Investigation of the mechanism of proton induced spallation reactions

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Abstract The mechanism of proton-nucleus interactions at GeV energies is still not well understood. The agreement between data and model predictions deteriorates with increasing beam energies and for the forward angles. This indicates the presence of preequilibrium processes which are not taken into consideration by present theoretical models. New experimental data are needed to put constraints to any new model of the reaction mechanism. The measurements are planned to be done to study proton induced reactions at energies in the range from 70 to 230 MeV.

1 Introduction

The spallation reactions have a wide range of applications in many fields of science and technology, e.g. astrophysics, material science, hybrid nuclear reactors, production of rare isotopes for medical purposes. All these applications are based on the knowledge of the spallation cross sections, which frequently cannot be obtained experimentally but has to be determined from theoretical models which in turn must be tested by experimental data. Possible nonequilibrium processes are presented schematically in fig. 1 together with the intranuclear cascade mechanism which is a standard part of the present day models. To proof reliability of the new theoretical models it is necessary to compare their predictions with inclusive and coincidence cross sections of proton induced reactions on several nuclear targets at various beam energies. The present project concerns such measurements to be done with the proton beam in the energy range from 70 MeV to 230 MeV.

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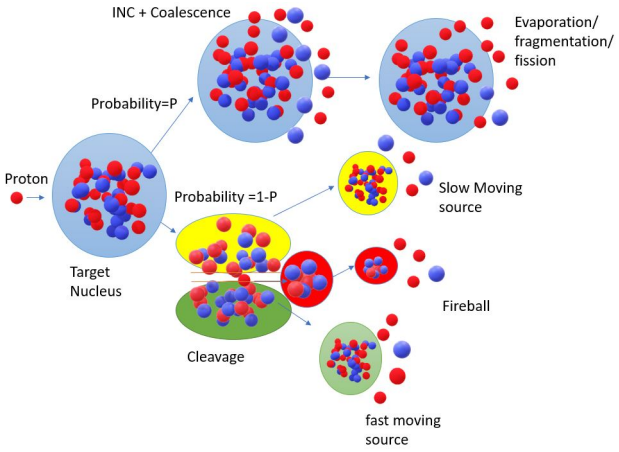

Fig. 1 Possible modes of the spallation reactions. The proton of the beam impinging on to the target nucleus initiates with probability P the intranuclear cascade of nucleon-nucleon and pion-nucleon collisions (present day models) or may induce with probability 1-P a cleavage of the target nucleus into three excited groups of nucleons: the smallest - fireball and two larger - the fast and slow moving sources (possible preequilibrium processes).

2 Investigations

It is planned using the new PROTEUS cyclotron of the Cyclotron Centre Bronowice, to measure the single spectra $d\sigma/d\Omega dE$ and coincidence spectra $d\sigma/d\Omega_1 dE_1 d\Omega_2 dE_2$ of LCP (i.e. $^{1-3}$H, ^{3,4}He) and IMF (i.e. ^{6}He,Li,Be,B,C,N,O.. ions) in proton induced reactions on various target nuclei (Al, Ni, Ag, Au). The experiment will be performed at different beam energies (70 - 230 MeV). The KRATTA [**?**](Krakow Triple Telescope Array) detection system can be used to measure the energy, angle of emission and isotopic composition of LCP and IMF. The main goal of the present experiment is to investigate experimentally the hypothesis presented above i.e. the presence of the “fireball” contribution to the reaction mechanism.