.046
550	9.770	0.58	0.976	0.762	0.041
570	9.711	0.58	0.963	0.736	0.041
590	9.667	0.59	0.955	0.726	0.039
610	9.982	0.61	0.985	0.684	0.037
630	9.938	0.61	0.978	0.657	0.035
650	10.020	0.63	0.985	0.633	0.035
670	9.983	0.62	0.980	0.623	0.034
690	9.924	0.65	0.974	0.605	0.033
710	10.296	0.64	1.011	0.562	0.031
735	10.467	0.65	1.028	0.540	0.029
765	10.509	0.63	1.033	0.526	0.027
795	10.032	0.62	0.988	0.543	0.030
825	9.881	0.62	0.976	0.544	0.030
855	9.970	0.63	0.988	0.538	0.029
885	10.013	0.62	0.996	0.531	0.029
915	9.768	0.62	0.974	0.531	0.029
945	9.755	0.62	0.978	0.530	0.029
975	9.597	0.59	0.969	0.533	0.029
1005	9.516	0.59	0.966	0.535	0.030
1020	9.401	0.59	0.958	0.529	0.030
1060	9.864	0.61	1.014	0.528	0.029
1100	9.822	0.62	1.019	0.510	0.028
1140	9.985	0.62	1.046	0.515	0.028
1180	9.486	0.59	1.005	0.512	0.028
1220	9.820	0.60	1.053	0.511	0.028

B.J.Allen et al./7/, of W.P.Poenitz et al. /8/ and of G.P.Lamase et al./9/ at energies where they had made calculations. In these new calculations all constituents of the NE 908 thin glass detector ^{6}Li, ^{7}Li, Si,O,Al,Mg,Ce) are included and the results show 1-10 % deviations from the earlier ones.

The changes in the standard efficiency values have naturally effect on the efficiency of the thick NE-912 glass detector, therefore, on the evaluation of the fission neutron energy spectrum. The energy dependence of the energy spectra of neutrons, efficiencies of the thick NE-912 glass detector with their estimated errors are shown in Table 1.

The comparision of the measured energy spectra with a Maxwell-distribution of T=1,42 parameter can be seen in Fig.2. The results of Märten's /10/ complex evaporation model calculation using a β=0,1 anisotropy value are shown by dashed line. As it can be seen, the measured spectra with exception of some points agrees well with the calculation.

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