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SEARCH FOR BREMSSTRAHLUNG RADIATION IN QUASI-FREE $NP \rightarrow NP\gamma$ REACTIONS

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Due to the high sensitivity of the $NN \rightarrow NN\gamma$ reaction to the nucleon – nucleon potential, Bremsstrahlung radiation is used as a tool to investigate details of the nucleon – nucleon interaction. Such investigations can be performed at the cooler synchrotron COSY in the Research Centre Jülich, by dint of the COSY–11 detection system.
The results of the identification of Bremsstrahlung radiation emitted via the $dp \rightarrow dp\gamma$ reaction in data taken with a proton target and a deuteron beam are presented and discussed.

Keywords: Bremsstrahlung radiation.

The installation of a neutron detector at the COSY-11 facility [1,2] enables to study a plethora of new reaction channels. It opens wide possibilities not only to investigate the isospin dependence of the meson production [3], but also to measure the Bremsstrahlung radiation created in the collisions of nucleons. The study of the latter process is interested since it is highly sensitive to the kind of the nucleon-nucleon potential, and hence may serve as a tool to discriminate between various existing potential models [4,5]. Although Bremsstrahlung radiation has been studied since many years, it is still the subject of interest of many theoretical and experimental groups [4,5,6,7].
At the COSY–11 experiment a signal from γ–quanta was observed in the time–of–flight distribution for the neutral particles measured between the target and the neutral particle detector [2]. This encouraged us to analyse the data in view of the Bremsstrahlung radiation in a free $dp \rightarrow dp\gamma$ and a quasi–free $np \rightarrow np\gamma$ reactions. Data have been taken using a proton target and a deuteron beam with a

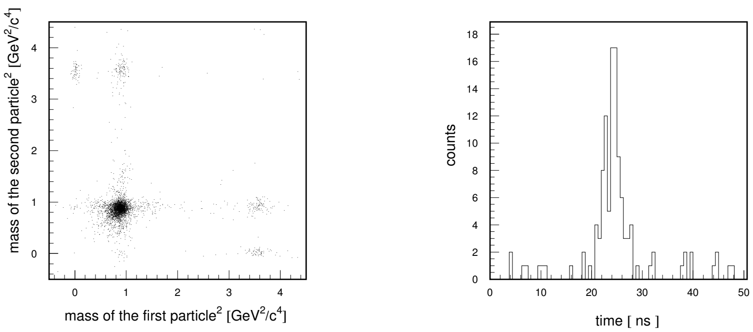

Fig. 1. **(left)** Scatter plot of invariant masses determined for events with two charged particles measured in coincidence. **(right)** Time–of–flight distribution obtained under assumption that additionally to a signal an in the neutron detector, one proton and one deuteron were identified.

momentum close to the threshold of the $dp \rightarrow dp\eta$ process. Events corresponding to the $dp \rightarrow dp\gamma$ and $dp \rightarrow ppn\gamma$ reaction have been identified by measuring the outgoing charged as well as neutral ejectiles. The protons and deuterons are detected by means of drift chambers and scintillator hodoscopes while neutrons and photons are registered in a scintillator–lead sandwich type detector. The momentum vectors of the charged ejectiles are reconstructed by tracking back the trajectories to the target point [1]. In case of a neutron the time–of–flight between the target and the neutral–particle–detector together with the known position of the hitted detection unit enables to determine its four–momentum vector [8].
In order to identify the $dp \rightarrow dp\gamma$ reaction events with two tracks in the drift chambers and a simultaneous signal in the neutron detector have been selected. In fig.1 (left) the squared mass of one particle is plotted versus the squared mass of the other registered particle. Based on this figure the measured reactions can be grouped according to the type of ejectiles. Thus reactions with two protons, proton and pion, proton and deuteron, and pion and deuteron can be clearly selected. Next the distribution of the time–of–flight between the target neutron detector was determined with requirement that one of the charged particles was identified as a proton and the other as a deuteron. Due to the baryon number conservation, gamma quanta are the only one possible source of a signal in a neutron detector. Indeed a clear peak around the time corresponding to the time–of–light of the light is visible (see fig.1 right). The gamma quanta may originate from Bremsstrahlung reaction or from the decay of produced mesons eg. via the $dp \rightarrow dp\pi^0 \rightarrow dp\gamma\gamma$. It is possible to distinguish between these hypothesis calculating the missing mass produced in the $dp \rightarrow dpX$ reaction. Fig.2 left shows the distribution of the squared missing mass as obtained for the $dp \rightarrow dpX$ reaction. A significant peak around 0 MeV^2/c^4 — the squared mass of a gamma quanta — constitute an evidence for events associated to the deuteron–proton bremsstrahlung. In addition a broad structure at

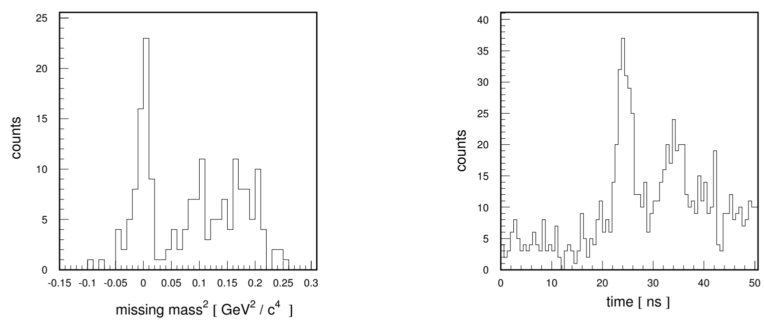

Fig. 2. **(left)** Distribution of the squared missing mass for the $dp \rightarrow dpX$ reaction. **(right)** Time–of–flight distribution obtained under assumption that additionally to a signal an in the neutron detector, two protons were identified.

higher masses originating from two pions emmited from reaction $dp \rightarrow dp\pi^0\pi^0$ or two gamma quanta from $dp \rightarrow dp\gamma\gamma$ reaction is visible. The extraction of the total cross section of the $dp \rightarrow dp\gamma$ reaction requires the luminosity and acceptance determination, which will be performed in the near future. The analysis of the $dp \rightarrow np\gamma p_{sp}$ reaction is more complicated, however in this case all three baryons, namely two protons and neutron can be measured in the drift chambers and in the neutron detector, respectively. Fig.2 (right) presents the time–of–flight with the condition that in coincidence with a neutral particle also two protons were identified. A clear signal originating from gamma quanta is seen at a time value of 24 ns which coresponds to the velocity of light. Using the missing mass technique, it might be possible to verify if gamma quanta originate from the direct $dp \rightarrow np\gamma p_{sp}$ reaction. At present the data analysis is in progress.

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