

U-TH FUEL CYCLE NEUTRON DATA

Vladimir M. Maslov¹, Mamoru Baba², Akira Hasegawa³, Nikolai V. Kornilov⁴,
Alexander B. Kagalenko⁴, Natalia A. Tetereva¹

¹ *Joint Institute for Nuclear and Energy Research - Sosny, 220109, Minsk-Sosny, Belarus*

² *Cyclotron and Radioisotope Center, Tohoku University, Sendai, Japan*

³ *Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken*

⁴ *Institute of Physics and Power Engineering, Obninsk, Russia*

Neutron data files of main nuclides of U-Th fuel cycle: ^{232}Th , ^{232}U , ^{233}U , ^{234}U , ^{231}Pa and ^{233}Pa are evaluated based on a full-scale Hauser-Feshbach theory, the basic constraint is the observed fission cross section description from $\sim\text{keV}$ to 20 MeV. Direct excitations for the ground state band, $\beta(\gamma)$ -vibration ($K^\pi = 0^+, 2^+$) as well as octupole ($K^\pi = 0^-$) band levels were calculated within coupled channels approach. Extended recently measured database on ^{238}U inelastic scattering contributed to fixing the model parameters. A model of soft, deformable rotator is used for the description of the collective vibrational-rotational states of even-even U and ^{232}Th . Collective levels of ^{238}U , ^{232}U , ^{234}U and ^{232}Th for excitations within a pairing gap were identified. Combined analysis of collective levels structure and differential scattering helps to assign the nature of vibrational bands and to define relevant deformation parameters. Levels of $K^\pi = 0^-$ band are defined by octupole deformation parameter β_3 and parameter μ_ξ of softness to the octupole vibrations. When angular distribution ^{238}U data are fitted with β_3 -parameter, level positions are kept unaffected with softness parameter μ_ξ . Experimental cross section data for the groups of octupole band levels of ^{238}U helped to define β_3 - and μ_ξ -values, the former are adopted for ^{232}Th and other U nuclei. Levels of second and third $K^\pi = 0^+$ bands are classified as quadrupole transversal γ - vibrations or longitudinal quadrupole β - vibrations. Both are defined by μ_β and μ_γ , softness parameters to respective vibrations. Anomalous rotational $K^\pi = 2^+$ γ - band levels are defined by non-axiality parameter γ_o which is correlated with different positions of $K^\pi = 2^+$ levels in ^{238}U , ^{234}U , ^{232}U and ^{232}Th . The rigid rotator optical model potential is also obtained. Prompt fission neutron spectra (PFNS) were calculated with the model [1], validated in case of ^{238}U and ^{232}Th PFNS data. Basically that is a “two-fragment” model, which takes into account contribution of neutrons, emitted in (n,xnf) reactions and reproduces their dependence on the target nuclide fissility.

Average unresolved resonance parameters, fast neutron cross sections, angular distributions and secondary neutron spectra differ very much from previous evaluations.

International Science and Technology Center under Project Agreement B-404 supported research.

References

- [1] V.M. Maslov et al., EuroPhysics Journal A, 18 (2003) 93.