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Analysis of γ-ray intensities from ^{56}Fe(n_{th},γ) reaction within the statistical model

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Decay properties of nuclear states in the region of high nuclear level density (NLD) are usually described within the statistical model of nucleus using the NLD and photon strength functions (PSFs) for transitions of different types and multipolarities. Sufficiently high NLD is reached at relatively low excitation energies in many medium-weight and heavy nuclei but in lighter nuclei (with mass $A \sim 30 - 100$) the NLD is still not very high even near the neutron separation energy S_n. Despite this fact the statistical model of the nucleus is used for description of decay of states near, and often well below S_n in these nuclei.

In the mentioned mass range information on PSFs for γ-ray energies well below S_n comes mainly from charged-particle induced reactions, analyzed using Oslo method~\cite{Schiller00}. Data analyzed with this method show that the PSFs should significantly decrease with E_γ for E_γ
$lesssim 3 - 4$ MeV. This feature is known as a strong low-energy enhancement (LEE) of PSFs and was for the first time reported in Fe nuclei~\cite{Voinov04}. Results from Oslo method were supported by two-step γ cascade data following thermal neutron capture measured at Budapest~\cite{Voinov04}. However, the data from this experiment can easily be contaminated by presence of soft bremsstrahlung induced by extremely intense primary transitions \cite{Becvar07} that may mimic the effect of LEE.

In practice, the LEE has been so far reported only from a very limited number of techniques other than Oslo method, although it is supported from shell model calculations that predict it in magnetic-dipole ($M1$) transitions~\cite{Schwengner13,Brown14,Mitbo18}. Any independent experimental confirmation of LEE is thus desired especially as data from radiative thermal neutron capture in Mo isotopes – where the LEE was also reported from Oslo data – seem inconsistent with any strong enhancement~\cite{Krticka08,Sheets09,Walker15}.

Almost complete decay scheme of ^{57}Fe, with more than 99% of intensity in placed transitions was published from radiative capture of thermal neutrons on ^{56}Fe several years ago~\cite{Firestone17}. In this contribution we present tests of a compatibility of these experimental data with several PSFs and NLD models. The main limitations of analysis come from expected fluctuations of individual transition intensities – they are believed to fluctuate according to Porter-Thomas distribution (PTD) around an E_γ-dependent expectation value \cite{Porter56}. The PTD predicts many transitions with low intensities, which may escape detection and a threshold for observation of transitions thus has to be considered in any analysis within the statistical model of nucleus. Several different observables from ^{56}Fe(n,γ) reaction can be checked against predictions from simulations.
Special interest is paid to primary transitions, that are relevant for the radiation cross section.

In addition, a new detailed analysis of two-step γ cascade spectra from ^{56}Fe(n,$\gamma\gamma$), re-measured at Nuclear Physics Institute at \v{R}e\v{z}, has been also made. A comparison of the results from this experiment will be presented too.

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