NUCLEAR LEVEL DENSITIES OF ^{47}V, ^{48}V, ^{49}V, ^{53}Mn, ^{54}Mn FROM NEUTRON EVAPORATION SPECTRA

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Abstract

Nuclear level density is an area of considerable interest in nuclear physics being very important for the creation of consistent theoretical description of excited nucleus properties and in making nuclear reaction cross-section calculations in the framework of statistical model for many branches of nuclear physics, nuclear astrophysics and applied areas. The general features of nuclear level density are known, but there are a considerable uncertainties of its functional forms conditioned by the shell inhomogeneity of a single-particle state spectrum, residual interaction, coherent effects of collective nature et al. The required accuracy of level density knowledge for nuclear cross-section calculation problems is ~ 10% in a wide range of excitation energy from 0.1 MeV to 20 MeV, and the existing data are often differed in (1.5-2) times. The experimental data on the nuclear level densities for many nuclei are derived, in the main, from the analysis of neutron resonance data and low-lying states. But this information is limited to rather narrow regions of excitation energy and spin, and its extrapolation can lead to essential errors both in absolute value of nuclear level density and its energy dependence, especially, in transition field from well-identified discrete states to continuum part of excitation spectrum. Obviously, it is necessary to attract other experimental methods of nuclear level density determination with scope of more wide ranges of excitation energy and spin. One of the information sources on nuclear level density in a range between the discrete states and the neutron binding energy are the spectra of particles emitted in nuclear reactions. In this case the type of reaction and the energy of incident particles should be choosen so that the contribution of nonequilibrium processes was minimum. These conditions are satisfied with the (p,n) reaction at proton energy up to 11 MeV. In the present work neutron spectra from (p,n) reaction on nuclei of ^{47}Ti, ^{48}Ti. ^{49}Ti, ^{53}Cr, ^{54}Cr have been measured at proton energies between 7 and 11 MeV. The measurements of neutron spectra were performed by time-of-flight fast neutron spectrometer on the pulsed tandem accelerator EGP-15 of IPPE. The high resolution and stability of time-of-flight spectrometer allowed to identify reliably the discrete low-lying levels together with continuum part of neutron spectra. Analysis of the measured data have been carried in the framework of statistical equilibrium and pre-equilibrium models of nuclear reactions. The calculations are done using the exact formalism of the statistical theory as given by Hauser-Feshbach with the generalized superfluid model of nucleus, the back-shifted Fermi-gas model and the composite formula of Gilbert-Cameron for nuclear level density. The nuclear level densities of ^{47}V, ^{48}V, ^{49}V, ^{53}Mn, ^{54}Mn, their energy dependences and model parameters have been determined. The obtained results have been discussed in totality with existing experimental and model systematics data.