Study of neutron emission in nuclear system decay for ^{1}H, ^{2}H, ^{4}He, and ^{12}C - Pb collisions at 1-2 AGeV

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Neutron double differential cross sections for interactions of 1-AGeV ^{2}H and ^{4}He, and 2-AGeV ^{1}H and ^{12}C ions with Pb nuclei were measured by the TOF method in angular range of the target nucleus fragmentation above 30°. The Moving Source Model (MSM) with four independent sources is applied with a purpose to reproduce the experimental data. The number of the sources corresponds to the number of main decay processes with neutron emission at GeV energies: the cascade stage in (1) peripheral and (2) central collisions, (3) neutron ejection in the fragmentation of high excited remnant occurring after the cascade in central collisions, and (4) the evaporation stage. Also the model is used in analysis of some available experimental data on neutron production in *p*-Pb collisions at intermediate energies. Fitting of the experimental data by the model expression allows to reach a perfect description of the neutron double differential cross sections. The source contributions, temperatures and velocities are studied as functions of the proton energy and the projectile mass. The source temperatures do not depend on energy and type of projectile nucleus. The third source temperature is 4.7 MeV and this value is in good agreement with the results obtained in the IMF emission studies. The comparison of the temperature and velocity parameters shows that probably the neutron and IMF sources have the same origin. The temperature found for the evaporation stage is slightly higher of typical values for the low energy reactions. Integration of the double differential cross sections over solid angle and energy allows to estimate the different source contributions to the mean neutron multiplicity. The mean neutron multiplicity obtained by this method for reactions of ^{1}H, ^{2}H, ^{4}He, ^{12}C projectiles with Pb nuclei are 21.8 ± 3.4, 17.1 ± 3.4, 22.5 ± 3.5, and 29.1 ± 4.5 neutrons per reaction respectively. The neutron ejection in the fragmentation process gives the relative contribution of 20-26%. The analysis performed for *p*-Pb interaction shows a saturation of the mean neutron multiplicity with proton energy above 1 GeV. Simultaneously relative fractions of the proton energy coming to the neutron kinetic energy and the total energy of neutron production reach levels of ~31% and ~40% respectively and they have very small dependence on energy above 1 GeV.