DESCRIPTION OF PECULARITIES OF PROMPT FISSION NEUTRON SPECTRUM IN SPONTANEOUS FISSION OF ^{252}Cf

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^{252}Cf is the model object in theoretical and experimental studying of prompt fission neuton spectrum in the both spontaneous and induced fission of heavy nuclei. However, the form of spectrum observed has not been clearly undestood especially in the region of lower ($\lesssim 1MeV$) and higher ($\gtrsim 10MeV$) energies. The last compiled data [1] are frequently used as a standart for the test of theoretical prescriptions of the neutron spectrum in spontaneous fission of ^{252}Cf . As can seen from the related literature that even the most sophisticated calculations, for instance [2], have tried to explain all the pecularities of the observed data by some difficulties through the complex considerations in their work. Within this context the motivation behind the present work, unlike the previous reports, is to clarify such pecularities in a simple but explicit manner using the evaporation mechanism of neutron emission from fully accelereated two complementary fission fragments having asymmetric mass distribution.

The laboratory spectrum of neutrons from average light ($\bar{A}_L = 108$) and average heavy ($\bar{A}_H = 144$) fragment is expressed by

$$N(E) = \int_{(\sqrt{E}-\sqrt{E_f})^2}^{(\sqrt{E}+\sqrt{E_f})^2} \frac{\varphi(\varepsilon)d\varepsilon}{4\sqrt{\varepsilon E_f}}$$

where ε and E are kinetic energies of neutron in the the center mass system of the fragment and in the laboratory system, respectively, while $\varphi(\varepsilon)$ is the center of mass neutron spectrum together with E_f being the fission fragment kinetic energy per nucleon. We use two different model functions for $\varphi(\varepsilon)$, dictated with the effects of neutron cascade emission and the initial excitation energy distribution of fission fragments on the emission spectrum [3]. These model functions are

$$\varphi_1 = c_1\varepsilon^{\lambda}e^{-\varepsilon/T_1}, \qquad \varphi_2(\varepsilon) = c_2(\varepsilon+\alpha)^{1/2}e^{-\epsilon/T_2}$$

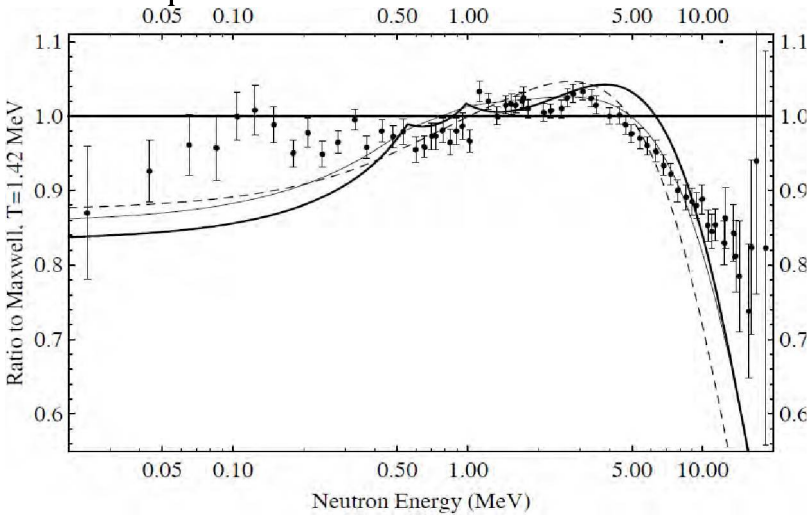
where c_1, c_2 are the normalisation constants defined by $\int_0^{\infty}\varphi(\varepsilon)\,d\varepsilon = 1$ and λ, T_1 together with α, T_2 are the corresponding model parameters which are determined (except λ) by the observed neutron average energy ($\bar{\varepsilon}_{exp}$) and energy dispertion ($\sigma^2 \approx 0{,}75\bar{\varepsilon}^2$) through the theoretical relations

$$\bar{\varepsilon} = (1+\lambda)T_1 = (3/2)T_2 - \alpha, \qquad \sigma^2 = (3/2)T_2^2$$

The exact values of $\bar{\varepsilon}_{exp}$ are taken from [4].Moreover, the λ values are used in two different versions as in [5], namely $\lambda = 5/11$ [6] for the both fragments and the other values determined in the experiment [7]. The necessary E_f values are also taken from [8]. The table below illustrates deduced parameter values used in the calculation of labaratory spectrum of neutrons from the light and heavy fragments and description of curves of followed calculated total spectra.

	$\bar{\varepsilon}_{exp}$, MeV	$\lambda; T_1$ (MeV) [6]	$\lambda; T_1$ (MeV) [7]	α, MeV	T_2, MeV	E_f, MeV
Light fragment	1,42	5/11; 0.976	0.38; 1.029	0,086	1,004	0,984
Heavy fragment	1,3	5/11; 0,89	0.35; 0,963	0,079	0,919	0,553
Total spectrum		Dashed curve	Thin solid curve	Thick solid curve		

Also, the calculated total neutron spectrum averaged over the the light and heavy fragment spectra with equal weights are shown below in the figure in comparision with the experimental data. The spectra are presented as ratio to the Maxwellian with $T = 1{,}42MeV$. As seen from the graph, the main pecularity of the observed spectrum in the energy range 0,5-3 MeV is well described by the model calculations reflecting the center of mass softening effect. The excess of slow neutrons drifting with the fragments contributes to the regions $E \sim 0{,}5\ MeV$ and $\sim 1MeV$ of the observed spectrum.



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